Threatened Species Program

Rainforest dependent threatened fauna of Kroombit Tops National Park Recovery Action Plan 2025-2035

Queensland Government

Prepared by: Threatened Species Operations, Wildlife and Threatened Species Operations, Department of the Environment, Tourism, Science and Innovation

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Cover photo: Kroombit tinkerfrog (top), Kroombit treefrog (middle) and Monteith's spiny crayfish (bottom), Harry Hines 2023.

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INTRODUCTION

The '*Rainforest dependent threatened fauna of Kroombit Tops National Park Recovery Action Plan'* was developed as part of the Queensland Department of the Environment, Tourism and Science (the Department) Threatened Species Program 2020–2040 framework. It provides the strategic management direction for the recovery of the Kroombit tinkerfrog (*Taudactylus pleione),* Kroombit treefrog *(Litoria kroombitensis),* and Monteith's spiny crayfish (*Euastacus monteithorum)*, which are all dependent upon rainforest ecosystems in the eastern part of Kroombit Tops National Park (KTNP).

The plan identifies the key threats that impact these species and sets out the recovery actions needed to address these threats and facilitate their recovery in Queensland. The goals, objectives and actions under this plan have been based on the best available information and developed in collaboration with key stakeholders.

The adaptive management approach that underpins this Recovery Action Plan (RAP) ensures that decision making, and the most effective management interventions are used in the recovery effort for the long-term.

Successful implementation of the recovery actions depends on the commitment and cooperation of all relevant stakeholders. The delivery of actions identified in the plan is a shared responsibility and one that is achieved through a collaborative and participatory approach. This document is non-statutory and does not bind any one potential contributor to resourcing or implementing the plan.

This RAP was approved by the Department and is subject to modification as dictated by new findings, changes in the status of these species, and the completion of recovery actions. Information in this RAP was accurate as of February 2025.

Term and review date

Timeframe: 10 years from 2025 to 2035

Review date: 5 years 2030

For further information on this or other Recovery Action Plans please contact Threatened.Species@des.qld.gov.au.

Acronyms and Abbreviations

AOO Area of Occupancy

CWS Currumbin Wildlife Sanctuary

DETSI Department of the Environment, Tourism, Science and Innovation

EOO Extent of Occurrence

EPBC *Environment Protection and Biodiversity Conservation Act 1999*

NCA *Nature Conservation Act 1992*

PCCC Port Curtis Coral Coast Trust

QPWS Queensland Parks and Wildlife Service

RE Regional Ecosystem

RAP Recovery Action Plan

SEQR QPWS South East Qld Region

EXECUTIVE SUMMARY

Species Summary

Species	Conservation Status		Distribution and Population
	NCA	EPBC	
Kroombit tinkerfrog *Taudactylus pleione*	Critically Endangered	Critically Endangered	Persists in very low numbers in two small, connected rainforest patches in the headwaters of Degalgil Creek, below the escarpment. Extent of occurrence (EOO) ≈ 5.2km² Area of occupancy (AOO) ≈ 20km² Habitat area ≈ 0.66km²
Kroombit treefrog *Litoria kroombitensis*	Critically Endangered	Critically Endangered	Known from Kroombit, Three Moon and Munholme Creeks, restricted and naturally fragmented distribution. Occurs in rainforest and adjoining wet sclerophyll forest between 550m and 900m elevation. EOO ≈ 32km² AOO ≈ 16km²
Monteith's spiny crayfish *Euastacus monteithorum*	Endangered	Endangered	Occurs in the headwaters of Kroombit, Munholme and Three Moon creeks on the Kroombit plateau and Degalgil, Diglum and Madsen creeks below the eastern escarpment. EOO ≈ 29km² AOO ≈ 48km² Disjunct very poorly known subpopulation occurs in the Mount Robert section of Dawes National Park, extending the total EOO to 112km². Most of the environment within the EOO is highly unsuitable for the species

Threats

Threats affecting the three threatened species are:

- **Critically small population size and poor genetic health.**
- **Climate change**: including increasing temperatures, declining rainfall, reduced precipitation from 'cloud stripping', increased severe drought and fire weather and climate driven change to vegetation structure and composition.
- **Feral pigs**: including predation, and habitat disturbance, degradation, and loss.
- **Cattle and horses**: including habitat disturbance and degradation.
- **Disease**: Amphibian chytridiomycosis currently impacting Kroombit tinkerfrog and Kroombit treefrog. Future risk includes diseases such as ranaviruses (Kroombit tinkerfrog and Kroombit treefrog) and crayfish plague (*Aphanomyces astaci* specifically for Monteith's spiny crayfish).
- **Adverse fire regimes**: including fire incursion into fire sensitive rainforest habitat, and inappropriate fire regimes in fire adapted riparian habitat.
- **Invasive weeds**: including ecosystem changing weeds currently impacting rainforest habitat such as Lantana (*Lantana camara)*, and invasive weeds that pose a future risk to rainforest habitat such as thatch grass (*Hyparrhenia rufa)* and guinea grass (*Megathyrsus maximus)*.

Vison Statement

‘By 2050 there are self-sustaining populations of Kroombit tinkerfrogs, Kroombit treefrogs, and Monteith’s spiny crayfish at KTNP. The populations are genetically diverse and occupy resilient habitat. The conservation status of each species has improved. The species are valued by the community, with First Nation’s People and the wider community involved in appropriate management activities.’

Goals

1. Reduce the impacts of small population size to improve the adaptive capacity of the Kroombit tinkerfrog.
2. Reduce impacts of invasive pest species (feral pigs, cattle, and horses, and plants) and fire on the three focal species and their habitat to increase population size and improve habitat condition.
3. Minimise the risk of spreading significant or novel diseases and parasites that are known or likely to impact the three focal species or their habitat to maintain healthy populations.
4. Improve understanding of the population trends of the three focal species to better effect management.
5. Improve understanding of the current genetic population structure and genetic health of each of the three focal species, to inform species management.
6. Improve engagement of key stakeholders and the local community in relation to the management of the three focal species to better effect recovery.

FIRST NATIONS PEOPLE

The Department is committed to progressing self-determination by recognising the rights and interests of First Nations people across Queensland. The *Gurra Gurra Framework 2020–2026* accelerates this commitment by reframing our relationship with First Nations peoples to work in genuine partnership to safeguard ecological and cultural values across Queensland.

The Department acknowledges and respects First Nations peoples’ lived experiences, knowledge, skills and expertise, and seeks to incorporate their perspectives into the policies, programs and systems that guide land and sea management. We commit to work in genuine partnership with First Nations people across Queensland to ensure their vision and knowledge of Country is appropriately reflected in the Threatened Species Program.

Kroombit tinkerfrog occurs on the Bailai, Gurang, Gooreng Gooreng, and Taribelang Bunda People’s traditional land.

Statement from the Bailai, Gurang, Gooreng Gooreng, and Taribelang Bunda People

The Baiai, Gurang, Gooreng Gooreng, and Taribeland Bunda People provided the below statement in relation to the Kroombit tinkerfrog.

> *“The Port Curtis Coral Coast (PCCC) First Nations Elders recognize and acknowledge the active commitment of QPWS in engaging with us to support and reinstate our cultural obligations to care for and protect the inhabitants in the environment in our country.*
>
> *The outcome of the Kroombit tinkerfrog recovery strategy is an extraordinary achievement and demonstration of real and practical care for these small but important inhabitants of our environment, that would ordinarily pass without a second thought once they were gone.*
>
> *We the First Nations People look forward to continuing the journey with QPWS for the revival and restoration of the proper population of the tinkerfrog and other threatened species in this area.”*

RECOVERY ACTION TABLES

Actions identified for the recovery of the rainforest dependent threatened fauna of KTNP during the life of this plan are described in the tables under each of the relevant goals and objectives. The information in the Action Tables should be interpreted as follows:

Factor	Description	1	2	3
Priority	Level of importance of the action	Taking prompt action is necessary to mitigate the threats and ensure the persistence of the species	Action is necessary to mitigate threats and work towards the long-term recovery of the species	Action is desirable, but not critical to recovery at this time but will provide for longer term recovery
Timeframe	Expected time to implement and /or achieve the result	Very short: 1-2 years	Short: 2-5yrs	Medium: 5-10yrs

Cost[1] - *Indicative cost estimate* $1000s; $10,000s; $100,000s; $1,000,000s

Potential Contributors[2] - Identify who leads the action (L). Other contributors (C) are also identified where possible.

Notes

1. Costs do not account for inflation, and do not include standard management activities on conservation estate by the Department that are to be considered as in-kind contribution. If an action is attributed a cost and it is led by the Department then at least a partial in-kind contribution is assumed. The provision of funds necessary to implement actions are subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities.
2. The nominated lead for actions is not necessarily responsible for cost, however the lead should coordinate as necessary to determine source/s of funding for the activity.

Table 1. Recovery Action Tables for the 'Rainforest dependent threatened fauna of Kroombit Tops National Park Recovery Action Plan 2025-2035' lists the goals, objectives, performance indicators and actions for the duration of the plan.

Abbreviations used: CWS = Currumbin Wildlife Sanctuary; DETSI = Department of the Environment, Tourism, Science and Innovation, EAU = Ecological Assessment Unit, TSO = Threatened Species Operations, SEQR = South East Qld Region of QPWS, WTSO = Wildlife and Threatened Species Operations Branch; L = lead; C = contributes.

Goal 1: Reduce the impacts of small population size to improve the adaptive capacity of the Kroombit tinkerfrog.

Objective 1.1: Maintain a genetically diverse captive breeding population of Kroombit tinkerfrogs at CWS for conservation translocations through to 2035.

Performance indicators

- Any Kroombit tinkerfrogs found during targeted surveys of known Diglum and Madsen creek catchment sites have been placed in the captive breeding program.
- The genetic diversity of captively bred Kroombit tinkerfrogs is improved.
- A captively bred population of Kroombit tinkerfrogs is successfully maintained for conservation translocations.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
1.1.1 Collect individuals found at known sites in Diglum and Madsen creek catchments for the Captive Breeding Program.	1	$10,000s	1	DETSI (EAU & TSO) (L), CWS (C), detection dog contractor (C)
1.1.2 Undertake the collection of Kroombit tinkerfrogs for captive breeding in accordance with the approved Translocation Proposal.	1	$10,000s	1	DESTI (EAU & TSO) (L), CWS (C), detection dog contractor (C)
1.1.3 Undertake captive breeding of Kroombit tinkerfrog in accordance with DETSI/CWS agreement and existing captive breeding protocols.	1	$100,000s	3	CWS (L), DETSI (EAU) (C), species experts (C)
1.1.4 Undertake genetic analysis of captive bred animals in accordance with DETSI/CWS agreement to inform management of the genetic diversity of the captive population.	2	$1,000s	2	CWS (L), DETSI (EAU) (C)

Objective 1.2: Increase the subpopulation size and resilience of Kroombit tinkerfrogs in occupied rainforest in Degalgil Creek catchment, through wild to wild and captive to wild translocation through to 2035.

Performance indicators

- Translocations occur under an approved and up-to-date Translocation Proposal.
- An increase in the number of calling male Kroombit tinkerfrogs in the headwaters of Degalgil Creek compared with baseline and control site data.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
1.2.1 Undertake wild to wild translocations between remaining occupied rainforest patches and augment Kroombit tinkerfrog numbers in the headwaters of Degalgil Creek catchment via the release of captive bred animals in accordance with the approved Translocation Proposal.	1	$1000s	2	DETSI (EAU, TSO) (L), CWS (C)
1.2.2 Monitor occupancy or number of calling males in the headwaters of Degalgil Creek catchment annually.	1	$1000s	3	DETSI (EAU, TSO) (L)
1.2.3 Prepare annual reports on the approved Translocation Proposal and submit to WTSO.	2	$100s	3	DETSI (EAU) (L)

Objective 1.3: Re-establish subpopulations of Kroombit tinkerfrogs at previously occupied rainforest patches below the escarpment through to 2035.

Performance indicators

- Establishment of > 2 subpopulations of Kroombit tinkerfrogs in previously occupied rainforest patches.
- An increase in the number of calling male Kroombit tinkerfrogs in the headwaters of Diglum Creek compared with first release numbers.
- An increase in the number of calling male Kroombit tinkerfrogs in previously occupied rainforest patches selected for release of animals compared with first release numbers.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
1.3.1 Release captive bred animals in escarpment rainforest patches in the headwaters of Diglum Creek catchment in accordance with the approved Translocation Proposal.	1	$1000s	2	DETSI (EAU, TSO) (L), CWS (C)
1.3.2 Monitor occupancy or number of calling males in the headwaters of Diglum Creek and any other locations where frogs are released annually.	1	$1000s	3	DETSI (EAU, TSO) (L)
1.3.3 Subject to the success of the release program, continue releasing captive bred animals in the headwaters of Diglum Creek and other previously occupied escarpment rainforest patches in accordance with an approved Translocation Proposal.	2	$1000s	3	DETSI (EAU, TSO) (L), CWS (C)

1.3.4 Prepare annual reports on the approved Translocation Proposal and submit to WTSO to provide an update of the animals released.	2	$100s	3	DETSI (EAU) (L)

Goal 2: Reduce impacts of invasive pest species (feral pigs, cattle, and horses, and plants) and fire on the three focal species and their habitat to increase population size and improve habitat condition.

Objective 2.1: Reduce the impact of feral pigs in currently occupied and previously occupied Kroombit tinkerfrog habitat by 2030 and continue through to 2035. Please note: these sites are also currently occupied Monteith's spiny crayfish.

