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Department of Climate Change, Energy,
the Environment and Water



Looking after Tjakura, Tjalapa, Mulyamiji, Warrarna, Nampu

National Recovery Plan for the Great Desert
Skink (*Liopholis kintorei*)

2023-2033



The Species Profile and Threats Database page linked to this recovery plan is obtainable from:

http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83160

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We sincerely thank the Traditional Custodians and Rangers who have contributed their extensive knowledge, data and ideas for saving the Great Desert Skink to the new Recovery Plan. We thank them for their efforts in managing the country on which it occurs and keeping both the skinks and their *Tjukurrpa* alive.

We would like to make special acknowledgement of the efforts of Steve McAlpin who conducted much of the foundational research on Great Desert Skinks and wrote the initial Recovery Plan and other documents which have been heavily drawn upon for the new Plan.

We would also like to thank the many other partners from Commonwealth and State environment departments, researchers, Aboriginal Corporations, Natural Resource Management bodies, community group representatives, private land managers/ custodians, and ecological consultants who have provided support, information and ideas for the Plan.

Front Cover Image credits

Tjalapa Painting by John Tjupurrula West, Kiwirrkurra IPA, 2019.

Summary

The Great Desert Skink (*Liopholis kintorei*) is a large orange skink. It lives in a communal family burrow system where young lizards are raised by their parents for the first two years of life. The Great Desert Skink is a species of cultural significance for Aboriginal people, both as an important Tjukurrpa species and a food resource. It is known by various names in different Aboriginal languages but for the purposes of this document it is mainly referred to as Tjakura.

Tjakura has disappeared from many places that it was known from in the pujiman (bushman) days (before Aboriginal people moved into settlements). It is now classified as Vulnerable to extinction under the Australian Government's Environment Protection and Biodiversity Conservation Act 1999, because of its small population size, and inferred continuing decline in range and abundance.

This Recovery Plan is a two-way science document. Its purpose is to bring together Indigenous Knowledge and scientific research about Tjakura into a single document that motivates and educates people about the most important management and research actions required to stop the decline, and support the recovery of, Tjakura over the next 10 years.

To create this Recovery Plan the Indigenous Desert Alliance (IDA) held a series of workshops with many stakeholders across the range of Tjakura in 2021 to establish a shared vision, define goals and objectives, and prioritise the actions needed to save this important animal from extinction.

Our shared Vision is "In 2050 Tjakura are safe on Country, babies are born and survive, rangers are caring for them, under the guidance of Elders, with the support of the broader community. Our cultural connection to Tjakura is strong and sustainable harvesting is possible because populations are healthy, abundant and genetically diverse, thriving in all the sites they were known from in 2023."

We will work towards this long-term vision by striving to achieve the following Goal over the next 10 years:

Overall Goal: In 2033 cultural knowledge of Tjakura remains strong, and the skink is no longer classified as Vulnerable to extinction because the global population continues to increase beyond 10,000 mature individuals, and neither the range or number of known sub-populations is declining because key sites are being actively managed by motivated rangers and other land managers.

Progress towards this goal will be measured using performance criteria associated with two specific Conservation Objectives and one Cultural Objective:

Conservation Objectives (and performance criteria)

- The range of the Tjakura remains stable
 - PC1: The Extent of Occurrence in 2033 is at least equal to the EoO in 2023
 - PC2: In 2033 Tjakura occupy all 20 places they were known from in 2023
- The size of the Tjakura population is growing
 - PC3: From 2023- 2033 there is an ongoing increasing trend in the number of known active burrows across the range
 - PC4: The estimated number of active burrows across the range exceeds 10,000

Cultural Objective (and performance criteria)

- Cultural Knowledge of Tjakura remains strong
 - PC5: In 2033 Tjakura cultural sites, stories and songs and ceremonies are known, documented and maintained across the Country where Tjakura occurs

Actions required to meet these Objectives are described in this Recovery Plan. They have been grouped into nine strategies.

Strategies

▪ **DOCUMENT AND SUPPORT CULTURAL KNOWLEDGE AND PRACTICES:**

Recognise culture is at the heart of conservation and support projects to record cultural knowledge and continue to engage in cultural practices.

▪ **MOTIVATE AND EDUCATE:** Increase the motivation to manage Tjakura through activities that promote its cultural and conservation significance and build its charisma and profile amongst the general public, government and scientists to ensure support for the species.

▪ **SURVEY NEW AREAS:** Establish current status by conducting additional surveys and consultation (especially around the edge of the range and in key gaps) to determine current distribution and number of subpopulations and identify where management is required.

▪ **FIRE MANAGEMENT:** Protect populations from fire by including specific targeted burns around main burrow areas in annual burning plans, and implementing these and broader scale burns in surrounding areas to reduce the chance of wildfire affecting burrows.

▪ **PREDATOR MANAGEMENT:** Conduct strategic predator control at selected, accessible sites, particularly if sites get burnt.

▪ **PROTECT TJAKURA HABITAT FROM OTHER HUMAN DISTURBANCES:** Protect Tjakura habitat from the impacts of mining, tourism, other infrastructure development, pastoralism, poaching and over-harvesting.

▪ **ADDRESS NEW AND EMERGING THREATS:** Investigate and address any additional threats to Tjakura populations including climate change, disease outbreaks and weeds.

▪ **MONITOR POPULATIONS:** Establish monitoring at key populations across a geographical spread of sites in NT, WA and SA.

▪ **SHARE INFORMATION:** Report successes and failures back to other stakeholders to continually refine management techniques and learn from and encourage each other.

Each of the nine strategies have a specific aim, a list of actions required to achieve the aim, and a set of desired outputs, outcomes and measurable indicators.

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Background

Purpose of this Plan

“All our rangers are getting together so we can look after Warrana, make a new plan for when we go out”

Christine Ellis, Newhaven Wildlife Sanctuary /Nyirripi Ranger, December 2021

This is a two-way science Recovery Plan that aims to bring together Traditional Ecological Knowledge and scientific research about the great desert skink into one document that motivates and educates people about the most important management and research actions required to stop the decline and support its recovery over the next 10 years.

This is the second National Recovery Plan for the Great Desert Skink. The first Plan was published in 2001 when scientific knowledge of this species was in the early stages of development and Ranger programs were yet to become established in the deserts. The original plan had the modest objectives of maintaining or improving the status of the Great Desert Skink, and improving fire and feral animal management around three key populations (McAlpin 2001).