Performance indicators

- The pig exclusion fences in the headwaters of Degalgil Creek catchment are maintained.
- No evidence of disturbance by feral pigs (trampling, digging and rooting) in fenced occupied Kroombit tinkerfrog habitat using a standardised assessment method.
- Only minor signs of disturbance by feral pigs (trampling, digging and rooting) in all other occupied Kroombit tinkerfrog habitat by 2026 using a standardised assessment method.
- Only minor signs of disturbance by feral pigs (trampling, digging and rooting) in previously occupied Kroombit tinkerfrog habitat below the escarpment by 2035 using a standardised assessment method.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
2.1.1 Inspect and maintain the existing feral pig exclusion fences in the headwaters of Degalgil Creek catchment and eradicate any pig that enter fenced area more than twice yearly.	1	$10,000s	3	DETSI (EAU) (L)
2.1.2 Undertake feral pig control in all occupied Kroombit tinkerfrog habitat 3-4 times a year.	1	$10,000s	1	DETSI (SEQR) (L)
2.1.3 Undertake feral pig control below the escarpment in Degalgil, Diglum, and Madsen creek catchments in all previously occupied Kroombit tinkerfrog and currently occupied Monteith's spiny crayfish habitat 3-4 times per year.	1	$10,000s	2	DETSI (SEQR) (L), FBA (C)
2.1.4 Liaise with Kroombit neighbours to control feral pigs on neighbouring properties below the escarpment and provide access for QPWS to undertake pest control.	2	$100,000s	2	DETSI (SEQR) (L), FBA (C)

Objective 2.2: Reduce the impact of feral pigs in plateau riparian habitat of Kroombit treefrog and Monteith's spiny crayfish by 2035. Please note: these sites cover previously occupied habitat for Kroombit tinkerfrog on the plateau.

Performance indicators

- Only minor signs of disturbance by feral pigs (trampling, digging and rooting) in occupied Kroombit treefrog and Monteith's spiny crayfish habitat on the plateau by 2030 using a standardised assessment method.
- Only minor signs of disturbance by feral pigs (trampling and rooting) in buffer zone around occupied Kroombit treefrog and Monteith's spiny crayfish habitat on the plateau by 2030 using a standardised assessment method.
- Only minor signs of disturbance by feral pigs (trampling, digging and rooting) in unoccupied Kroombit treefrog habitat in Dry and Griffiths creek catchments by 2035 using a standardised assessment method.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
2.2.1 Undertake feral pig control in occupied Kroombit treefrog and Monteith's spiny crayfish habitat in Kroombit, Three Moon and Munholme creek catchments on the plateau.	1	$10,000s	1	DETSI (SEQR) (L), FBA (C)
2.2.2 Undertake feral pig control in buffer zones around occupied Kroombit treefrog and Monteith's spiny crayfish habitat in Kroombit, Three Moon and Munholme creek catchments on the plateau.	2	$10,000s	2	DETSI (SEQR) (L), FBA (C)
2.2.3 Undertake feral pig control in previously occupied Kroombit treefrog habitat in Dry and Griffiths creek catchments on the plateau.	3	$10,000s	3	DETSI (SEQR) (L), FBA (C)

Objective 2.3: Reduce the impact of cattle and horses in plateau riparian areas occupied by Kroombit treefrog and Monteith's spiny crayfish by 2030 and continue through to 2035.

Performance indicators

- Only minor signs of disturbance and overgrazing by cattle and horses at 'indicator' sites of plateau riparian areas in Kroombit, Three Moon and Munholme creek catchments by 2030 with an over-grazing health condition class of at least 'good with some concerns' and maintained until 2035.
- Fenced boundary of KTNP secure by 2030.
- 50% of the estimated numbers of cattle and horses in 2024 are removed from KTNP by 2030.
- 50% of the estimated numbers of cattle and horses in 2030 are removed from KTNP by 2035.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
2.3.1 Undertake cattle and horse control in each of the Kroombit, Three Moon and Munholme creek catchments on the plateau.	1	$100,000s	2	DETSI (SEQR) (L), FBA (C)

2.3.2 Liaise/negotiate with Park neighbours regarding removal of neighbour's cattle and horses from KTNP and the improvement of the boundary fence integrity.	3	$10,000s	3	DETSI (SEQR) (L), FBA (C)
Objective 2.4: Control lantana and other invasive weeds in occupied and previously occupied Kroombit tinkerfrog habitat below the escarpment by 2030 and continue through to 2035.				
Performance indicators • No Lantana or other ecosystem changing weeds in fenced occupied Kroombit tinkerfrog habitat by 2025 and fenced area maintains a pest plant health condition class of 'good' until 2035. • The buffer zone within 500m of occupied Kroombit tinkerfrog habitat in Degalgil Creek catchment maintains suitable vegetation with a pest plant health condition class of at least 'good with some concern' through to 2035. • Other key areas in occupied and previously occupied Kroombit tinkerfrog habitat below the escarpment maintain suitable vegetation to support Kroombit tinkerfrogs with a pest plant health condition class of at least 'good with some concern' by 2035.				
Action	**Priority**	**Indicative cost**	**Timeframe**	**Potential Contributors**
2.4.1 Eradicate lantana (*Lantana camara)* and other ecosystem changing weeds from fenced occupied Kroombit tinkerfrog habitat in Degalgil Creek catchment.	1	$10,000s	1	DETSI (SEQR) (L), FBA (C), First Nations groups (C)
2.4.2 Undertake strategic control of lantana and other ecosystem changing weeds in all other occupied Kroombit tinkerfrog habitat (other than the fenced occupied area) in Degalgil Creek catchment.	2	$10,000s	2	DETSI (SEQR) (L), FBA (C), First Nations groups (C)
2.4.3 Monitor thatch grass (*Hyparrhenia rufa)* within 500m buffer zones of occupied Kroombit tinkerfrog habitat in Degalgil Creek catchment and remove if detected.	2	$10,000s	3	DETSI (SEQR) (L), FBA (C), First Nations groups (C)
2.4.4 Undertake strategic control of lantana and other ecosystem changing weeds in all previously occupied Kroombit tinkerfrog habitat below the escarpment.	3	$10,000s	3	DETSI (SEQR) (L), FBA (C), First Nations groups (C)

Objective 2.5: Control lantana, thatch grass and other ecosystem changing weeds in plateau riparian areas occupied by Kroombit treefrog and Monteith's spiny crayfish and previously occupied areas by Kroombit tinkerfrog by 2030 and continue through to 2035.

Performance indicators

- Key areas in occupied Kroombit treefrog and Monteith's spiny crayfish in Kroombit, Three Moon and Munholme creek catchments on the plateau maintain suitable vegetation to support the species with a pest plant health condition class of at least 'good with some concern' by 2030 and maintained until 2035.
- All toolbox talks for QPWS staff and contractors include risk of weed spread when new staff/contractors are present.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
2.5.1 Undertake strategic control of lantana in occupied Kroombit treefrog and Monteith's spiny crayfish and previously occupied Kroombit tinkerfrog habitat in Kroombit, Three Moon and Munholme creek catchments on the plateau.	2	$10,000s	2	DETSI (SEQR) (L), FBA (C), First Nations groups (C)
2.5.2 Monitor lantana, parthenium (*Parthenium hysterophorus)*, praxelis (*Praxelis clematidea)* and thatch grass (*Hyparrhenia rufa)* in plateau riparian areas and creek systems and carry out strategic control if detected.	2	$10,000s	3	DETSI (SEQR) (L), FBA (C), First Nations groups (C)
2.5.3 All staff to complete toolbox talk education programs on risks of weed spread.	1	$100s	3	DETSI (SEQR) (L)

Objective 2.6: Minimise risk of fire incursion and associated impacts in habitat occupied by the three focal species through to 2035.

Performance indicators

- Minimal impacts from fire or fire incursion in fire sensitive rainforest occupied by the three focal species at KTNP with a fire damage health condition class of at least 'good with some concerns'.
- Bushfire suppression activities do not adversely affect the three focal species.
- Fire management activities have been undertaken in line with an approved Fire Management Strategy for KTNP.
- Annual reports are made on the implementation and progress of the approved Fire Management Strategy for KTNP.
- Fire planning and delivery are implemented in collaboration with First Nations partners and KTNP neighbours.
- Long term access to neighbouring properties for fire and pest control activities has been investigated and progressed.
- The approved Fire Management Strategy for KTNP is updated after regular review.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
2.6.1 Undertake planned burns as identified in the KTNP Fire Management Strategy, in fire adapted vegetation communities surrounding fire sensitive rainforest and riparian communities.	1	$10,000s	1	DETSI (SEQR) (L)

2.6.2 Prioritise bushfire suppression in areas where bushfire spread may pose a risk to rainforest patches below the eastern escarpment (i.e. the foot slopes and rolling hills to the north and south, and on the adjacent plateau, to prevent fires moving through the escarpment landscape) in collaboration with First Nations partners and neighbours.	1	$10,000s	2	DETSI (SEQR) (L)
2.6.3 Ensure bushfire suppression activities in the form of retardants, surfactants, and gels during water bombing, and machinery to create fire breaks are not used on/ do not damage occupied rainforest patches.	1	$1000s	3	DETSI (SEQR) (L)
2.6.4 Explore options to allow for ongoing access by QPWS to properties adjacent to the KTNP eastern escarpment to undertake fire management.	1	$100s	1	DETSI (SEQR) (L)

Goal 3: Minimise the risk of spreading significant or novel diseases and parasites that are known or likely to impact the three focal species or their habitat to maintain healthy populations.

Objective 3.1: Prevent the human-mediated spread of significant diseases and parasites known to impact the three focal species or their habitat by 2035.

Performance indicators

- There are no new human-mediated outbreaks of pathogens or parasites that cause disease in the populations and habitats of the three focal species.
- All QPWS staff and on-site contractors at KTNP are aware of, understand and implement operational biosecurity protocols.
- All toolbox talks for QPWS staff and contractors include risk of pathogen spread when new staff/contractors are present.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
3.1.1 Follow hygiene protocols consistent with the 'Threat abatement plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis' when activities are carried out in riparian habitats to reduce the spread of chytrid and reduce and prevent the spread of other pathogens and parasites which may cause disease in the three focal species.	1	$100s	3	DETSI (SEQR) (L), CWS (C), FBA (C), First Nations groups (C), Research institute/Qld Museum, External contractors
3.1.2 Develop toolbox talk to educate on risks of pathogen introduction	1	$100s	3	DETSI (EAU (L), TSO (C)
3.1.3 All staff involved in management operations at KTNP to complete toolbox talk education program	1	$100s	3	DETSI (SEQR) (L)
3.1.4 Undertake basic health assessment of focal species where possible when undertaking population monitoring and take appropriate action if disease is suspected.	1	$1000s	3	DETSI (EAU (L), TSO (C)

Objective 3.2: Investigate and where feasible implement safe and effective methods to control chytrid fungus in Kroombit tinkerfrog (captive and wild) and Kroombit treefrog by 2035.

Performance indicators

- As part of the captive husbandry project, options for prophylactic treatment of chytrid in captive bred animals have been investigated.
- All captive Kroombit tinkerfrogs destined for release into the wild have been treated with safe and effective prophylactic chytrid treatment if available.
- Options for treatment of chytrid for wild Kroombit tinkerfrogs and Kroombit treefrogs have been investigated.
- All captured/accessible wild Kroombit tinkerfrogs and Kroombit treefrogs have been treated with safe and effective chytrid treatment if available.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
3.2.1 Investigate safe and effective options for prophylactic treatment of chytrid in captive bred Kroombit tinkerfrogs.	1	$10,000s	2	Research institution (L), CWS (C)
3.2.2 If feasible, implement safe and effective treatment of chytrid on captive Kroombit tinkerfrogs destined for release into the wild.	1	$100s	2	CWS (L)
3.2.3 Investigate safe, effective and feasible treatment of chytrid for use on wild Kroombit treefrogs and Kroombit tinkerfrogs.	2	$10,000s	2	Research Institution (L), DETSI (EAU) (C)
3.2.4 Implement safe, effective and feasible treatment of chytrid on wild Kroombit treefrogs and Kroombit tinkerfrogs.	3	$10,000s	3	DETSI (EAU (L), TSO (C), SEQR (C))

Goal 4: Improve understanding of the population trends of the three focal species to better effect management.

Objective 4.1: Investigate the calling phenology of Kroombit treefrog to inform monitoring by 2027.

Performance indicators

- An acoustic call recogniser has been developed for Kroombit treefrog calls.
- Calling phenology of the Kroombit treefrog is understood and informs acoustic monitoring, survey design and the species' management.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
4.1.1 Develop an acoustic call recogniser for Kroombit treefrog calls.	1	$1000s	2	Research Institution (L), DETSI (EAU) (C)
4.1.2 Process and analyse existing acoustic recordings which targeted Kroombit treefrog to determine calling phenology.	1	$1000s	2	Research Institution (L), DETSI (EAU) (C)
4.1.3 Design a survey and monitoring method for Kroombit treefrog using its calling phenology.	2	$1000s	2	Research Institution (L), DETSI (EAU) (C)

Objective 4.2: Investigate the current distribution and abundance of Monteith's spiny crayfish to inform monitoring by 2026.

Performance indicators

- Existing records of Monteith's spiny crayfish have been captured and analysed.
- The distribution and abundance of the Monteith's spiny crayfish is understood and informs the species' monitoring and management.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
4.2.1 Collate and analyse Monteith's spiny crayfish records from previous Kroombit tinkerfrog survey and monitoring work.	1	$1000s	1	DETSI (EAU (L), TSO (C))
4.2.2 Design a survey and monitoring method for Monteith's spiny crayfish using results of analysis of existing Monteith's spiny crayfish data.	1	$1000s	2	DETSI (EAU (L), TSO (C))

Objective 4.3 Establish the overall population trend of each of the three focal species through to 2035.

Performance indicators

- The population trend, area of occupancy and extent of occurrence of all focal species are known and each species' conservation status has been re/assessed, detecting any changes measured against historical data where available.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
4.3.1 Use the monitoring data collected to establish population trends, area of occupancy and extent of occurrence for Kroombit tinkerfrog and assess the species' conservation status.	2	$1000s	2	DETSI (EAU (L), TSO (C))
4.3.2 Undertake annual population monitoring of Kroombit treefrogs at KTNP using results from action 4.1.3.	2	$1000s	3	DETSI (EAU (L), TSO (C))
4.3.3 Use the monitoring data collected to establish population trends, area of occupancy and extent of occurrence for Kroombit treefrog and assess the species' conservation status.	2	$1000s	3	DETSI (EAU (L), TSO (C))
4.3.4 Undertake annual population monitoring of Monteith's spiny crayfish at Kroombit using results from action 4.2.2.	1	$1000s	3	DETSI (EAU (L), TSO (C))
4.3.5 Use the monitoring data collected to establish population trends, area of occupancy and extent of occurrence for Monteith's crayfish and assess the species' conservation status.	2	$1000s	3	DETSI (EAU (L), TSO (C))

Goal 5: Improve understanding of the current genetic population structure and genetic health of each of the three focal species, to inform species management.

Objective 5.1: Investigate population genetics and genetic health of the three focal species by 2035.

Performance indicators

- Genetic population structure and health of each species is understood and informs their management.

Action	Priority	Indicative cost	Timeframe	Potential Contributors
5.1.1 Collect statistically, spatially and temporally appropriate tissue samples (including suitable existing samples) of all three focal species at KTNP (include samples of Monteith's spiny crayfish at Dawes National Park).	1	$1000s	2	DETSI (EAU, TSO) (L)
5.1.2 Conduct genetic analyses of the three focal species.	1	$1000s	2	Research institute
5.1.3 Use genetic analysis of Monteith's spiny crayfish to inform taxonomic resolution of the species.	3	$1000s	3	Research institute/Qld Museum
5.1.4 Implement recommendations based on the genetic analyses to improve genetic health and inform management, translocation and/or captive breeding planning for the three focal species (where relevant).	1	$1000s	3	DETSI (EAU, TSO) (L)

Goal 6: Improve engagement of key stakeholders and the local community in relation to the management of the three focal species to better effect recovery.

Objective 6.1: Increase collaboration between stakeholders in the delivery of recovery actions by 2030.

Performance indicators

- A working group is established and representative of the stakeholder group, operating with a Terms of Reference, and have met bi-annually.
- Actions are being undertaken in accordance with the 'Rainforest dependent threatened fauna of Kroombit Tops National Park Recovery Action Plan'.
- Members of the Bailai, Gurang, Gooreng Gooreng, and Taribelang Bunda Peoples have been provided with opportunities to be involved in recovery actions for the focal species.
- Key stakeholders are involved in recovery actions

Action	Priority	Indicative cost	Timeframe	Potential Contributors
6.1.1 Establish a formal working group with key stakeholders that is guided by a Terms of Reference.	2	$100s	1	DETSI (TSO)
6.1.2 Working group to meet bi-annually to discuss the progress against recovery	2	$100s	3	DETSI (L), CWS,

actions.				species experts, FBA, PCCC.
6.1.3. Regularly engage with First Nations peoples to inform and discuss opportunities for collaboration in relation to the actions under the Recovery Action Plan.	1	$1000s	3	DETSI, PCCC.
Objective 6.2: Increase funding sources for the delivery of the Recovery Action Plan by 2030.				
Performance indicators • Partnerships are maintained, developed, secured, and/or established to implement the 'Rainforest dependent threatened fauna of Kroombit Tops National Park Recovery Action Plan'. • Funding to implement recovery actions has increased compared to 2023 baseline funding.				
Action	**Priority**	**Indicative cost**	**Timeframe**	**Potential Contributors**
6.2.1 Investigate external partnerships to fund the implementation of the 'Rainforest dependent threatened fauna of Kroombit Tops National Park Recovery Action Plan'.	1	$100s	1	DETSI (TSO)
6.2.2 Identify pathways and actively approach corporate entities to secure long-term funding to implement the 'Rainforest dependent threatened fauna of Kroombit Tops National Park Recovery Action Plan'.	2	$100s	1	DETSI (TSO)
Objective 6.3: Increase community support for the three focal species within the local and regional community by 2030.				
Performance indicators • Several community groups that are involved in recovery actions for the 'Rainforest dependent threatened fauna of Kroombit Tops National Park Recovery Action Plan'.				
Action	**Priority**	**Indicative cost**	**Timeframe**	**Potential Contributors**
6.3.1 Develop a communications strategy that promotes the focal species and recovery efforts with an aim to build support from the broader community through its implementation.	2	$1000s	1	DETSI (TSO)

CONTEXT

Kroombit tinkerfrog (*Taudactylus pleione*), Kroombit treefrog (*Litoria kroombitensis*), and Monteith's spiny crayfish (*Euastacus monteithorum*) are dependent upon rainforest ecosystems in the eastern section of KTNP, south-west of Gladstone, in Queensland. The eastern section of the national park lies within the Southeast Queensland Bioregion.

Kroombit Tops National Park is a mesic, temperate island arising from the surrounding drier and hotter subtropical lowlands (Hines 2014). Rainfall chiefly occurs in late spring and summer. However, the eastern escarpment and adjacent plateau are often cloaked in mist and cloud stripping adds significantly to the available moisture (Hines 2014). Rainfall decreases and temperature increases at lower altitudes and away from the escarpment. The variation in geology, rainfall and landform across KTNP results in a diversity of floral and faunal communities, with several endemic species and over 70 other plant and vertebrate taxa at their northern limit or with other significant disjunct populations (Hines 2014).

Both Kroombit tinkerfrog and Kroombit treefrog are endemic to the mesic forests of eastern KTNP. Searches in high-altitude wet sclerophyll and rainforest patches on nearby ranges (e.g. Mt Robert, Bulburin) have not recorded Kroombit tinkerfrogs or Kroombit treefrogs (QPWS unpublished data). A majority of the habitat for Monteith's spiny crayfish also occurs at KTNP, but a second disjunct subpopulation was discovered about 25km southeast at Mt. Robert, in Dawes National Park. However taxonomic resolution is required. Monteith's spiny crayfish occurs at most current and historic sites occupied by Kroombit tinkerfrog and Kroombit treefrog. Historically, the Kroombit tinkerfrog co-occurred with Kroombit treefrog in the Kroombit and Munholme creek catchments. However, these species no longer co-occur together. The three species and their core habitat are impacted by a range of shared threats.

Figure 1 shows the distribution of rainforest patches that form the core habitat for Kroombit tinkerfrog, Kroombit treefrog and Monteith's spiny crayfish, and relevant creek catchments in the eastern part of KTNP, Queensland Australia. Table 2 shows the historic and current extent of the three focal species at KTNP by creeks.

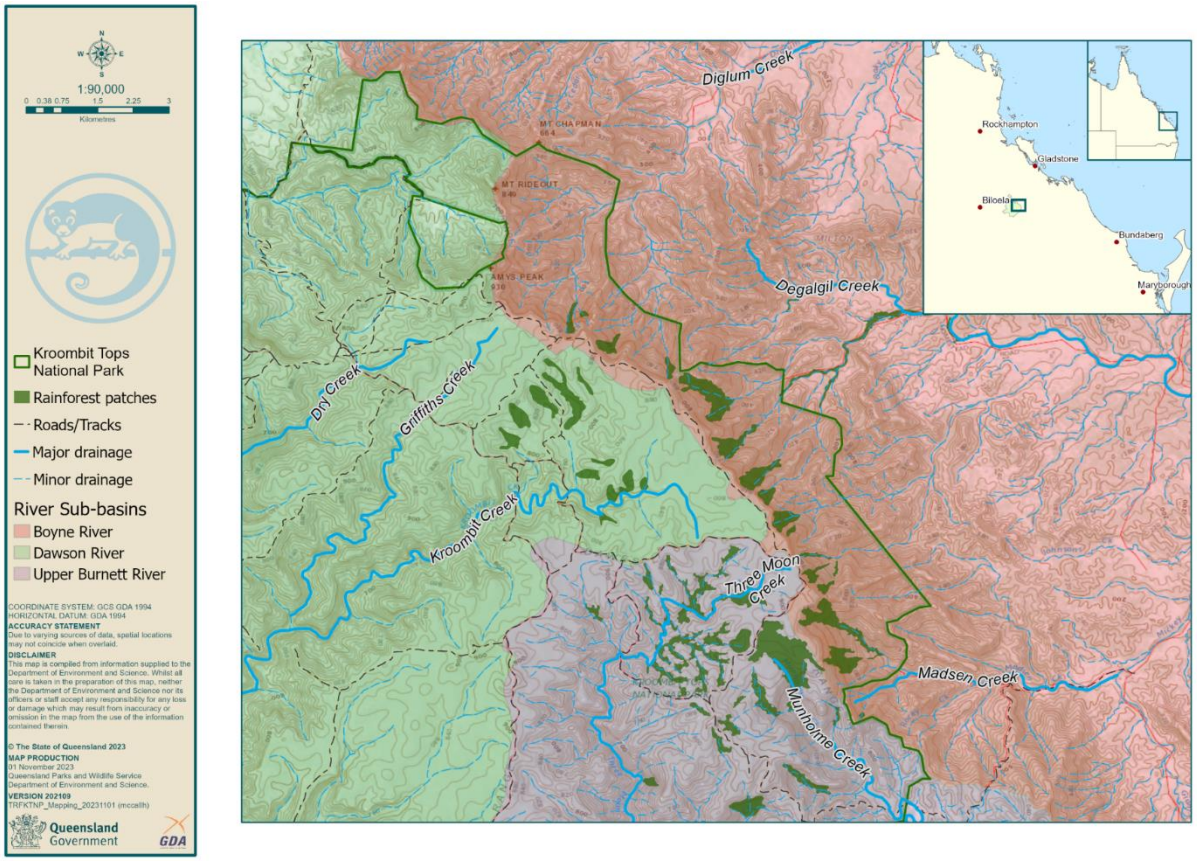

Figure 1. The distribution of rainforest patches that form the core habitat for Kroombit tinkerfrog, Kroombit treefrog and Monteith's spiny crayfish - eastern part of Kroombit Tops National Park.

Table 2. Historic and current species distributions at Kroombit Tops National Park

Extent	Species	Plateau					Below escarpment		
		Kroombit Creek	Munholme Creek	Three Moon Creek	Dry Creek	Griffiths Creek	Degalgil Creek	Diglum Creek	Madsen Creek
Historic	Kroombit tinkerfrog	✓	✓				✓	✓	✓
	Kroombit Tree Frog	✓	✓	✓	✓	✓			
	Monteith's crayfish	✓	✓	✓			✓	✓	✓
Current	Kroombit tinkerfrog						✓	✓	
	Kroombit Tree Frog	✓	✓	✓					
	Monteith's crayfish	✓	✓	✓			✓	✓	✓

Species Information

Kroombit tinkerfrog (*Taudactylus pleione*)

Conservation Status

Legislation	Conservation status
Nature Conservation Act 1992	Critically Endangered
Environment Protection and Biodiversity Conservation Act 1999	Critically Endangered

The species is listed as Critically Endangered with a declining trend under the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (IUCN SSC Amphibian Specialist Group 2022).

With recent and ongoing population declines, ongoing threats to the species, and possibly fewer than 150 adults remaining in the population (see below), the Kroombit tinkerfrog is considered at very high risk of extinction. A recent assessment of threatened Australian frogs (Geyle et al. 2021) concluded that the Kroombit tinkerfrog is likely to be extinct by 2040 unless more is done to recover the species.

Taxonomy and Description

The Kroombit tinkerfrog (*Taudactylus pleione)* was discovered in 1983 and described by Czechura (1986a). It belongs to the family Myobatrachidae. The species' taxonomy is conventionally accepted.

The Kroombit tinkerfrog is a small, highly cryptic, ground-dwelling frog with a snout-vent length between 25-31mm. Adults are grey-brown to reddish-brown dorsally with a prominent broad bar between the eyes, a prominent 'butterfly' or 'X'-shaped mark on the back, and the legs are marked with transverse bars. Males are similar to females, except that mature females are larger and typically redder in colouration. Juveniles are rarely observed but their colouration and patterning resemble that of adult males (Czechura 1986a; Meyer et al. 2001; Clarke 2006).

The calls of male Kroombit tinkerfrogs are readily distinguishable from other frog species and consist of 1-28 metallic 'tinks' with a dominant frequency of approximately 2.8kHz (Czechura 1986a; Meyer et al. 2001; Clarke 2006; H.B. Hines unpublished data). The series of 'tinks' slows towards the end of the call, lasting 0.6-5.1 seconds, and is repeated at rates ranging from 6.8-19.3 calls per minute.

Biology and Ecology

Breeding biology

Calling activity in adult male Kroombit tinkerfrogs has been recorded in all months of the year, but peaks in the austral summer from late-November to early-March (McLeod 2023). Photoperiod is the leading determinant of calling activity. However, increased minimum air temperature and humidity, low barometric pressure and daily rainfall, and high rainfall over the preceding month also positively affect calling activity (McLeod 2023). Kroombit tinkerfrogs predominantly call during twilight hours (± 1h at sunrise and sunset) (McLeod 2023). During wet or overcast conditions, calls can be heard at any time of the day or night (QPWS unpublished data). Males normally call from cover such as rock crevices, crayfish burrows, and under fallen palm and fern fronds (Czechura 1986a; Meyer et al. 2001; Tangey and Clarke 2002; Clarke 2006) and demonstrate a high degree of site fidelity (Clarke 2006; Hines 2021).

To date, amplexus, eggs and tadpoles of Kroombit tinkerfrogs have not been seen in the wild and observation of females are extremely rare. However, young subadult and recently metamorphosed individuals have been seen in late summer, suggesting breeding is likely to occur in summer or late spring (QPWS unpublished data). Captive animals have bred in spring and summer after storms and heavy rain (Hines 2021). This species may breed in seepage pools under rock piles or other subterranean water bodies, with tadpoles remaining hidden (Venz 2020).