The plan was successful in encouraging targeted fire management, predator control and long-term monitoring programs around three populations (Newhaven Wildlife Sanctuary Wildlife Sanctuary, Kiwirrkurra, Uluru/Yulara). Many other actions in the original plan have also been implemented and the conservation status of the Great Desert Skink has been maintained.

While this second Plan builds on the work of the first, it draws more strongly on information and priorities of Indigenous Knowledge holders from across the deserts, as well as information in the Australian Government’s Conservation Advice (TSSC 2016), an IUCN assessment in 2017 (Paltridge et al. 2017) and a suite of scientific studies, surveys, local management plans and monitoring programs conducted since the original Recovery Plan was written. It incorporates new knowledge of subpopulations, threats and stakeholder interest, and outlines a roadmap towards removing the great desert skink from the threatened species list.

Listening to the ideas of Traditional Owners and Rangers from the beginning of the Recovery Planning process is a new approach the Australian Government is using to make Recovery Plans for Threatened Species especially for those species of cultural significance.

What is a Recovery Plan?

A recovery plan is a document that describes the most important management actions and research necessary to save a species from extinction.

It should bring together the knowledge, ideas and perspectives of Indigenous Australians and other stakeholders.

A Recovery Plan must include clear objectives for the recovery of the species, criteria that will indicate if the Objectives are being met and Actions to achieve the Objectives. It must clearly describe the known threats to the species and provide maps of its distribution, highlighting important habitat and populations.

The Government can use Recovery Plans to prioritise where they direct funding, and also to make decisions on development applications.

Managers can use Recovery Plans to help guide their management and monitoring programs.

Scientists can use Recovery Plans to work out what the most useful research projects would be to help save a species.

How we made this plan

This Recovery Plan is the culmination of many meetings and discussions held between 2011 and 2021.

Steve McAlpin wrote a lot of the background ecology information, which has been updated with the results of more recent surveys and research projects.

Many people contributed to the Conservation Advice and IUCN review in 2016 and 2017.

Following the compilation of a local Recovery Plan for Tjakura in the Anangu Pitjantjatjara Yankuytjatjara Lands (Partridge 2008), other groups conducted local consultations to produce their own regional plans for Great Desert Skink work in their areas (e.g. Tjakura Rangers on the Katiti Petermann Indigenous Protected Area (IPA)).

The idea to write an Indigenous-led Recovery Plan was sparked at a meeting of Tjakura experts from Punmu, Nyirripi and Kiwirrkurra at Australian Wildlife Conservancy's Newhaven Wildlife Sanctuary in April 2018 where groups shared knowledge about Tjakura cultural information, monitoring and management. This meeting instigated discussions about sustainable hunting of Tjakura, and the groups made a statement that as Rangers they don't endorse eating Tjakura anymore.

Tjakura knowledge sharing sessions were held at the annual IDA conferences in both 2018 and 2019. The 2019 conference also included a mapping session with the Department of Climate Change, Energy, the Environment and Water (DCCEEW) to update the known distribution across the desert, and a field trip to demonstrate burrow monitoring surveys on the Katiti Petermann IPA near Uluru Kata Tjuta National Park (UKTNP).

Support staff from multiple Indigenous land management groups in NT, WA and SA and Australian Wildlife Conservancy, had several phone meetings in 2020 and 2021 with DAWE to further develop the idea of creating an Indigenous-led Recovery Plan, as well as organising collaborative activities to conduct surveys together, and to learn from and inspire each other.

In September 2021 DCCEEW contracted the IDA to lead the writing of the new Recovery Plan. Between October and December 2021 the IDA held Tjakura workshops in Fitzroy Crossing, Wiluna, Yulara and Alice Springs to give Ranger groups and other land management organisations involved with Tjakura work the opportunity to share knowledge and ideas and to set priorities for the new Recovery Plan.

The Fitzroy Crossing meeting was a short information session attended by Ranger teams from Kiwirrkurra, Ngururpa, Paruku, Ngurra Kayanta, Gooniyandi, Ngururra, Nyangumarta, Karajarri, Yawaru, and Nyamal.

The Wiluna workshop was attended by Rangers representing Punmu, Birriliburu IPA, Matuwa Kurara IPA, Wakamurru and Gingirana.

The Yulara workshop was attended by UKTNP Rangers, Central Land Council (CLC) Rangers from Docker River, Angas Downs and Mutijulu, and staff and Indigenous Trainees from Voyages Ayers Rock Resort. The Alice Springs workshop was attended by Rangers from Kiwirrkurra, South Tanami IPA, Newhaven Wildlife Sanctuary and Nyirripi, other CLC staff, NT government, Territory NRM and Australian Wildlife Conservancy staff from Newhaven Wildlife Sanctuary and Ngallurtju Sanctuaries.

The IDA has collated information from all these meetings and combined it with information from research papers, reports and regional management plans into this Recovery Plan.

Photograph 1. Tjakura Recovery Plan workshop at Wiluna, October 2021.



Source: Desert Support Services

Photograph 2. On country fire planning to protect Tjakura workshop, Punmu, October 2015.



Source: Desert Support Services

Species Description – what is Tjakura

Tjakura – widely known in English as the Great Desert Skink (*Liopholis kintorei*) – is a large orange (or sometimes grey) skink of similar size to a blue-tongue lizard. It lives in a big communal family burrow system with a nearby latrine where the family all deposit their scats.

Tjakura is a species of cultural significance for Aboriginal people, both as an important Tjukurrpa species and a food resource. It is known by a variety of local names in Aboriginal languages – **Tjakura** in the Pitjantjatjara, Yankunytjatjara and Ngaanyatjarra languages, **Warrarna** in Warlpiri language, **Tjalapa** by Pintupi speakers, **Mulyamiji** in the Manyjilijarra language spoken by Martu, **Nampu** in the language of the Mantjintjarra Ngalia people and **Aran** spoken by the Anmatjere (McAlpin, 2001). For the purpose of this document we will use **Tjakura** because this name covers the highest number of subpopulations, from the South Australian Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, to southern NT, and across to the Ngaanyatjarra Lands of Western Australia.