In captivity, unpigmented jellied eggs (between 60-117) are laid under rocks in shallow water, with eggs adhering to the underside of rocks. Under captive conditions, tadpoles complete metamorphosis between 8 and 12 months after spawning (M. Vella, pers. comm. Sept 2023). Kroombit tinkerfrogs are thought to reach sexual maturity between 18-24 months, although this is yet to be confirmed (M. Vella, pers. comm. Sept 2023).

Life expectancy in the wild is estimated to be 7-8 years (QPWS, unpublished data) and generation length is conservatively estimated to be between 3-5 years (Hines 2009; Venz 2020).

Foraging and diet

Observations in the wild suggest adult Kroombit tinkerfrogs are likely to subsist on a diet of terrestrial arthropods found amongst rocks and leaf litter, including geometer moth larvae (family Geometridae) and spiders (Venz 2020). In captivity, adult Kroombit tinkerfrogs are fed a diet of small crickets, while subadult frogs are fed collembola and pin-head crickets (Hines 2021). Tadpoles are likely to subsist on a diet of very fine organic material suspended in silt or clay.

Habitat requirements

The Kroombit tinkerfrog currently inhabits first-order rocky streams and seepages in rainforest between 400 and 800 metres elevation (TSSC 2017). Specifically, the species is associated with isolated patches of simple notophyll vine forest with a piccabeen palm (*Archontophoenix cunninghamiana)* understorey in steep boulder scree gullies (equivalent to Regional Ecosystem RE 12.12.1) provided in mapping by Clarke (2006). This RE is naturally highly fragmented at KTNP (Clarke 2006). Within rainforest patches, Kroombit tinkerfrogs only occupy gullies where palms occur (associated with water), rather than where hoop pine (*Araucaria cunninghamii)* occurs (often associated with rock) (H. Hines pers. comm. Nov 2023).

In the past, Kroombit tinkerfrogs were also known from plateau streams in the headwaters of Kroombit Creek on the Kroombit plateau, inhabiting vegetation dominated by coachwood (*Ceratopetalum apetalum)* and/or piccabeen palm and often with emergent hoop pine (Czechura 1986a, 1986b; Meyer et al. 2001; Clarke 2006).

The species is highly cryptic and shelters down rock crevices and amongst rock and boulder piles (TSSC 2017) in the vicinity of permanent and ephemeral rocky seepages and in sheltered rocky scree (Czechura 1986a; Cunningham and James 1994; Clarke et al 1999). Individuals have also been found under logs, organic litter, in crayfish burrows, and inside the curled-up ends of fallen palm fronds (Cunningham and James 1994; Czechura 1986a).

Many call perches have little or no surface water in proximity (Clarke 2006; QPWS unpublished data). Eggs and tadpoles of the Kroombit tinkerfrog have not been seen in the wild (Venz 2020).

No frogs have ever been recorded away from drainage lines (e.g. ridges or saddles between drainage lines) but survey effort and detectability in these areas is very limited (Venz 2020). The use of rock piles and deep rock crevices for shelter allows Kroombit tinkerfrogs to avoid exposure to potentially lethal temperatures, with average temperatures down rock crevices and rock piles approximately 6.5°C lower than above ground (QPWS unpublished data). This is likely important for the species which, like other *Taudactylus*, appears highly sensitive to heat stress (Johnson 1971; Hines 2021).

Movement and dispersal

Adult males are highly agile and capable of climbing near-vertical rock-faces (Clarke 2006). However, calling males show a high degree of call perch site fidelity within and between years and are often clustered in areas of seepages (Clarke 2006). Occasional shifts in their position from year to year suggest Kroombit tinkerfrogs may be capable of longer-range movements (potentially tens to hundreds of metres) within suitable rainforest habitat, under suitable conditions (Hines 2021).

The dispersal of Kroombit tinkerfrogs is largely undocumented. The environment between isolated rainforest patches comprises steep dry ridges dominated by dry sclerophyll forest and high escarpments and movement between isolated rainforest patches through relatively hotter and drier open forest is unlikely or very limited. The species is strongly associated with a moist environment that is relatively well buffered from temperature fluctuations (e.g. rock and boulder piles in proximity to seepages). While the physiological tolerances of Kroombit tinkerfrogs are unknown, observations of the species indicate it is susceptible to heat stress (Johnson 1971; TSSC 2017; Venz 2020; Hines

2021), and a closely related species (southern day frog *Taudactylus diurnus*) has a low tolerance to desiccation (Johnson 1971). Therefore, movement between isolated rainforest patches may only be possible during extended wet periods, if at all, when relative humidity is high enough to allow the frogs to traverse without becoming desiccated (Clarke 2006). The distance between accessible occupied rainforest patches was not an important factor affecting patch occupancy, suggesting the escarpment itself is not a barrier to dispersal for the Kroombit tinkerfrog (Clarke 2006). However, the drying climate at KTNP may restrict movement, preventing dispersal and gene flow. Whether this has resulted in genetic structuring across rainforest patches is unknown (Hines 2021).

Species Distribution and Populations

Historic Distribution

Historically, the Kroombit tinkerfrog had a highly restricted, fragmented distribution, occurring in 12 discrete isolated patches of notophyll vine forest between 400m and 800m elevation in the headwaters of Degalgil, Diglum, and Madsen (below the escarpment) and Kroombit, and Munholme creek catchments (on the Kroombit plateau) (QPWS unpublished data) (Figure 1). The species is estimated to have occupied an area of 596 ha. Targeted monitoring and surveys since the mid-1990s show a significant decline in the distribution and abundance of the species (TSSC 2017).

Kroombit tinkerfrogs have never been recorded from the largest patch of seemingly suitable habitat on the Kroombit plateau in the headwaters of Three Moon Creek (Figure 1) and is suspected to have declined and become extirpated from this patch prior to the species' discovery in 1983. The Kroombit tinkerfrog is known to have occurred at plateau streams in the headwaters of Kroombit Creek (Figure 1) but has not been recorded there since 2008, despite significant ongoing survey effort. The species is now considered to be extirpated from the plateau (TSSC 2017; QPWS unpublished data) and plateau streams may no longer be suitable habitat for Kroombit tinkerfrogs due to the threat posed by amphibian chytridiomycosis (see below) until effective management of the causal pathogen, *Batrachochytrium dendrobatidis*, is developed.

In the late 1900s and early 2000s Kroombit tinkerfrogs were also found in isolated rainforest patches of RE 12.12.1 below the large escarpment in the east of KTNP, in the headwaters of Diglum Creek catchment (Clarke et al. 1999; TSSC 2017). However, subsequent monitoring and surveys indicated the species declined and likely disappeared from a substantial number of these patches (QPWS unpublished data). These areas are known to contain suitable rainforest habitat for the species, and the impacts of threats within them are also comparatively lower than on the plateau. As a result, these areas remain suitable habitat for Kroombit tinkerfrogs.

Current distribution

The current EOO and AOO for the Kroombit tinkerfrog is 5.205 km² (520.45 ha) and 20 km² (2,000 ha) respectively (Venz 2020). The Kroombit tinkerfrog is found in rainforest of the Degalgil and Diglum creek catchments, in approximately 66 ha of habitat (Figure 1) (Hines 2021). Kroombit tinkerfrogs are still being established in one rainforest patch in the Diglum Creek catchment after individuals were reintroduced in March and November 2023 (McCall pers. com. 2024).

Overall population size and trends

Assuming a 1:1 sex ratio, the estimated maximum population size is 150 adults. Juvenile and adult survivorship and the age structure of populations in the wild are unknown. Intensive monitoring has detected a maximum of 75 calling adult male frogs at KTNP, (as of 2021; QPWS unpublished data) in the remaining rainforest areas occupied by the species.

In February 1984 Czechura recorded a conservative estimate of 200 males calling from 750-1000m of rainforest gully (Hines 2009). Given this estimate in a small section of rainforest and the amount of unoccupied potential habitat that exists, it can be assumed that the population size at or prior to the species' discovery may have been in the thousands (Hines 2009). The number of Kroombit tinkerfrogs recorded in recent times has never approached those recorded by Czechura in February 1984 which is five times the maximum count (40 animals at one site on 31 Jan 2008) across all surveys at all sites since, despite ongoing targeted surveys (Cunningham and James 1994, Hines 2009).

Subpopulation size and trends

Due to the highly specific habitat requirements of Kroombit tinkerfrogs and the potential barriers to dispersal and gene flow, subpopulations could be identified according to individual patches of notophyll rainforest or by catchment headwaters level.

Currently, wild subpopulations of the Kroombit tinkerfrog are only known to occur within two rainforest patches, with the largest remaining subpopulation occurring within a single rainforest patch in the Degalgil Creek catchment (Hines 2009) (Table 3). Surveys prior to 2021 in adjacent rainforest patches in the Diglum and Madsen creek catchments where the species was previously known to occur, did not locate any individuals of the species (QPWS unpublished data;Table 3). These subpopulations may be perilously low or the species may have declined and disappeared at these sites. Individuals were reintroduced to a rainforest patch in the Diglum Creek catchment in March and November 2023 through an approved Translocation Proposal.

Table 3. Creek catchments with rainforest patches currently and previously occupied by the Kroombit tinkerfrog at Kroombit Tops National Park. Adapted from (Hines 2021).

Catchment	Total rainforest patches[1]	Location	Status of Catchment
Kroombit Creek	3	Plateau	Unoccupied
Diglum Creek	2	Escarpment	Occupied (1 via translocation)
Degalgil Creek	5	Escarpment	Occupied
Madsen Creek	2	Escarpment	Unoccupied
Munholme Creek	1	Plateau	Unoccupied

[1]Note: where a rainforest patch spans a major catchment boundary the patch is subdivided into parts which are count as one patch each, for example the large patch that spans Three Moon, Madsen and Munholme creeks is divided into three, one for each catchment.

Kroombit treefrog (*Litoria kroombitensis*)

Conservation Status

Legislation	Conservation status
Nature Conservation Act 1992	Critically Endangered
Environment Protection and Biodiversity Conservation Act 1999	Critically Endangered

The species is listed as Critically Endangered with a declining trend under the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (IUCN SSC Amphibian Specialist Group 2022a).

With recent and ongoing population declines, ongoing threats to the species, and unknown population size (see below), the Kroombit treefrog is considered at moderate to high-risk of extinction. A recent assessment of threatened Australian frogs (Geyle et al. 2021) concluded that the Kroombit treefrog may become extinct by 2040 unless more is done to recover the species.

Taxonomy and Description

The Kroombit treefrog (*Litoria kroombitensis*) was described by Hoskin et al. (2013) and belongs to the family Hylidae. The species' taxonomy is conventionally accepted.

The Kroombit treefrog is a small (< 45mm snout-to-vent length (SVL)) smooth, green or greenish-brown frog with distinct, rounded finger and toe pads. A thin gold line runs from the naris over the eye and tympanum to above the forelimb. White gilding appears on the trailing edges of the fore- and hindlimbs. The species has a blunt, gently rounded snout. Females are larger than males, and their body width is wider than their head, while the male body width equals the head before tapering off (Hoskin et al. 2013).

The calls of male Kroombit treefrogs are readily distinguishable from other frog species in the area and consists of a short, crisp whine followed by one or two chirps (Hoskin et al. 2013).

Biology and Ecology

Breeding biology

The Kroombit treefrog is a stream-breeding species. Calling males are encountered along slow and intermittently flowing streams (Hines 2014), where they call from low and overhanging vegetation, rocks, and debris in or near the stream edge (Venz 2019). Breeding activity occurs from August through to February (Hoskin et al. 2013; Venz 2019). Amplexus is axillary. Kroombit treefrog eggs are darkly pigmented and laid in masses of 100-300, wrapped around submerged twigs and branches in pools with largely static or slow-flowing water (Hoskin et al. 2013). The egg masses can become covered by a fine layer of silt soon after laying.

Kroombit treefrog tadpoles have a brown body with darker areas over the braincase and gut (Hoskin et al. 2013). Tadpoles are found in still pools along and adjacent to slow and intermittently flowing streams in rainforest. These pools form within the stream bed, often on rocky cascades (Venz 2019), and occupied pools are free of fish except for the occasional longfin eel (*Anguilla reinhardtii*) (Hoskin et al. 2013). Tadpoles have been recorded August to mid-February (Venz 2019). Recently metamorphosed frogs have been recorded from November to February.

Age at sexual maturity, life expectancy or natural mortality rates are unknown for the Kroombit treefrog. However, similar species of *Litoria* reach sexual maturity between 1-3 years and 2-4 years post metamorphosis for males and females, respectively (Venz 2019).

Foraging and diet

While the diet of adult Kroombit treefrogs is unknown, they are likely to subsist on terrestrial arthropods found amongst rocks and leaf litter. Tadpoles are largely benthonic, feeding on sediment (most commonly silt) at the bottom of pools (Hoskin et al. 2013).

Habitat requirements

The Kroombit treefrog inhabits slow and intermittently flowing streams in rainforest and adjoining wet to moist sclerophyll forests and woodlands (equivalent to REs 12.12.20, 12.9-10.20) between about 550 and 900m, with most records above 750m (Hoskin et al. 2013).

Adult, breeding Kroombit treefrogs are encountered in and along intermittently flowing streams, while recently metamorphosed frogs have been recorded sitting out on stream-side vegetation (Hoskin et al. 2013). Non-breeding adults and sub-adults are rarely encountered but presumably feed and shelter along the streams and in adjacent forest (Hoskin et al. 2013).

Movement and dispersal

The Kroombit treefrog is typically nocturnal. The degree of male call perch site fidelity is unknown for this species. However, individuals are often clumped in areas of the stream with suitable breeding habitat.