Originally in the *Egernia* genus, the scientific name of Tjakura changed from *Egernia kintorei* to *Liopholis kintorei* in 2008. Two similar but smaller species within the *Liopholis* genus (*L. striata* and *L. inornata*) remain common through the Australian deserts while a third member of the genus (*L. slateri*) has a narrow, restricted distribution centred on Alice Springs and is also classified as threatened. The night skink (*L. striata*) appears very similar to Tjakura but is only half the size and has a smaller simpler burrow system with only small scats.

Tjakura can reach a total length of 450 mm and weigh up to 300 g. Males are bigger than females and have a larger, wider head. Tails are often shortened due to damage during fights or predation attempts but intact tails are slightly longer than the head-body length, and become swollen at the base in good seasons when fat is stored. The colour of Tjakura range from bright orange to a dull brown or even grey. The belly ranges from bright yellow to cream or grey. The Martu name Mulyamiji means Red Nose.

Photograph 3. Kiwirrkurra Elder Walimpirri Tjapaltjari holding a tjulyulka (night skink) and a Tjalapa (Pintupi word for Great Desert Skink) to show the difference in size between the two closely related species.



Source: Kiwirrkurra IPA

Photograph 4. A Tjakura at the entrance to its burrow



Source: Nicolas Rakatopare, Yulara, 2021.

Cultural Significance

Tjakura is a special animal for Aboriginal people across the desert who continue to celebrate it in art, dance and song. It used to be an important source of meat for Aboriginal people, and is part of the creation story with its own Tjukurrpa sites and ceremonies.

The Kiwirrkurra women have a song about Tjalapa and blue-tongue. The story is about the mother blue-tongue fighting with mother Tjalapa because she is jealous that the tjalapa's babies have pretty little pink noses and fair skin but her babies have big black heads (Yukultji Napangati, personal communication, 2018).

To perform this song the Kiwirrkurra women paint their bodies to dance, using paint made from the Tjalapa's kuna (scats, or faecal pellets). The black part of the scat makes black paint to depict the blue-tongue and the white uric acid on the Tjalapa kuna makes the white paint for the light-skinned Tjalapa.

In the APY Lands there is a Tjakura Tjukurrpa site on the Watarru IPA called Aralya where an army of snake-men came down from Uluru and murdered the ancestral Tjakura - Wati Tjakura with spears (Ninuku Arts 2019). He tried to escape but was killed and his family came to grieve and bury him. It was in the vicinity of the Tjakura Tjukurrpa site that senior Anangu women Mary Pan and Iluwanti Ken rediscovered Tjakura (previously thought to be extinct in South Australia) in 1998 (Daniel, 1999). In 2015 Josephine Mick and Tjulkiwa Atira organised an intergenerational camp at Watarru to revisit the Tjakura colonies and revitalise its traditional story through art. A giant figure of a Tjakura was created from tjanpi (spinifex) (Photograph 5). In 2019, Kiwirrkurra Ranger, John Tjupurrula West, created a magnificent painting of Tjalapa signifying the cultural significance of the lizard to his people (Photograph 6).

“Warrarna is really special to us because it's got Tjukurrpa. The early days they used to eat Warrarna but this time they don't eat Warrarna because we became a Ranger. We look after them.” Christine Ellis, Newhaven Wildlife Sanctuary/Nyirripi Ranger, December 2021

“I been grow up for Warrarna. It has good taste, like a fish. You have to clean him, the skin, then put it in the fire... Long time right. Not now, not today, we Ranger.”

Alice Henwood, Newhaven Wildlife Sanctuary/Nyirripi Ranger, December 2021

“My mum and dad used to cook this one for us because it's nice and soft, soft for kids to eat, no bones”

Katherine Njamme, Ngururrpa Ranger, October 2018.

“Tjalapa – we used to eat him. My mother used to get a full coolamon of Tjalapa – big ones and little ones. All around Bilaluna country, and here too”

Bessie Doonday, Paruku IPA, October 2018.

Photograph 5. Wati Tjakura sculpture featured in Aralya Project catalogue.



Source: Ninuku Arts (2019).

Photograph 6. Tjalapa painting by John Tjupurrula West



Source: Kiwirrkurra IPA/Tim McGrath

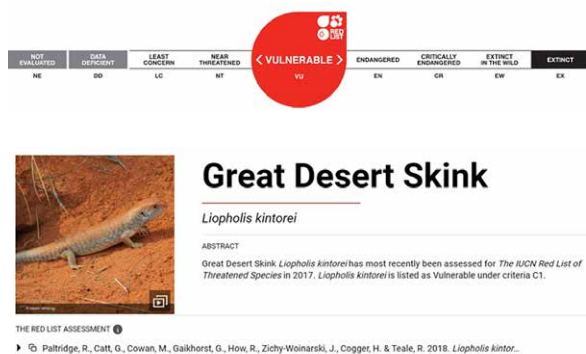
Conservation Status

The Conservation Status of an animal describes how likely it is to go extinct in the near future. This is based on its overall population size, extent of occurrence (geographic range), area of occupancy (area within its range where burrows still occur), and trends in population abundance.

The Tjakura is a threatened species, classified as **Vulnerable** to extinction under the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). This means that it is at risk of going extinct in the wild (in the next 100 years) if nothing is done to manage threats. Under State and Territory legislation the Tjakura is listed as **Vulnerable** in the NT and WA and **Endangered** in SA.

The most recent review of the status of *Tjakura* occurred in 2017 for the IUCN Red List, when a panel of experts confirmed its Vulnerable status based on criterion C1 (overall population size < 10,000 mature individuals and estimated continuing decline of >10% within 10 years).

Figure 1. The Great Desert Skink is recognised internationally as a Vulnerable species on the IUCN Red List.



We hope that by the end of the life of this Recovery Plan our work will show that Tjakura is no longer threatened with extinction. To achieve our goal of removing Tjakura from the threatened species list we will need to be able to demonstrate that our management and monitoring are effective enough to show that:

- There are more than 10,000 adult Tjakura across Australia
- Overall population trend is stable or increasing over a 10-year period
- Geographic range (Extent of Occurrence) is not declining, and
- Number of known inhabited places remains stable

These criteria, drawn from the IUCN Red List guidelines (IUCN 2022), have been incorporated into the performance criteria measures that we have chosen for our conservation objectives and overall goal.

Where does Tjakura live?

Historical distribution

Historically Tjakura occurred across a large area of inland Australia from the Broome region in the north-west across the Great Sandy and Tanami Deserts to Tennant Creek in the north-east, to Wiluna in the south-west and east across the Gibson and Great Victoria Deserts to north-western SA (Figure 1).

Tjakura was originally described and named in the scientific literature from a specimen collected in 1891 from the northern Great Victoria Desert, about 150 km south-east of Warburton. Other historical museum specimens were collected from Bililuna and Godfrey's Tank (northern Canning Stock Route) in 1931, Punt Rockhole (south of Amata in SA) in 1932, Lapi lapi (north of Lake Mackay) in 1957, in the vicinity of Rabbit Flat (1938), Mount Liebig (1933), between Wiluna, Leinster and Laverton and at Warburton in the 1960s and Angas Downs and Yuendumu in the 1970s (McAlpin 2001). Additional specimens recorded from Roebuck Bay in 1896 and Tennant Creek in 1906 are likely to have been brought in from adjacent desert areas of unknown distance.

There were no further sightings of Tjakura at many of these sites around the edge of the former range post-1980 and by the time the first Recovery Plan for Tjakura was written in 2001 it was assumed that the range of Tjakura had contracted significantly from the edges. Interviews with senior Traditional Owners from Watarru, Uluru and Yuendumu revealed that Tjakura had gone locally extinct at many sites they were formerly known from, leaving only a small number of widely separated sites within its distribution. Extensive tracking surveys through the Great Sandy Desert by Martu Rangers found Tjakura at only 3/150 track-plots (McGilvray 2013), and only 7 of 165 track-plots in the Tanami Desert in the 1990s (Rick Southgate, unpublished data, in McAlpin 2001). At UKTNP they were recorded at 15/190 survey sites (McAlpin 1997). None were found in the biological surveys conducted across the APY Lands from 1991 to 2001 (Robinson *et al.* 2003) however Tjakura was rediscovered in South Australia in 1997 when two Aboriginal women came across some burrows on the Watarru IPA which was the first record for SA in 63 years (Daniel 1999, Partridge 2008).

Current distribution

The review of the status of Tjakura conducted for the IUCN in 2017 described 12 known regional subpopulations across an overall Extent of Occurrence of about 500,000 km² (Paltridge *et al.* 2017). However, subsequent survey work conducted by Aboriginal Rangers and consultants have extended the known range in the south-west (Birriliburu IPA, Matuwa IPA, Jigalong area and Lake Wells near Cosmo Newberry), increasing the Extent of Occurrence to 770,000 km². New subpopulations have also been detected within the existing range, on the Ngururrpa IPA, along the Tanami Road and on the Ngaanyatjarra Lands. The currently known distribution of Tjakura is shown in Figure 1. Sites where Tjakura have been confirmed as present in recent years are listed in Table 1.

One of the largest Tjakura surveys conducted in recent years was the targeted searches conducted on the Ngaanyatjarra Lands in 2018 and 2019. After mining consultants discovered a large subpopulation occurred at a potential mine site 30 km south of Jameson (106 active burrows in 400 km², Western Wildlife 2019) the Ngaanyatjarra Rangers were contracted to conduct a regional survey of Tjakura within a 200km radius of the mine site (Ngaanyatjarra Council Land & Culture, 2019). They recorded 60 active burrows across a vast area, with many new sites mapped between Jameson, Warnarn, Warrakurna and Blackstone. As this population also extends to Warburton, Tjirrkarli, and Patjarr, the Ngaanyatjarra Lands may support the largest known regional population of Tjakura in Australia.

Another extensive survey was conducted along the route of the new Tanami Pipeline, which follows the Tanami Road. The 500 km transect, which essentially traverses the north-eastern boundary of the known range of the Tjakura was surveyed by walking the entire route on foot, searching for burrows. Although a high density of burrows was recorded at the northern end of the pipeline (>300 burrows within 13 km of core habitat through the Sangsters Bore palaeodrainage channel), and scattered burrows occurred within 50 km north and south of the high-density area, there was only one location found in the southern 300 km section, due east of the Newhaven Wildlife Sanctuary population (Eco Logical Australia 2018).

Other large populations, known to comprise more than 100 burrows, occur on Newhaven Wildlife Sanctuary, UKTNP (and the adjacent Yulara Freehold Land and Katiti-Petermann IPA), and on the Kiwirrkurra IPA.

A study of the genetic diversity of Tjakura across its range revealed that sufficient similarity occurred between Newhaven Wildlife Sanctuary and Sangsters Bore subpopulations to infer historical connectivity;

Watarru, Docker River and Warburton animals were also grouped, but the Uluru population was genetically distinct, leading scientists to believe it has been cut off from western sites for at least 350,000 years (Dennison *et al.* 2015). There has been no genetic analysis of any of the other Western Australian subpopulations.