The dispersal of this species is largely unknown. Movement between stream catchments through relatively warmer and drier open forest may be limited. However, the appearance of single males in Dry Creek in 2004 and 2010 suggests at least infrequent dispersal across catchments (Venz 2019).

Species Distribution and Populations

Distribution: current and historical extent

The Kroombit treefrog has a fragmented distribution, occurring in rainforest and adjoining wet sclerophyll forest between 550m and 900m elevation (Hoskin et al. 2013), with most records above 750m (Venz 2013). Historically the species occurred in the headwaters of Dry, Griffiths, Kroombit, Three Moon and Munholme creeks on the KTNP plateau. Extensive surveys since the mid-1990s indicate a significant decline in the subpopulations of Kroombit treefrog from the late 1990's (Hoskin et al. 2013; Venz 2019).

Although both Kroombit treefrog adults and tadpoles were recorded in Dry Creek in the mid-1990s (Cunningham and James 1994; Schulz 1994) and adults were recorded in Griffiths Creek (Cunningham and James 1994), only a single male was recorded in Dry Creek in 2004 and again in 2010 (Venz 2019). No other individuals have since been recorded in these creek catchments over the last two decades (Venz 2019).

Its EOO was estimated to be 32km² (3,200ha) (Hoskin et al. 2013) and AOO of 16 km² (1,600 ha) (TSSC 2019) (Figure 1). Currently, the Kroombit treefrog is only known to occur in Kroombit, Three Moon and Munholme creeks (Figure 1) (QPWS unpublished data), and the species has a patchy distribution, even within apparently suitable habitat (Venz 2019). The EOO of the Kroombit treefrog is now estimated to occur over less than 22.7 km² (2,270 ha) (Venz 2019).

Overall population size and trends

There have been no estimates of overall population size for the Kroombit treefrog. Previously, population density was reported to vary greatly across plateau monitoring sites with the maximum number of adult males varying from 5 to 62 per 100m between 1996–2011 (Hoskin et al. 2013). However, the species is typically recorded at low numbers during most surveys with fewer than five frogs per site recorded for more than 75% of standard monitoring surveys (Venz 2019). In addition, nocturnal survey counts of adult and sub-adult Kroombit treefrogs at monitoring sites across occupied creek catchments since the 1990s indicate a continuing decline in numbers (Venz 2019), with average counts decreasing by more than 50% within the 2010s (Venz 2019).

Previously, Kroombit treefrogs occurring within each catchment were considered isolated and therefore potentially different subpopulations (Hines 2012; Hoskin et al. 2013). However, it is now thought that Kroombit treefrogs from Kroombit, Three Moon and Munholme creek catchments may

form a single population, with no evidence of genetic sub-structuring between stream catchments (Venz 2019).

Monteith's spiny crayfish *(Euastacus monteithorum)*

Conservation Status

Legislation	Conservation status
Nature Conservation Act 1992	Endangered
Environment Protection and Biodiversity Conservation Act 1999	Endangered

The species is listed as Critically Endangered with an unknown trend under the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (Coughran and Furse 2010).

Taxonomy and Description

Monteith's spiny crayfish (*Euastacus monteithorum)* was described by Morgan (1989) and belongs to the family Parastacidae (Decapoda). Phylogenetic analyses by Shull et al. (2005) and molecular taxonomic analyses of Austin et al. (2022) confirm its validity as a distinct taxon.

Monteith's spiny crayfish is characterised by a small body size and relatively few spines, with a maximum recorded occipital carapace length (OCL) of 47.1 mm and weighing up to 44g (Mathieson & Schulz 1998). Dorsal thoracic spines are absent and first postorbital ridge spines and dorsal carpal spines on chelae are lacking. The species is dark green in colour with orange leg joints, eye sockets and antennae, and a hint of steel blue on the sides (McCormack 2012). A small group of ventral spines on the cephalon and along the cervical groove are noticeable due to their white to yellow colouration. Abdominal spines are small, blunt, and yellow. However, colour is typically not a reliable diagnostic characteristic in freshwater crayfish as it can vary greatly within species, even within a section of stream (Page 2021).

Biology and Ecology

Breeding biology

Little is known specifically about the breeding biology of Monteith's spiny crayfish. However, similar small, upland *Euastacus* species are typically long lived, have slow growth, and are slow to reach maturity (Furse and Coughran 2011).

Sexual maturity is considered to occur at an OCL of 35mm (approx. 22g) in females (McCormack 2012). The presence of freshly moulted large mature females observed in early June suggests breeding and brooding may commence in late June and continue over winter and spring (Page 2021), as mating occurs just after moulting in *Euastacus* species (McCormack 2012). Eggs mature and develop under the tail, protected by the female until they hatch. After hatching they remain under the female's tail through a further two stages of development before moulting and becoming adults in the third stage (McCormack 2012). At this point they become independent (McCormack 2012). Females have been recorded with eggs and juveniles present under their tails in January and February (Mathieson & Schulz 1998), and many juveniles (200+) were also seen with two or more size cohorts (15 –25mm total length) at this time (Page 2021).

Life expectancy or natural mortality rates are unknown for Monteith's spiny crayfish. *Euastacus* species moult to grow and it is during moulting that individuals are most vulnerable (Honan & Mitchell 1995a; Turvey and Merrick 1997a; Morey 1998; Furse & Wild 2004). Juveniles moult regularly, up to five times in the first year, twice in the second and commonly only once per year thereafter. Therefore, the mortality of juvenile Monteith's spiny crayfish may be high and reduce with age and size.

Foraging and diet

The diet of Monteith's spiny crayfish unknown, however *Euastacus* species are omnivorous, opportunistic feeders (carrion if available, tadpoles, detritus, roots, leaves) (McCormack 2012).

Habitat requirements

Monteith's spiny crayfish inhabits cool, clear flowing streams, with permanent pools over a rocky and clay substrates on the Kroombit plateau, shaded by palms and other dense rainforest. The species also inhabits wet areas of permanent seepages in shady rainforest gullies below the escarpment (McCormack 2012; Page 2021). The species occurs between 500m and 900m elevation (Page 2021). Areas occupied by Monteith's spiny crayfish at Kroombit are typically over 800m in elevation (Page 2021). Specifically, the species is associated with isolated patches of simple notophyll vine forest with a piccabeen palm (*Archontophoenix cunninghamiana)* understorey in steep boulder scree gullies (equivalent to Regional Ecosystem 12.12.1) (Page 2021). Within rainforest patches below the escarpment, Monteith's spiny crayfish only occupy gullies where palms occur (associated with water), rather than where hoop pine (*Araucaria cunninghamii)* occur (often associated with rock) (H. Hines pers. comm. Nov 2023). Water temperatures of streams inhabited by the species are unknown.

Species of the genus *Euastacus* make burrows in the streambank and bed, some of which are extensive with two or more entrances and up to 2m in length (McCormack 2012). Entrances may be at or below water level in the forest floor (McCormack 2012). They also make burrows in steep scree slopes in rainforest some distance from obvious drainage lines, potentially burrowing down into the water table (Page 2021).

Movement and dispersal

Monteith's spiny crayfish are largely nocturnal and spend most of their time in burrows, although they are occasionally observed in-stream or on the forest floor (Page 2021). Movements between streams and catchments within KTNP, or between Dawes National Park and KTNP are unknown.

Species Distribution and Populations

Distribution: current and historical extent

Monteith's spiny crayfish has a highly restricted, fragmented distribution, occurring in rainforest streams and seepages between 500m and 900m elevation, in the headwaters of Kroombit, Munholme and Three Moon creeks on the Kroombit plateau and Degalgil, Diglum, and Madsen creeks over the eastern escarpment (Figure 1) (Hines 2014; Page 2021). Monteith's spiny crayfish occurs at all current and historic sites occupied by the Kroombit tinkerfrog and all rainforest sites currently occupied by the Kroombit treefrog. While crayfish burrows may have been recorded in the western section of Three Moon Creek, there are no current records of any individuals of Monteith's spiny crayfish in this location (Page 2021). There are also other rainforest patches on the plateau that represent potentially suitable habitat for the species from which the species is not currently known (Page 2021).

The extent of occurrence (EOO) of the species at KTNP is estimated at 29 km^2 (2,900 ha) (total EOO across range is 112 km^2 (11,200 ha)) (Page 2021). Past or current changes in the species distribution at KTNP are unknown.

While much of the habitat for Monteith's spiny crayfish occurs at KTNP, a second disjunct subpopulation was discovered approximately 25km to the southeast at Mt. Robert, in Dawes National Park. The intervening landscape between the two national parks (approximately 25 km) is unsuitable habitat and dispersal is unlikely. Similar distances separate entirely distinct, but related, species of *Euastacus* elsewhere in isolated, upland rainforest mountain areas in Queensland (Furse et al. 2013). While the specimens from Dawes National Park are currently assigned to *Euastacus monteithorum,* molecular taxonomic analyses are warranted as it is possible that the Dawes and KTNP subpopulation are not the same taxon (Page 2021).

This species is not actively managed or monitored specifically but is often encountered and recorded during Kroombit tinkerfrog monitoring. Past or current changes in the species distribution at KTNP are unknown.

Overall population size and trends

There have been no estimates of overall population size for Monteith's spiny crayfish. Overall population and or subpopulation trends of this species at KTNP therefore remain unknown.

Threats

Kroombit tinkerfrog, Kroombit treefrog and Monteith's spiny crayfish are impacted by a range of threats, most of which are shared by two or all three species. The threats are discussed in more detail below.

Critically Small Population Size and Poor Genetic Health

Small populations are more vulnerable to local extinction during environmental catastrophes (e.g. fire, floods, disease). It also leaves them more susceptible to genetic drift and loss of genetic variation (poor genetic health) when populations are highly fragmented. Poor genetic health leaves species vulnerable to low breeding success due to low fitness from inbreeding, difficulties finding a mate, and increased environmental and demographic stochasticity due to a lack of genetic variation to adapt (Caughley 1994; Ralls et al. 2018). It also erodes the adaptive capacity of a species to deal with current threats, and to endure future environmental change.

The Kroombit tinkerfrog has a highly fragmented distribution, with a critically small population size estimated at less than 150 adults. Movement between isolated rainforest patches is unlikely or limited resulting in potential barriers to dispersal and thus gene flow. Given recent population decline, genetic diversity within the overall population is likely to be low and the risk of inbreeding depression is high (C. Hoskin, pers. comm.). As such there is an inferred risk of poor genetic health.

Although the genome of the Kroombit tinkerfrog has been successfully sequenced (Farquharson et al. 2023), the genetic population structure remains poorly understood. Genetic sampling of Kroombit tinkerfrogs in the wild has proven problematic due to difficulties capturing animals (e.g., disturbance to critical habitat features such as call perches, females and juveniles being highly cryptic) and issues with non-invasive sampling techniques (with the extraction of DNA from skin swabs proving unsuccessful due to problems with low DNA yield) (C. Hoskin, pers. comm. Oct 2023). Genetic assessment of tissue samples from captive animals that die would give baseline insights into the genetic diversity in this species, using genomic techniques (C. Hoskin, pers. comm. Oct 2023).

Population metrics, dispersal and gene flow are unknown for Kroombit treefrog and Monteith's spiny crayfish. While the population sizes of the species are unknown, both species have restricted and fragmented distributions. It is unknown whether each species remains genetically interconnected across catchments, which would lower the risk of inbreeding depression. Should declines in distribution and habitat fragmentation continue to occur these species may be at risk from critically small population size and poor genetic health in the future.

Climate Change

Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases is a key threatening process under the EPBC Act (DCCEEW 2023a) and is a serious threat affecting range-restricted cool, high elevation, rainforest species (DCCEEW 2023c).

Since the early 20th Century, Australia has warmed by 1.47 °C, southern Australia has dried while rainfall in northern Australia has generally increased (BoM and CSIRO 2022). At a regional scale the climate of Kroombit and surrounding areas has seen warming consistent with the national trend in conjunction with below average wet season rainfall in the period 2000 to 2021. Callemondah Station (about 5km north-west of occupied habitat critical to all three focal species) has recorded a 15% decline in wet season rainfall since 1923 (BoM 2022). While there is considerable certainty in relation to future changes in climate (e.g. it is getting hotter, heavy rainfall events are getting heavier), understanding of the detail is inherently uncertain. The future climate of the 2050s (which covers the long-term time scale of the Vision for the three species) will be affected by international efforts to reduce greenhouse gas emissions combined with natural variability in the climate system. Climate predictions are also affected by inadequacies in climate models. As a result, climate projection analyses result in a range of possible future climates but can usefully be subdivided into 'climate

futures' (Whetton et al. 2012; Clarke et al. 2011) based on their likely impact on the key habitats of KTNP; a hot dry future, or a less hot, wetter future.

Hot dry future

By the 2050s, the climate of core rainforest habitat for the three focal species is expected to be around 20% drier and at least 2°C hotter in the wet season than during the 1990s. This is likely to result in more frequent hot days. Days with maximum temperature above 30°C are expected to more than double on average (between 65 and 87 days per year) compared to the 1990s average (23.5 days per year). Days hotter than 35°C were uncommon in the 1990s, occurring about once every three years on average. By the 2050s, these are expected to occur about 3 times per year. The combination of reduced rainfall and increased temperatures is expected to result in a 10% increase in evapotranspiration. Despite the decline in mean rainfall, heavy rainfall events are expected to be more intense, increasing by around 10% (Clarke et al. 2011; Whetton et al. 2012).

Less hot, wetter future

By the 2050s, the climate of core rainforest habitat for the three focal species is expected to be around 15% drier and about 1°C hotter in the wet season than during the 1990s. Days with a maximum temperature above 30°C are expected to almost double (around 44 days per year) on average compared to the 1990s average (23.5 days per year). Days hotter than 35°C were uncommon in the 1990s, occurring on average about once every three years. By the 2050s, these are expected to occur about once every 1.5 years. The combination of reduced rainfall and increased temperatures is expected to result in a 5% increase in evapotranspiration. Despite the decline in mean rainfall, heavy rainfall events are expected to be more intense, increasing by around 15-25% (Clarke et al. 2011; Whetton et al. 2012).