Photograph 7. Steve McAlpin observing Tjakura



Source: Josef Schofield

Figure 2. The indicative distribution of the Great Desert Skink

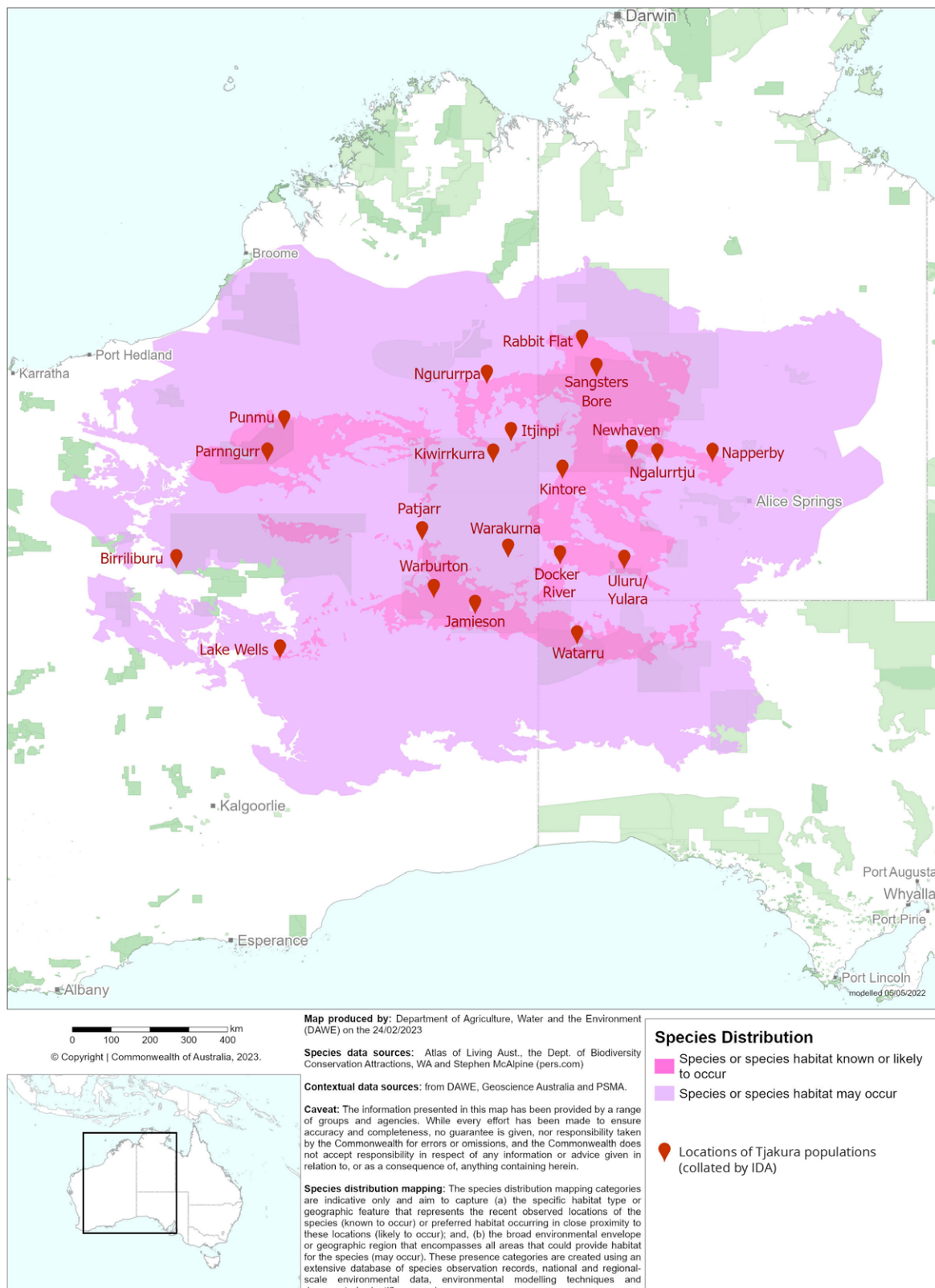


Table 1. Sites where the Great Desert Skink is known to occur as of 2022.

Location	Land manager	Estimated population upper limit in 2001	Estimated population upper limit in 2022	Comments (Number of known burrows, how well surveyed)	Reference (who should be credited with information in the assessment)
Ngaanyatjarra Lands: Multiple sites including Warakurna, Jamieson, Patjarr and Warburton	Ngaanyatjarra Land and Culture	< 2500	2000	106 burrows found in 4000 ha area south of Jameson and another 60 burrows found scattered across vast area of Ngaanyatjarra (NG) Lands in 2018-2019 indicates a large population	Ngaanyatjarra Council (2019) Western Wildlife (2019)
Kiwirrkurra IPA includes 2 known subpopulations (near Kiwirrkurra community and NW of Lake Mackay)	Tjamu Tjamu Aboriginal Corporation and Desert Support Services	500	>500	100 active burrows mapped in 100 ha in 2022, likely to be > 500 across the area >20 burrows found in an hour searching NW of Lake Mackay, likely to be 100 in this area	Tjamu Tjamu Aboriginal Corporation unpublished data, (2021)
Punmu and Parngurr on the Martu Native Title Determination	Kanyirninpa Jukurrpa	Unknown	< 100	About 20 burrows found around each of Punmu and Parngurr in recent years, after considerable search effort.	Kanyirninpa Jukurrpa unpublished data, (2017)
Lake Wells Station	Pastoral Lease	Not listed	20	4 burrows found in 223 km of transect walked	Western Wildlife (2018)
Birriliburu IPA	Birriliburu Land Management Company	Not listed	<50	>20 active burrows found across 3 sites along a 20km wide area of Birriliburu IPA	Birriliburu Pty Ltd., unpublished data, (2021)
Ngururrpa IPA	Parna Ngururrpa AC and Desert Support Services	Not listed	100	25 burrows found in an area of about 2500 ha in 2020, several burrows at 2nd site, not well surveyed	Parna Ngururrpa Aboriginal Corporation unpublished data 2020
South Tanami Indigenous Protected Area Rabbit Flat to Sangster’s Bore	Central Land Council	< 2250	2000	300 active burrows recorded in 13km of walked transect through Sangsters Bore area in 2017-18)	Eco Logical Australia (2018)
Uluru-Kata Tjuta National Park population (including Ayers Rock Resort and adjacent area of Katiti Petermann IPA)	Parks Australia, Voyages Indigenous Tourism Australia, Central Land Council,	< 500	500 for combined Yulara/Uluru subpopulation	120 active burrows recorded in 2016. Extensive surveys and annual monitoring occur at both Uluru and Yulara. Considerable number of burrows lost to wildfire in 2012	Parks Australia unpublished data (2017)
		<350			R. Paltridge, unpublished data (2021)
Newhaven Wildlife Sanctuary Wildlife Sanctuary	Australian Wildlife Conservancy	Not documented in 2001 Rec Plan	2000	153 active burrows in 8x50ha monitoring sites in 2021. >700 active burrows have been mapped across the property.	Australian Wildlife Conservancy, unpublished data, (2021)
Ngarlurr tj u Aboriginal Land Trust	Australian Wildlife Conservancy in partnership with Ngalurr tj u ALT	Not documented in 2001 Rec Plan	<20	First record discovered on Ngalurr tj u ALT in 2021, and lots of potential habitat.	Australian Wildlife Conservancy; Ngalurr tj u Aboriginal Land Trust and Central Land Council, unpublished data, (2021)
Kintore on the Haasts Bluff IPA	Central Land Council	Not specified	50	Recorded near community, but no census conducted yet	
Watarru Indigenous Protected Area in the Anangu- Pitjantjatjara Yankunytjara Lands	Anangu- Pitjantjatjara Yankunytjara Land Management	< 50	50-100	12 active burrows found in 2013	APY Land Management unpublished data, (2013)
Docker River on the Katiti Petermann IPA	Katiti-Petermann IPA	Not documented in 2001	<50	8 active burrows recorded in 2016	Central Land Council, unpublished data, (2017)
Napperby (Pastoral Lease)	Napperby Pastoral Lease	Not documented in 2001	<20	1 active burrow found in 2015 but no longer active in 2016, no others found in area despite extensive searching. 2 burrows found along Tanami gas pipeline in 2018	GHD (2015) Eco Logical Australia (2018)

Habitat

“Us Rangers, we know where Warrana living. So we look between the salt lake and the sand dunes, we know where they are”

Christine Ellis, Newhaven Wildlife Sanctuary /Nyirripi Ranger, December 2021

Tjakura occupies a variety of environments across their distribution from hard spinifex gravelly plains and sandplains to semi-saline soft spinifex sandplains, and even non-spinifex mulga (*Acacia aneura*) woodland. A common feature of occupied habitat appears to be a more benign fire regime where fire size and/or frequency is limited by either regular burning by Aboriginal people or other land managers, or an inherent patchiness in fuels (due to presence of bare salt pan or rock outcropping).

Tjakura commonly occurs on open spinifex sandplains and adjacent dune field swales but rarely in extensive dune fields or rocky outcrops. Most sites are on low nutrient soils derived from laterites, sandstones and quartzites, supporting a simple, low, open shrubland flora that is usually dominated by spinifex hummock grasses with scattered shrubs including various *Acacia*, Eucalypt, *Grevillea* and *Hakea* species, and often the sub-shrub *Androcalva loxophylla*. Tjakura inhabit sandplain habitat on the Kiwirrkurra IPA, Kintore area, Katiti Petermann IPA and UKTNP/Yulara. Spinifex species vary but is most commonly hard spinifex (*Triodia basedowii*).

In the Tanami Desert and parts of the Great Sandy Desert (including Newhaven Wildlife Sanctuary, Lake Mackay and Punmu subpopulations), Tjakura also inhabits palaeodrainage country featuring slightly saline depressions or chains of dry salt lakes, with soft spinifex (*T. pungens*), tea tree (*Melaleuca* spp.) shrubs and the salt tolerant sub-shrub *Pluchea ferdinandi-muelleri*. In contrast to *T. basedowii* that can only regrow from seed, soft spinifex resprouts after fire, which means this habitat has the highest fire frequency (being able to carry fire again after about 7 years).

In the Gibson Desert, north of Warburton, habitat includes areas of gently undulating gravelly downs (buckshot plain) known locally as ‘Rira.’ In this landscape the soil surface is characterised by a layer of small laterite pebbles and vegetated with hard spinifex (*T. basedowii*). Areas of ‘Rira’ inhabited by Tjakura are notable for their ‘islands’ of diverse vegetation growing around the general area of the burrow entrances, possibly due to the burrowing activity, water harvesting into burrow depressions and a concentration of nutrients produced by burrow occupants (Steve McAlpin personal observations, 2014).

The population at Watarru (in northern SA) is unique in occurring in grassy mulga woodland. It is the only known population to occur in non-spinifex systems. Here the habitat comprises open mulga (*Acacia aneura sens. lat.*) and minyura (*A. minyura*) woodland over woollybutt grass (*Eragrostis eriopoda*) with scattered *Eremophila gilesii* shrubs (McAlpin 2001, 2007, Partridge 2008). In contrast to the fire-prone spinifex sites, this habitat burns infrequently.

Photograph 8. Sandplain habitat dominated by hard spinifex (Triodia basedowii) with mixed acacias and other shrubs on the Kiwirrkurra IPA in WA.



Source: Kiwirrkurra IPA

Photograph 9. Semi-saline Spinifex Sandplain habitat dominated by Soft Spinifex (Triodia pungens) and Tea Tree (Melaleuca glomerata) on Newhaven Wildlife Sanctuary in NT.



Source: Desert Wildlife Services

Photograph 10. Open mulga woodland habitat with an understorey of Woolybutt grass (Eragrostis eriopoda) with scattered Eremophila gilesii on the Watarru IPA in SA.



Source: Desert Wildlife Services

Ecology

“Warrana lives with its family in one burrow. Mum and dad look after them. Sometimes dad goes out looking for a feed and make another burrow then comes back and they make scat on one place. So there’s different scat you can find next to the burrow, there’s a big one, small one and the baby one.”

Christine Ellis, Newhaven Wildlife Sanctuary /Nyirripi Ranger, December 2021

Tjakura is one of the few reptile species in the world known to build a complex family burrow system and look after their young (McAlpin *et al.* 2011). Burrows are often developed from old holes originally constructed by other burrowing animals such as sand goanna (*Varanus gouldii*), brush-tailed mulgara (*Dasycercus blythi*), spinifex hopping-mouse (*Notomys alexis*) or night skink (*L. striata*). Males dig the burrows, starting with a single tunnel that is gradually added to over successive years as the family grows. Well established breeding burrows are about 10 m wide and have 10-20 burrow entrances to tunnels that interconnect underground (McAlpin *et al.* 2011). At Yulara the oldest burrow in the monitoring program was continually inhabited by Tjakura for 16 years (Paltridge and Eldridge 2020) before eventually going inactive 12 months after being burnt. Burrows extend to depths of 80-100 cm, where temperatures remain stable, and humidity does not fall below 80% (Moore *et al.* 2017).

A burrow system has one or more latrines where the family members all deposit their scats in a pile. These ‘toilets’ are usually located among vegetation within a couple of metres of a burrow entrance. The latrine plays an important role in advertising burrow ownership, occupancy and the genetics of the occupants. For example, as the size of the scats is directly related to the size of the Tjakura living in that burrow, inspection of the latrine reveals whether there is a big adult male present and if breeding has been successful. However, it should be noted that dung beetles emerge in rainy weather and can rapidly demolish latrines.

A family burrow may have up to 10 animals living inside – the parents, and their young from the past two years. The mother Tjakura is believed to use only one burrow system, and her children are all full siblings,

sharing a single mother and father, but a male may move between several burrows of wives and children (McAlpin *et al.*, 2011). At two to three years of age male Tjakura leave home to establish their own burrow and attempt to start a new family. Genetic analysis has shown most Tjakura establish burrows within 4 km of their parents’ homes, but dispersals up to 9 km are occasionally recorded (McAlpin 2011).