Future climate and the rainforest dependant threatened fauna of KTNP

All three of the focal species are dependent upon the relatively cool and humid environments provided by rainforest and wet sclerophyll communities, mostly at high altitudes, at KTNP. While microhabitat use of rock crevices, rock piles and burrows by these species may provide some shelter from temperature and/or moisture changes due to climate change (Shoo et al. 2010; Suggitt et al. 2011; Storlie et al. 2014), upland rainforests of northern Australia have been predicted to shrink by 50% with a 1°C increase in temperature (Hines 2009), with severe consequences for some frog populations (Williams et al. 2003).

A dramatic reduction in rainforest area at KTNP would likely be catastrophic for the Kroombit tinkerfrog, Kroombit treefrog and Monteith's spiny crayfish, which already inhabit such small, isolated rainforest patches (TSSC 2017; Venz 2019; Page 2021). Clarke (2006) showed that patch size was a significant influence on occupation status and, in general, patches of less than 20ha in size were unlikely to be suitable for occupation by Kroombit tinkerfrogs. If temperatures were to increase by 1°C and rainforest to shrink by 50%, nine of the 12 rainforest patches containing suitable habitat for the Kroombit tinkerfrog would be rendered uninhabitable. If this were combined with a 5% reduction in rainfall, the calling onset period model (Clarke 2006) indicates calling may be reduced by 3-17% resulting in fewer opportunities for breeding. Increasing dryness may also cause rainforest canopies to open allowing larger and more frequent sun flecks to reach the forest floor, which may lead to a reduction in suitable call-sites and fewer suitable oviposition sites for Kroombit tinkerfrogs. Furthermore, increased temperatures leading to more frequent fire events, coupled with predicted reduction and drying of rainforest patch sizes, could greatly increase the risk posed by fire to Kroombit tinkerfrog, Kroombit treefrog and Monteith's spiny crayfish populations.

Climate change is also expected to affect the surface water hydrology of KTNP (see above). Currently, cloud stripping occurs in rainforests above 600m in elevation (WTMA 2008). With every degree of warming, the base of the cloud condensation layer is predicted to rise by an average of 100m (WTMA 2008). If current temperatures increase by up to 2.5°C for RCP4.5 by 2090 (Dowdy et al. 2015), the cloud stripping condensation layer may be expected to rise from 600m to 850m in elevation, even under a moderate mitigation scenario. As cloud cover shifts upwards, there may be a significant reduction in the amount of moisture input through cloud stripping at KTNP. This will affect rainforest areas, downstream ecosystems, and the threatened species reliant on them (such as Monteith's spiny crayfish) through reduced stream flow. However, despite overall declines in mean rainfall, flood events and landslides caused by more intense, heavy rainfall events have led to

changes in gully structure, loss of vegetation and weed invasion in some areas. During the 2011 and 2013 flood events many of the drainage lines occupied by Kroombit tinkerfrog below the eastern escarpment suffered extensive landslips, resulting in loss of many mature trees, soil and rock. At some sites this has likely impacted groundwater flows.

The physiological tolerances of these species are unknown. However, observations of the Kroombit tinkerfrog indicate it is susceptible to heat stress (TSSC 2017; Venz 2020; Hines 2021). A closely related species (southern day frog *Taudactylus diurnus*) has a low tolerance to desiccation, and critical thermal maxima (CTmax, a hard physiological limit on individual survival) ranged from 28.4°C to 33.7°C (Johnson 1971). Species of *Euastacus* are also sensitive to increasing temperatures (Lowe et al. 2010; Bone et al. 2015, 2017). When exposed to chronic, steadily increasing temperature, the mountain crayfish (*Euastacus sulcatus)* exhibited sluggish behaviour at approximately 23°C and incapacitation at approximately 27°C (Bone et al. 2014). It is unlikely that Monteith's spiny crayfish will have the capacity to physiologically adapt to warmer conditions or relocate to cooler habitats as temperatures increase. These traits suggest all three focal species may have an increased vulnerability to increasing temperatures under climate change. In addition, climate change can also cause population declines due to the accrual of physiological damage over time and, in situations with multiple stressors (feral pigs, fire incursion etc) that reduce individual performance by altering metabolic demands, hydration, and foraging effort (Rohr and Palmer 2013). A decline in ecological fitness attributable to increasing temperature may cause population extinctions even where species stay within their thermal tolerance range (Bone et al. 2014; Merino-Viteri 2018). Severe limitations may be imposed on the survival of eggs, embryos and small metamorphs of frog species as they are highly susceptible to desiccation under dry and or hot conditions (Merino-Viteri 2018). Changing species distributions, as lower elevation species seek thermal refuge at higher elevations, may also lead to increased competition for resources with existing montane species.

Feral Pigs

Feral pigs (*Sus scrofa)* are opportunistic, omnivorous feeders that present a direct threat to frogs through predation, whether via incidental or deliberate ingestion (Jolly et al. 2010; Wishart et al. 2015), and indirectly through degradation and destruction of the ground layer inhabited by terrestrial and fossorial species (Mitchell 2010). Predation, habitat degradation, competition and disease transmission by feral pigs is listed as a key threatening process under the EPBC Act (DCCEEW 2023a).

Feral pigs were first recorded at KTNP in the early 2000s (QPWS unpublished data). Initially signs of feral pigs were recorded in rainforest patches below the escarpment. However, the numbers of feral pigs and the extent and severity of damage to areas of Kroombit tinkerfrog, Kroombit treefrog and Monteith's spiny crayfish habitat increased substantially as pigs spread across all surveyed rainforest patches below the escarpment and onto the plateau (DCCEEW 2023b). Damage by pigs has been observed in the seepages and drainage lines of critical Kroombit tinkerfrog habitat, where they have dug up large areas whilst feeding and wallowing (TSSC 2017). Damage has been seen along plateau streams and throughout the interior where large tracts of vegetation have been disturbed in Kroombit treefrog and Monteith's spiny crayfish habitat (DNPRSR 2013; Hines 2014; Page 2021). These impacts destroy frog call perches, nesting, and shelter sites, crayfish burrows, and cause siltation and reduce water quality (QPWS unpublished data). The microclimate at ground level is significantly altered and some streams in the area now carry heavy silt loads (TSSC 2017). Increased silt loads affect embryos and tadpoles by reducing their fitness at metamorphosis and the availability of food.

Feral pigs may also indiscriminately ingest frogs (adults, juveniles and eggs) and crayfish, and crush individuals as they forage and wallow (TSSC 2017; Page 2021). Damage by pigs also appears to have resulted in a reduction in ground cover (including seedling /sapling trees and other herbaceous vegetation) in and around streams and seepages (Hines 2021).

Feral pig impacts are greatest during periods of prolonged dry weather, as they congregate around streams and seepages at KTNP (QPWS unpublished data). With reduced rainfall and increased frequency of droughts due to anthropogenic climate change, the impact of pigs on threatened species habitats are likely to increase. Ongoing management of pigs is therefore critical for the long-term persistence of Kroombit tinkerfrogs, Kroombit treefrogs and Monteith's spiny crayfish.

Cattle and Horses

The area that is now KTNP includes areas that were previously State Forest, Forest reserve and National Park (Hines 2014). Historically, grazing was permitted over timber reserves and in national parks in Queensland (DES 2023a, b, c), and as a result KTNP includes areas formally used for grazing and stock reserves (Hines 2014; DNPRSR 2013). Cattle (*Bos taurus)* and horses (*Equus caballus)* are still present in KTNP due to this grazing activity and incursion from neighbouring properties (DNPRSR 2013).

Grazing regimes for livestock and grazing by cattle and horses reduces native vegetation cover, introduces weeds, and can lead to changes in plant species composition, soil structure and soil nutrient levels (Michael et al. 2010), as well as fouling of water. Rocky outcrops may also be trampled by cattle and horses, destroying the interstitial spaces and changing the thermal conditions which compromise their value as refugia (Michael et al. 2010). Loss of stream-side vegetation used as sheltering, feeding and calling sites for Kroombit treefrogs, and trampling of streambanks housing crayfish burrows will also negatively impact these threatened species. Impacts increase during dry periods as cattle and horses congregate around streams and seepages in rainforest at KTNP (QPWS unpublished). During drought periods, cattle have also been observed feeding on and inadvertently killing juvenile piccabeen palms (*Archontophoenix cunninghamiana*) which could affect the recruitment of palms and thereby degrade areas of Kroombit treefrog and (now former) Kroombit tinkerfrog habitat on the plateau in the long term (Hines 2021). Habitat alteration and loss of riparian vegetation is also an important factor affecting the distribution and survival of *Euastacus* species (Furse and Coughran 2011).

The impacts of cattle and horses are likely to be more significant for areas on the KTNP plateau, as escarpments sites are largely inaccessible to them (Hines and Clarke 2012). Therefore, cattle and horses are a threat to the Kroombit treefrog and Monteith's spiny crayfish inhabiting the plateau, but no longer a direct threat to the Kroombit tinkerfrog which is now only found in the very rugged, steep terrain of the drainage lines below the escarpment. However, impacts at the head of Kroombit Creek continue, as do the effects on water quality downstream in the species' current habitat which effects the species indirectly.

While the control or eradication of cattle and horses is a lower priority for areas currently occupied by the Kroombit tinkerfrog, their removal from the eastern section of KTNP will be of significant benefit to the Kroombit treefrog and Monteith's spiny crayfish reliant on these streams. It is also critical to the restoration of former Kroombit tinkerfrog habitat on the plateau, and of importance for other frog species, including the vulnerable tusked frog (*Adelotus brevis)* (Hines 2012; Hines and Clarke 2012).

Disease

Amphibian chytridiomycosis

Amphibian chytridiomycosis is a fatal disease caused by the chytrid fungus (*Batrachochytrium dendrobatidis)*. The fungus is a key threatening process listed under the EPBC Act (DCCEEW 2023a).

While there is no direct evidence of chytrid causing declines in the Kroombit tinkerfrog population, there is strong circumstantial evidence implicating the pathogen in the species' decline, including:

- observed mortality, declines and disappearances of other *Taudactylus* species.
- widespread occurrence of chytrid at Kroombit KTNP (Berger 2001; Symonds et al. 2007; QPWS unpublished data).
- the presence of reservoir host species for amphibian chytrid fungus at KTNP in sites where the Kroombit tinkerfrog has disappeared (extirpation from the plateau and persistence below the escarpment where there are fewer known hosts).
- the presence of sick and dead individuals of other frog species infected with chytrid at sites occupied by the Kroombit tinkerfrog.
- Kroombit tinkerfrogs test positive for chytrid in the wild (QPWS and CWS, unpublished data).
- a moribund wild Kroombit tinkerfrog with very high chytrid load died despite treatment with

antifungals and osmotic solution.

- observed susceptibility of Kroombit tinkerfrogs to chytrid in captivity (CWS, unpublished data).

Chytridiomycosis also poses a significant threat to the Kroombit treefrog, as moribund and dead frogs found between 1998 - 2002 were tested and found to be heavily infected with chytrid (QPWS unpublished data). Sick and dead individuals showing clinical signs consistent with chytridiomycosis continue to be recorded during surveys (QPWS unpublished data).

Histological and DNA analysis of the mouthparts of tadpoles or skin swabs of adult frogs, post-mortem analysis of sick and dead frogs (Berger 2001; Symonds et al. 2007; Murray et al. 2010) and recent eDNA testing of stream water (QPWS and CWS unpublished data), suggest a high prevalence of chytrid amongst various frog species at plateau streams in KTNP. The higher prevalence of chytrid at these streams may be due to the presence of reservoir hosts for amphibian chytrid fungus, including non-declining frog species such as the great barred frog (*Mixophyes fasciolatus*), central stony creek frog (*Litoria wilcoxii*) and clicking froglet (*Crinia signifera*). Cooler, wetter conditions and the presence of permanent water at plateau sites is also likely to favour the growth, development, and persistence of chytrid (Commonwealth of Australia 2016; Puschendorf et al. 2011).

DNA testing of skin swabs of Kroombit tinkerfrogs has also confirmed the presence of chytrid in several creek catchments below the escarpment (QPWS and CWS, unpublished data). The very limited evidence suggests the prevalence of chytrid infection at escarpment sites may be lower than plateau sites, with very few individuals testing positive for chytrid and eDNA analysis of water samples returning negative results at escarpment sites (QPWS and CWS, unpublished data). Infection levels (zoospore counts) for Kroombit tinkerfrogs that test positive for chytrid at escarpment sites are also usually low (QPWS and CWS, unpublished data).

A further potential reservoir species for chytrid at both plateau and escarpment sites is Monteith's spiny crayfish, which co-occurs with the Kroombit tinkerfrog and Kroombit treefrog. Numerous taxa were identified as potential reservoirs and vectors of chytrid in a recent review by Prahl et al. (2020). Crayfish and reptiles were found to be prominent and consistent non-amphibian hosts. The infection status of Monteith's spiny crayfish is unknown. It is also unknown whether chytrid has a negative impact on the population of Monteith's spiny crayfish. However, chytrid has been shown to cause gill tissue damage, inhibiting respiration and causing some mortality, in crayfish (*Procambarus alleni*) overseas (Nordheim, et al. 2021).

Currently, there are no effective methods for eliminating chytrid in the wild and it is therefore likely to remain an ongoing threat to the Kroombit tinkerfrog and Kroombit treefrog. The threat posed by amphibian chytrid fungus could potentially increase if more virulent strains of chytrid are introduced to KTNP.

Crayfish plague

Crayfish plague is a highly contagious fungal disease caused by *Aphanomyces astaci* that is uniformly fatal (100 % mortality) to susceptible species (Panteleit et al. 2017). Crayfish plague devastated native populations freshwater crayfish species in Europe and Asia after its introduction from North America (Panteleit et al. 2017). In Scandinavia, national declines in crayfish populations were up to 80 % and some lakes where crayfish were eliminated became choked with aquatic plants (Abrahamsson 1966).

The translocation of North American crayfish, in particular signal crayfish *(Pacifastacus leniusculus)* and red swamp crayfish *(Procambarus clarkia)*, is responsible for the disease's movement outside of its native range. Infected crayfish from the Americas can be reservoir hosts and are largely unaffected by the disease (DAWE 2019). Red swamp crayfish are prohibited aquatic animals under the *Biosecurity Act 2014,* and it is illegal to sell this species in Queensland (DAF 2023).

Many strains of the disease prefer the cooler temperatures, characteristic of Monteith's spiny crayfish habitat. Crayfish plague is not currently known in Australia but is documented as fatal to Australian freshwater crayfish (Unestam 1975), and it is listed on Australia's National List of Reportable Diseases of Aquatic Animals (DAFF 2023). It poses an extremely high risk to native freshwater crayfish species in the event of it reaching Australian rivers and streams (DAWE 2019).

A single, illegally imported crayfish, infected with crayfish plague has the capacity to devastate the entire Australian crayfish fauna. Most likely via an unlicensed/illegal collector vector (or aquarium discard). Increasing illegal wildlife/aquarium trade appreciably increases the risk and probability of the disease's introduction to Australia (Furse 2014).

Other diseases

Numerous other pathogens and parasites are known to cause disease in amphibians (for details see Densmore and Green 2007). A number of these pathogens/parasites have been implicated in disease outbreaks and mortality of captive animals. However, very few are known to have caused population declines or extinctions. Notable exceptions include the ranaviruses and bacterium *Aeromonas hydrophila*, both of which have been implicated in mass mortality events affecting amphibian species (Bradford 1991; Carey 1993; WHA 2016). Movement of people through the rainforest habitats and streams at KTNP for illegal collection of Monteith's spiny crayfish or other recreational activities may also facilitate the introduction and/or spread of diseases and parasites to core habitats inhabited by all three focal species. Accurately assessing the threat posed by parasites and pathogens other than chytrid is problematic due to a lack of knowledge of the pathogens/parasites affecting animals in the wild and the susceptibility of Kroombit tinkerfrogs and Kroombit treefrogs to diseases other than chytridiomycosis.

There is also the potential for ecosystem changing forest pathogens to occur within the habitat of these frog species, such as dieback caused by *Phytophthora cinnamomi* (Commonwealth of Australia 2018). However, there is no evidence of forest die-back at KTNP (QPWS unpublished data).

Adequate hygiene protocols consistent with the 'Threat abatement plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis' and strict procedures are required to maintain disease and pathogen free captive populations of species, in addition to prerelease screenings of animals.

Adverse Fire Regimes

A fire regime is the pattern, frequency, intensity, season and type of fires that occur at a point in the landscape over time (Melzer and Hines 2022). Fire regimes that cause declines in biodiversity is a key threatening process listed under the EPBC Act (DCCEEW 2023a), and fire incursion poses a significant threat to these threatened species. Rainforest ecosystems are highly fire-sensitive and fire impacts are significant even at very low fire severity (DAWE 2022). All three threatened species inhabit rainforest habitats at KTNP.

As the Kroombit tinkerfrog occupies rocky streams and seepages, living amongst leaf-litter, logs, and rocks (Clarke 2006), any fires in rainforest occupied by the species are likely to result in some direct mortality. Although the Kroombit treefrog is strongly associated with larger permanent streams or pools, fires in rainforest habitats are most likely to occur during prolonged droughts when there is little or no surface water available at KTNP. Individuals may shelter in moist locations (e.g. rock crevices). However, habitat degradation through the loss of habitats for daytime refuges, nesting and calling sites, and an associated reduction in arthropod habitat and thus food availability are factors impacting frog species immediately post-fire (Hines et al. 2020a). It is not clear what the direct impact of fire on Monteith's spiny crayfish may be, however a similar high elevation rainforest species (Ellen Clark's Crayfish *Euastacus clarkae*) suffered mass mortality directly after a fire (McCormack 2015). This was attributed to the loss of ground cover exposing bare soil and shallow burrows (in shallow slow flowing water) and to rapidly rising temperatures which stressed and killed the crayfish (McCormack 2015). The secondary impacts from post-fire run-off and sedimentation resulting in deterioration of water quality (pH changes and low dissolved oxygen concentration) and altered habitat (see Ward et al. 2022; Whiterod et al. 2023) may also impact Monteith's spiny crayfish and tadpoles of the two focal frog species. Whiterod et al. (2023) identified that during the 2019-20 Australian wildfires emergency rescue (ex situ management) and subsequent reintroduction of some freshwater crayfish were critical actions to mitigate impacts of fire.

The large rainforest patch in the headwaters of Munholme and Three Moon creeks is likely a significant important fire refuge for the Kroombit treefrog and Monteith's spiny crayfish, however there is evidence of historical fires within this patch, such as fire scars and emergent brushbox, Sydney blue gum and *Acacia melanoxylon*. High intensity bushfires at KTNP in the 1990s burnt rainforest on

the Kroombit plateau (TSSC 2017). It is possible that the 1994 fire may be partially responsible for the decline of the Kroombit tinkerfrog in the Kroombit Creek catchment (Hines 2009). In 2018, fire burnt into escarpment sites occupied by the Kroombit tinkerfrog, though not to the same extent as earlier fires on the plateau (QPWS unpublished data). These past fires have resulted in significant damage to fire-sensitive riparian rainforest communities, including killing or damaging large rainforest trees. This caused subsequent tree falls and opened the forest canopy, allowing invasion of lantana (Venz 2020). In recent years, areas of subtropical rainforest in Queensland considered safe from fire due to their moist microclimates, became dry enough to burn (Kooyman et al., 2020; Hines et al. 2020; Hines et al. 2022; Melzer et al. 2020; Meiklejohn et al. 2021; Hines et al. 2021; and Hines et al. 2020a), demonstrating that these types of habitat are more susceptible to fire impacts than had previously been recognised. Kroombit tinkerfrog rainforest habitat is particularly at risk due to its narrow configuration in steep terrain with adjoining fire-adapted eucalypt communities.

The rainforest and wet sclerophyll forest inhabited by the Kroombit tinkerfrog, Monteith's spiny crayfish, and Kroombit treefrog respectively, are surrounded by more flammable and often steep, dry vegetation communities, including RE 12.12.5 *Corymbia citriodora* subsp. *variegata*, *Eucalyptus crebra* woodland on Mesozoic to Proterozoic igneous rocks, and RE 12.12.20 *Eucalyptus saligna* tall open forest on Mesozoic to Proterozoic igneous rocks. Fire scars on larger trees are not infrequent in rainforest patches at KTNP (QPWS unpublished data), suggesting a long history of fire incursion into these fire sensitive communities.

Recovery of rainforest in burnt areas is protracted and fires can initiate transformational changes owing to long-term structural change and weed and pest invasion (DAWE 2022; see below), which may result in permanent loss of habitat and therefore decline in population numbers or loss of entire subpopulations. With harsher fire weather and El Niño-driven drought projected to occur across the region due to climate change (under RCP8.5; Dowdy et al. 2015), fire poses a growing threat to the Kroombit tinkerfrog, Kroombit treefrog and Monteith's spiny crayfish. Effective management of fire and fuel loads adjoining areas of critical rainforest habitat is essential for the persistence of these species.

However, caution must be exercised when carrying out bushfire suppression activities during operations. All three focal species are at risk from the use of retardants, wetting agents and gels during water bombing due to the chemicals within them used to supress fires (Harry Hines pers. com. Nov 2023). Similarly, caution must be exercised to prevent machinery used to create fire breaks from damaging occupied rainforest patches (Harry Hines pers. com. Nov 2023).

Invasive Weeds

Invasive weeds are known to alter fuel loads and thus fire ecology in rainforest habitats (Fensham et al. 1994; Berry et al. 2011; Chambers et al. 2019). Problematic weed species occurring within or near Kroombit tinkerfrog, Kroombit treefrog and Monteith's spiny crayfish habitat include thatch grass and lantana (Hines 2021; DNPRSR 2013). Both invasive weeds are known to increase fire incursion and severity and impede recovery of native vegetation following disturbance in rainforest communities (Hines et al. 2020a). Lantana increases fuel loads and provides a more continuous fuel layer in the understory (Berry et al. 2011). A positive feedback loop occurs, whereby lantana invasion facilitates fire and fire facilitates further lantana invasion (Fensham et al. 1994; Berry et al. 2011; Hiremath and Sundaram 2005).

Lantana forms dense infestations in and immediately adjacent to areas of occupied Kroombit tinkerfrog habitat, increasing the threat of fire (Hines 2021) and degrading riparian habitats occupied by Kroombit treefrogs (Hoskin et al. 2013). The spread and establishment of lantana is facilitated by disturbance from feral pigs, cattle and horses, and natural events such as floods, landslips and fire, all of which have occurred at sites currently or formerly occupied by the Kroombit tinkerfrog (Hines 2021), and habitat occupied by the Kroombit treefrog and Monteith's spiny crayfish.

Illegal Collection

Australian freshwater crayfish are at risk of illegal collection for sale in Australia and overseas, for a variety of reasons, including aquarium trade, food, and bait. All *Euastacus* species are classed "no take" species under the Queensland *Fisheries Act 1994* (Furse & Coughran 2011). It is unknown whether Monteith's spiny crayfish has been the subject of illegal collecting for the aquarium trade

(Coughran & Furse 2012), however collapsible pots have been found in Kroombit Creek (Page 2021). As this species is rare it may be considered valuable and therefore be at risk of collection for the illegal wildlife trade. Alternatively, Monteith's spiny crayfish may be inadvertently captured by fishers targeting *Cherax* species (yabbies), which is still an illegal activity within most national parks including KTNP) (Coughran & Furse 2010). Although the population size of Monteith's spiny crayfish is unknown, removal of individuals could be detrimental to the population. Movement of people through the rainforest habitats and streams at KTNP for illegal collection activities may also facilitate the introduction and/or spread of diseases and parasites to core habitats inhabited by all three focal species.

Threat Assessment

Each of the threats outlined above has been assessed for this RAP to determine the risk posed to the Kroombit tinkerfrog, Kroombit treefrog and Monteith's spiny crayfish using a risk matrix. This, in turn, determines the priority for actions. The risk matrix considers the likelihood of a threat occurring and the consequences of that threat. Threats may act differently in different parts of the species' range and at different times of year, but the precautionary principle dictates that the threat category is determined by the subpopulation at highest risk. Population-wide threats are generally considered to present a higher risk. The risk matrix uses a qualitative assessment drawing on peer reviewed literature and expert opinion. In some cases, the consequences of threats are unknown. In these cases, the precautionary principle has been applied.

Levels of risk and the associated priority for action are defined as follows:

- *Very High* – immediate mitigation action required.
- *High* – mitigation action and an adaptive management plan required; the precautionary principle should be applied.
- *Moderate* – obtain additional information and develop mitigation action if required.
- *Low* – monitor the threat occurrence and reassess threat level if likelihood or consequences change.

Categories for likelihood are defined as follows:

- *Almost certain* – expected to occur every year.
- *Likely* – expected to occur at least once every five years.
- *Possible* – might occur at some time.
- *Unlikely* – such events are known to have occurred but only a few times.
- *Rare or Unknown* – may occur only in exceptional circumstances; OR it is currently unknown how often the incident will occur.

Categories for consequences are defined as follows:

- *Not significant* – no long-term effect on individuals or populations.
- *Minor* – individuals are adversely affected but no effect at population level.
- *Moderate* – population recovery stalls or reduces.
- *Major* – population decreases.
- *Catastrophic* – population extinction.

Table 4. Threat assessment for Kroombit tinkerfrog: escarpment habitat.

Likelihood of occurrence	Consequence				
	Not significant	Minor	Moderate	Major	Catastrophic
Almost certain			Invasive weeds	Chytrid	Feral pigs Climate change Genetic health
Likely			Adverse fire regimes	Small population	
Possible					
Unlikely	Cattle and horses				
Unknown			Other diseases		
Risk matrix legend/Risk rating:					
LOW RISK	MODERATE RISK		HIGH RISK	VERY HIGH RISK	

Table 5. Threat assessment for Kroombit tinkerfrog: plateau habitat.

Likelihood of occurrence	Consequence				
	Not significant	Minor	Moderate	Major	Catastrophic
Almost certain		Invasive weeds		Feral Pigs Cattle & horses	Small population Genetic health Climate change Chytrid
Likely					
Possible			Adverse fire regimes		
Unlikely					
Unknown			Other diseases		
Risk matrix legend/Risk rating:					
LOW RISK	MODERATE RISK		HIGH RISK	VERY HIGH RISK	

Table 6. Threat assessment for Kroombit treefrog.

Likelihood of occurrence	Consequence				
	Not significant	Minor	Moderate	Major	Catastrophic
Almost certain		Invasive weeds		Feral pigs Cattle and horses Small population Genetic health Climate change Chytrid	
Likely					
Possible			Adverse fire regimes		
Unlikely					
Unknown			Other diseases		
Risk matrix legend/Risk rating:					
LOW RISK	MODERATE RISK		HIGH RISK	VERY HIGH RISK	

Table 7. Threat assessment for Monteith's spiny crayfish.

Likelihood of occurrence	Consequence				
	Not significant	Minor	Moderate	Major	Catastrophic
Almost certain		Invasive weeds		Feral pigs Cattle and horses Climate change	
Likely					
Possible	Illegal collection		Adverse fire regimes		
Unlikely					
Unknown				Small population Genetic health Crayfish plague	
Risk matrix legend/Risk rating:					
LOW RISK	MODERATE RISK		HIGH RISK	VERY HIGH RISK	

Summary of threat assessment

Table 8. A summary of the Threat Assessments for the three focal species indicating the Risk Rating or Level of each threat identified for the species.