Tjakura hibernate in the winter, becoming inactive as night-time (and soil) temperatures cool. In the south of their range hibernation can go from April to September, but in warmer temperatures in the north it may only be 2-3 months.

When males wake up from hibernation they usually do some burrow maintenance, digging out the burrow entrances. Tjakura then mate early in the season (late September-early October) and females give birth to 1-7 babies around Christmas time. Baby Tjakura are 70 mm from snout to vent when they are born, but grow quickly, reaching about 100 mm before their first hibernation and 140 mm by their second winter (McAlpin 2011).

Tjakura spend most of the day inside their burrows, becoming most active in the late afternoon when they bask outside the burrow before going out looking for food in the early evening. They may also bask in the sun in the early morning and make short forays from burrow entrances to collect food items. Much of the day and late at night is spent shuffling up and down a tunnel keeping their temperature in a preferred range of about 32°C (Moore *et al.* 2017). They may also spend time sitting just inside a burrow entrance, waiting to ambush passing prey.

Tjakura are omnivorous and eat plant material, invertebrates and any vertebrates small enough to be swallowed including geckoes and small mammals. At Parngurr Tjakura were recorded on camera carrying frogs in their mouths (Parngurr Rangers 2021). A wide range of invertebrates are eaten including beetles, cockroaches, grasshoppers, spiders and centipedes but harvester termites (*Drepanotermes* spp.) make up the bulk of their diet (McAlpin 1997). Several hundred termites may be eaten in a sitting by a large adult Tjakura during rainy spells when the worker termites are out harvesting spinifex pieces or the alate termites are swarming to begin new colonies. Plant material eaten in good seasons includes bush tomato (*Solanum* spp.) fruits, parakeelya (*Calandrinia* spp.) leaves and paper daisy (*Leucochrysum stipitatum*) flowers (McAlpin 1997).

Photograph 11. Tjakura are one of the few reptile species in the world that care for their young.



Source: Birriliburu IPA

Ecosystem Function of Tjakura

Tjakura play an important role in the ecological processes and functions of the areas they inhabit. Their extensive underground burrows systems provide a safe, thermally stable refuge for other animals seeking shelter from predators and/or climatic extremes. Such refugia have become increasingly important following the loss of larger burrowing mammals (bandicoots and bettongs) for non-burrowing species such as the Woma python (Bruton *et al.* 2014) which is regularly recorded on camera traps deployed at burrows (Ridley 2015, Moore *et al.* 2017). The brush-tailed mulgara also frequently uses Tjakura burrows (Molyneux *et al.* 2018) but it is unknown whether this is to prey on young skinks, as a refuge from predators or for thermoregulation benefits.

Burrows also harvest water, interrupt localised sheetflow from heavy rains and cycle nutrients. This appears to promote localised plant germination, growth and diversity.

Main Threats

Unmanaged fire and unsustainable predation by feral cats, foxes and dingoes are the two major threats to Tjakura populations, and it is likely that these two threatening processes act in synergy.

“When big wildfire come through Warrana won’t be safe without spinifex because cat will be getting them and the dingo, so we have to do the little firebreaks next to the burrow so Warrana can stay safe and the little families”

Christine Ellis, Newhaven Wildlife Sanctuary/Nyirripi Ranger, December 2021

Unmanaged Fire

Information from senior Knowledge holders suggests that Tjakura used to be much more common and widespread in the “pujiman” days when Aboriginal people were living traditional nomadic lifestyles. As people moved into settlements in the 1950s and 60s the fine scale fire mosaic that had been maintained by regular burning was obliterated by occasional lightning-induced wildfires that were at 10-100 times larger than the mean fire size under the traditional fire regime (Burrows 2006, Blackwood *et al.* 2022).

When fire removes the vegetation cover from Tjakura burrows, most burrows become inactive within 12 months (Moore *et al.* 2015). At Yulara, a 20-year burrow monitoring program across 11 sites found that there was continuous turnover of burrows with an average of 30% of unburnt burrows becoming inactive each year (range = 12 - 55%) as new ones were established. However, when sites were burnt, 83% of burrows became inactive within 12 months of the fire occurring (Paltridge and Eldridge 2021) and number of active burrows at burnt sites plummeted 1-2 years after fire. Similarly, within UKTNP, the Tjakura subpopulation suffered significant declines in the number of active burrows at sites after wildfires occurred (Bennison and West 2018). Broad-scale surveys across Newhaven Wildlife Sanctuary Wildlife Sanctuary found only 16% of 78 active burrows recorded occurred in recently burnt habitats (Moore *et al.* 2015).

Whether burnt burrows become inactive because Tjakura families are unable to survive post-fire or move to another area is still not entirely known. Clearly Tjakura can survive the immediate impacts of fire by remaining deep within their burrows and while some animals may be able to relocate to nearby areas of unburnt habitat after a fire, a radio-tracking and burrow monitoring study at Newhaven Wildlife Sanctuary did not find any evidence of Tjakura shifting homes in the first month after a fire, but did find that the majority of burnt burrows became inactive within 4 months of being burnt (Moore *et al.* 2015).

The extensive effort required to construct complex family burrows and the considerable risk of predation when dispersing through burnt habitats suggests it’s unlikely that Tjakura family groups will collectively relocate after fire. Rather, the disappearance of Tjakura from recently burnt burrows is assumed to be due to increased vulnerability to predation when their spinifex cover is removed.

Predation

Feral cats have been found to be a significant predator of Tjakura.

Cats, foxes, dingoes, goannas, woma pythons, and mulgaras are all potential predators that have been recorded visiting Tjakura burrows (Moore *et al.* 2017, Ridley 2015) but cats were the predators recorded most frequently at burrows during the Newhaven Wildlife Sanctuary burning experiment (Moore *et al.* 2017). Although there was no evidence that cats visited burnt burrows more often than unburnt burrows (Moore *et al.* 2017), we assume that the cats’ hunting success was greater at the more open burnt sites, based on a study of cat hunting success in the Kimberley (McGregor *et al.* 2015). The loss of Tjakura from burrows in the Newhaven Wildlife Sanctuary burning experiment coincided with a period of high cat predation on Tjakura (Moore *et al.* 2015). Of the five cats recorded visiting the burrows at the time, three were found to contain Tjakura remains in their stomachs and a half-eaten Tjakura was found beside the tracks of a fourth cat the day it was killed (Paltridge, R. and Ellis, C. (2016), Australian Wildlife Conservancy unpublished data). Furthermore, Tjakura remains were found in 49% of 39 cat scats, 18% of 17 fox scats and 14% of 65 dingo scats (Moore *et al.* 2015).