Threat	Risk Rating			
	Low Risk	Moderate Risk	High Risk	Very High Risk
Small Population & Poor Genetic Health			Monteith's spiny crayfish	Kroombit tinkerfrog Kroombit treefrog
Climate Change				All species
Feral Pigs				All species
Cattle and Horses	Kroombit tinkerfrog (escarpment)			All species (plateau)
Disease				
Amphibian chytrid fungus				Kroombit tinkerfrog Kroombit treefrog
Crayfish plague				Monteith's spiny crayfish
Other Disease		Kroombit tinkerfrog Kroombit treefrog		
Adverse Fire Regimes			All species	
Invasive Weeds		All species (plateau)		Kroombit tinkerfrog (escarpment)
Illegal Collection	Monteith's spiny crayfish			

Previous and Current Conservation and Management Actions

Kroombit Tops National Park is managed by Queensland Parks and Wildlife Service, under the Values Based Management Framework (VBMF). The VBMF identifies the Kroombit tinkerfrog and 'Plateau riparian areas' as Key Natural Values at KTNP. 'Plateau riparian areas' comprise the upland, headwater streams at KTNP (Kroombit, Three Moon and Munholme creek catchments) which provide critical habitat for the Kroombit treefrog and Monteith's spiny crayfish.

QPWS designate the Overall Level of Service (LoS) required for Kroombit is 'High', and the LoS required for Pest and Natural values is 'Exceptional'. Combined, the VBMF and LoS gives rainforest dependent threatened fauna of KTNP, and in particular the Kroombit tinkerfrog, a high priority for management at the Regional and State level (QPWS unpublished). The QPWS pest management strategy outlines a whole-of-park approach for the management of pest plants and animals.

Critically Small Population Size and Poor Genetic Health

Captive breeding measures and conservation translocations are being used to abate the threat of critically small population size and its likely impact of poor genetic health. A small captive population of Kroombit tinkerfrogs is held at Currumbin Wildlife Sanctuary (CWS). Captively bred animals are being used to augment existing subpopulations and re-introduce individuals to extirpated sites under an approved translocation proposal. Successful breeding (production of eggs and tadpoles) occurred in Jan-Feb 2020 and is ongoing.

Population size, and the genetic health of Kroombit treefrog and Monteith's spiny crayfish remain unknown, and to date, no systematic sampling to determine population size and genetics has occurred for these species at KTNP.

Climate Change

There is no threat abatement plan under the EPBC Act for this key threatening process and are no threat abatement or management actions in place specifically for the Kroombit tinkerfrog, Kroombit treefrog or Monteith's spiny crayfish regarding this threatening process. Measures to address climate change itself are of a global nature. However, local action remains essential to mitigate some of the impacts of climate change at the local scale. Identifying refuge habitat or habitat that will persist longer into the future for the three focal species is important. In addition, maximising the resilience of ecosystems supporting these threatened species and effective mitigation of the threats affecting these species outlined in this RAP are critical to slow the impacts of climate change.

Feral Pigs

Threat abatement and current management practices for feral pigs are detailed in 'Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)' (Commonwealth of Australia 2017). The QPWS pest management strategy for KTNP outlines a whole-of-park approach for the management of pest plants and animals (DES 2021) with a goal for minor to no impact from feral pigs at key sites by 2025 (DES 2018; DES 2023). The Department and other organisations such as the Fitzroy Basin Association, have provided funds to support pest management actions at KTNP.

A feral pig control program was established in 2000 at KTNP, and has included trapping, baiting, shooting and the use of Judas sows. Despite this, there were still high numbers of pigs in the lowlands and recent widespread evidence of habitat degradation by feral pigs (Venz 2019; Venz 2020). The lower eastern escarpment area cannot be readily ground baited due to its rugged terrain (DES 2021). Increased aerial 1080 baiting for pigs across KTNP has seen a reduction in pig damage (H. Hines pers. comm. Nov 2023).

A feral pig exclusion fence (stage 1 approximately 100m perimeter) was erected in November 2015 around seepages in the headwaters of Degalgil Creek in rainforest occupied by the Kroombit tinkerfrog (Hines 2023). The exclusion fence halted and reversed the impact of feral pigs on Kroombit tinkerfrog habitat in this area. Since the removal and exclusion of feral pigs, a dense litter layer has redeveloped, ferns and shrubs have increased in density, and there has been no disturbance to call perches or the seepages (Hines 2023). An extension was added to the lower edge of the fenced area in September 2021, incorporating more of the drainage line downstream (stage 2 an additional 200m perimeter) (Hines 2023). Ongoing maintenance of this fence is undertaken by QPWS staff and volunteers. Fencing at other sites is not feasible due to access constraints, terrain, and large volumes of overland flow during flood events (Hines 2023). The threats posed by feral pigs to the three focal species will require ongoing management through the implementation of control programs.

Cattle and Horses

QPWS pest management strategy for KTNP aims to reduce the impacts of feral cattle and horses on plateau riparian communities and creek systems (DES 2021). In the late 1990s rangers were actively engaged in control programs to remove feral horses and unwanted cattle, and the horse population was estimated as less than 80 animals by the year 2000 (DES 2021). However, follow up efforts were hampered leading to steady increases in feral cattle and horses over the next fifteen years, to

approximately 2000 horses in 2016 (DES 2021; No estimates are given for cattle.). Few serviceable stock fences and no holding paddocks remain in use within KTNP which presents a major issue in the control of any stock being mustered. Mustering of unwanted cattle and feral horses is also difficult due to the rugged terrain, fallen timber, safety risks to horse riders and stock mustering vehicles, and transport of stock is problematic due to the steep unsealed roads and entrance road load capacity (DES 2021). In 2010 a fence was constructed to exclude stock from KTNP. In recent years QPWS has been negotiating with adjoining lessees to secure boundary fences and do a final stock removal as leases expire. Ongoing maintenance of the boundary fence is required. The threats posed by cattle and horses to Kroombit treefrog and Monteith's spiny crayfish will require ongoing management.

Disease

The 'Threat abatement plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis' (Commonwealth of Australia 2016) aims to control and limit the spread of chytrid. This includes decreasing the impact of infection within frog populations that are currently infected and preventing further spread. Hygiene protocols that are consistent with the goals and recommendations of the national Threat Abatement Plan are currently in place for frog surveys, monitoring, translocation, and for other research activities within or adjacent to riparian habitats. Implementation of these protocols will help reduce the risk of introducing and spreading other potential environmental pathogens into the system.

DNA testing of skin swabs of Kroombit tinkerfrogs and eDNA analysis of water samples for the presence of chytrid has occurred at escarpment sites in both occupied and previously occupied rainforest patches in Degalgil and Diglum creeks respectively. Similarly, DNA testing of skin swabs of Kroombit treefrogs and analysis of water samples for the presence of chytrid has also been carried out at plateau sites formerly occupied by the Kroombit tinkerfrogs.

As part of the captive husbandry project, options for prophylactic treatment of chytrid in captive bred animals are also being investigated. If a safe and effective treatment for use on Kroombit tinkerfrogs is developed, this will be applied to captive animals destined for release into the wild.

Adverse Fire Regimes

Fire is managed by QPWS at KTNP through a detailed fire strategy which is updated regularly. A key goal of this strategy is to minimise the likelihood and severity of fires in fire sensitive ecosystems such as rainforest (DES 2018; DES 2023), which is the core habitat of the three focal species. The strategy provides a mechanism for cooperative fire management with First Nations people, neighbouring properties and rural fire brigades. Implementation of the strategy will improve management of fire in the area. As most of the rainforest habitat for the three focal species are narrow patches surrounded by fire adapted eucalypt forest and woodlands, often on steep slopes, fire incursion will remain an ongoing threat under climate change and will require ongoing management. The presence of lantana further exacerbates the risk of fire to rainforest and their ecotones at KTNP.

Management of fire along the eastern escarpment at KTNP, that includes critical habitat for Kroombit tinkerfrog and Monteith's spiny crayfish, is a regional QPWS priority. Aerial ignition is now used for planned burns in adjacent fire-adapted communities in this otherwise inaccessible part of the park to achieve better outcomes for protection of rainforest patches.

Invasive Weeds

The QPWS pest management strategy for KTNP aims to prevent establishment of thatch grass (*Hyparrhenia rufa)* and eradicate lantana *Lantana camara* in fenced habitat occupied by the Kroombit tinkerfrog in Degalgil Creek catchment (DES 2021). It also aims to prevent the spread of large areas of lantana and small patches of parthenium (*Parthenium hysterophorus)*, *Praxelis clematidea* and thatch grass in Kroombit Creek catchment on the plateau and impacting threatened species habitat. However, prior to 2020 there had been no targeted control of lantana in the rainforest patches occupied by the Kroombit tinkerfrog or plateau riparian areas (Venz 2019; Venz 2020). Rainforest patches occupied by the Kroombit tinkerfrog are difficult to access. Control methods have been chemical and mechanical (hand-control). Given the interaction of fire and lantana these control efforts

aim to lessen the impacts of fire, particularly at the rainforest ecotones. The threats posed by invasive weeds will require ongoing management.

Illegal collection

There is no threat abatement plan in place specifically for the illegal collection Australian freshwater crayfish. All *Euastacus* species are classed “no take” species under the Queensland *Fisheries Act 1994*. There have been no management actions regarding the potential illegal collection of Monteith’s spiny crayfish at KTNP, beyond the protective measures afforded to all national parks in Queensland.

RECOVERY STRATEGY

This Recovery Action Plan guides recovery actions for rainforest dependent threatened fauna of KTNP for the next 10 years. Specifically, this RAP covers the Kroombit tinkerfrog, Kroombit treefrog, and Monteith’s spiny crayfish.

Vision

The long-term vision of the recovery program for rainforest dependent threatened fauna of KTNP extends beyond the life of this plan but this statement is important to ensure a consistent, long-term strategy.

By 2050 there are self-sustaining populations of Kroombit tinkerfrogs, Kroombit treefrogs, and Monteith’s spiny crayfish at KTNP. The populations are genetically diverse and occupy resilient habitat. The conservation status of each species has improved. The species are valued by the community, with First Nation’s People and the wider community involved in appropriate management activities.

Operationalised Visions

Kroombit tinkerfrog

By 2035, the Kroombit tinkerfrog population has not declined from the 2023 baseline of 150 frogs and the condition of critical habitat below the escarpment has improved. There is a genetically healthy breeding captive population, if still required to support the wild population.

By 2050, the Kroombit tinkerfrog population size has increased to more than 500 mature individuals, the distribution of the species has expanded to occupy 5 rainforest patches at KTNP, with more than 50 mature individuals per rainforest patch. The condition of previously occupied habitat on the plateau has improved so that it is available for potential reintroductions should measures to improve resilience to chytrid become available.

Kroombit treefrog

By 2035, the Kroombit treefrog persists in all sub-catchments occupied in 2023, with a population that is stable or increasing from the established baseline, and the condition of critical habitat has improved.

By 2050 there is a self-sustaining* population of Kroombit treefrogs with more than 100 mature individuals in each of the five sub-catchments of KTNP, Three Moon and Munholme creeks. The habitat quality has improved.

Monteith’s spiny crayfish

By 2050, Monteith’s spiny crayfish at KTNP persists in all sub-catchments occupied in 2023, its population is stable or increasing from the established baseline, and the condition of critical habitat has improved.

*Self-sustaining – population that remains stable or increases with no human intervention

Goals

There are six goals presented in the following section, each with specific objectives and actions, that are practical and operational steps toward achieving the long-term vision. These goals are for the life of the plan.

1. Reduce the impacts of small population size to improve the adaptive capacity of the Kroombit tinkerfrog.
2. Reduce impacts of invasive pest species (feral pigs, cattle, and horses, and plants) and fire on the three focal species and their habitat to increase population size and improve habitat condition.
3. Minimise the risk of spreading significant or novel diseases and parasites that are known or likely to impact the three focal species or their habitat to maintain healthy populations.
4. Improve understanding of the population trends of the three focal species to better effect management.
5. Improve understanding of the current genetic population structure and genetic health of each of the three focal species, to inform species management.
6. Improve engagement of key stakeholders and the local community in relation to the management of the three focal species to better effect recovery.

EVALUATION AND REVIEW

The establishment of a working group is proposed to oversee the implementation of this RAP. The working group will review progress against each objective annually by considering the status of each action and how it contributes to achieving the objective. Where objectives have only been partially met or not at all, strategies to address the issues will be developed. If necessary, the objective will be amended or reconsidered and any changes to the approved RAP will be proposed to the TSO Director via the Chair of the working group. An annual report that addresses the progress against each objective will be developed and submitted to the TSO Manager/Director.

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Appendix 1: Statement of Co-Benefit

The KTNP plateau riparian areas have high biodiversity values driven by the unique environmental conditions (geology and climate). These creek systems, in conjunction with the riparian vegetation communities, contribute significantly to the health of the catchment along with providing refuge for near threatened or threatened species, particularly threatened frog species.

The upland, headwater streams of Kroombit, Three Moon and Munholme Creeks provide critical habitat for significant but poorly mapped warm temperate and subtropical rainforest communities. This includes the disjunct northern extent of warm temperate rainforest dominated by coachwood (*Ceratopetalum apetalum)*.

A significant population of the more widely distributed Vulnerable tusked frog (*Adelotus brevis)* also occurs at Kroombit, and the area also provides habitat for the endemic vulnerable orchid *Bulbophyllum weinthalii* subsp. s*triatum*, and near threatened plants *Muellerina myrtifolia* and *Thismia rodwayi.*

Many of the actions outlined in this Recovery Action Plan will benefit these species and ecosystems at KTNP.