Photograph 12. A feral cat on caught on remote camera with a Tjakura in its mouth.



Source: Anangu Pitjantjatjara Yankunytjatjara Land Management

High levels of predation on Tjakura have also been recorded at Yulara where remains were found in 28% of 36 cat scats and 8% of 13 fox scats (but not in 16 dingo scats) between 2012 and 2020 (Paltridge and Eldridge 2021). Predation in this case was not linked to fire but was most severe in 2012 following a period of increasing predator populations in response to an eruption of native rodents. When the rodents crashed a surplus of hungry predators switched to eating reptiles including Tjakura.

On the Kiwirrkurra IPA Tjakura remains were found in only 4% of 47 cat stomachs and 50 scat samples collected between 2014 and 2019 (Paltridge *et al.* 2020). It was suggested that ongoing cat control throughout this period may have prevented cats becoming specialised on Tjakura prey, being continually removed before they built up knowledge of the location of Tjakura burrows in the area (Paltridge *et al.* 2020).

Dingoes can also be a significant predator of Tjakura, particularly after fire. After a different fire event at Newhaven Wildlife Sanctuary, despite effective management of cats preventing cat predation at exposed burrows, camera-trap monitoring revealed a significant increase in the visitation of dingoes to Tjakura burrows and Tjakura remains were found in 73% of 15 dingo scats (Paltridge and Ellis, unpublished data). However, at Sangsters Bore Tjakura was found in 7% of the 84 dingo scats analysed, 7% of 57 fox scats and 14% of 7 cat scats between 2002-2007 (Paltridge, unpublished data).

Other Threats – Disturbance from Development

Many of the main known Tjakura populations are threatened by disturbance from developments associated with mining or tourism infrastructure. For example, a new 500 km long gas pipeline to service a mine was established through the Tanami Desert population in 2018, a new road is proposed in the vicinity of the Ngururrpa population, a new mine is being established in the middle of the Ngaanyatjarra population and small-scale habitat clearance continues to occur around Ayers Rock Resort as the range of tourism activities continues to expand.

Direct impacts of such developments for Tjakura subpopulations include the destruction of burrows by heavy machinery, increased mortality due to roadkill, and potentially increasing predator activity in areas with increased human habitation.

On the positive side, development applications provide the resources and impetus to conduct surveys in very remote areas and such surveys have contributed significant information to our knowledge of where Tjakura occur. Construction of new roads through habitat may also assist with fire management.

Other Threats - Weeds

A likely indirect impact of increased disturbance to Tjakura habitat, even if it is only temporary such as during establishment of a gas pipeline, is the risk of spreading weeds such as buffel grass (*Cenchrus ciliaris*, *Cenchrus setiger*) through the habitat. Encroachment of the fast-growing, ecosystem transforming buffel grass into Tjakura habitats would allow more frequent fires, leaving Tjakura exposed to predators more often. A change in the dominant vegetation from spinifex to buffel grass would also alter food availability.

Other threats – Feral Herbivores

Feral camels occur across the range of the Tjakura. On the APY Lands, where high numbers of camels have been recorded around the Watarru population, Anangu have expressed concern about Tjakura burrows being abandoned after being trampled by camels and requested that camel control activities target Tjakura sites (Partridge 2008). As a preliminary measure, Rangers built stick fences around a small number of burrows to protect them from the impacts of camel trampling. Pastoralism, primarily cattle grazing can also impact *Tjakura* habitat and populations through overgrazing, trampling of burrows and soil compaction.

Rabbits also occur at some Tjakura sites, particularly in the salt lake country (Sangsters Bore, Newhaven Wildlife Sanctuary Wildlife), UKTNP and in the APY Lands. Anangu Rangers at Watarru observed rabbits colonising a Tjakura burrow (Partridge 2008). The presence of rabbits at sites may also bolster predator populations.

Other Threats - Overharvesting

Where cats and fire have already combined to fragment Tjakura subpopulations to tiny remnants, any extra pressures can result in local extinctions. Traditional harvesting is one such pressure that could potentially extinguish a small remnant subpopulation of Tjakura. The issue of whether harvesting is sustainable at any particular site is a delicate issue that needs to be discussed with communities who are still eating Tjakura. Having a robust monitoring program can provide useful information for these discussions.

Other Threats – Climate Change

Climate warming has been suggested as a cause of recent local extinctions of various reptile species including the Tjakura (Sinervo *et al.* 2010) due to direct effects of exposure to temperature extremes, and restricted opportunities for activity in suitable ambient temperatures. However, investigation of the thermal constraints of Tjakura revealed climate warming was unlikely to cause extinctions of subpopulations because the deep burrow systems provide an extremely effective buffer against temperature extremes and desiccation, and warmer outside temperatures provide more rather than less opportunities for surface activity (Moore *et al.* 2017).

Other impacts of climate change may have significant impacts on Tjakura. Although the effect of climate change on desert rainfall patterns cannot be predicted with confidence, more extreme fire-weather conditions have been forecast (IPCC Interactive Atlas), meaning fire management will become increasingly important to protect *Tjakura* subpopulations.

Other Threats – Loss of knowledge, capacity and motivation to manage country

A more general potential threat to the recovery of the Tjakura would be a diminished network of people within the range of the Tjakura with the knowledge, motivation and resources to find Tjakura and manage its habitat. Recognising that culture is at the heart of conservation for Aboriginal people and Traditional Ecological Knowledge about Tjakura is even more threatened than the species itself, it is crucial that we support people to continue recording and engaging with cultural sites, stories and ceremonies about Tjakura, as well as ethno-ecological information about the animal, before the knowledgeable old people pass away. Similarly, if funding for Ranger programs and IPAs is reduced, there would be diminished capacity to continue managing country, conducting surveys and passing on intergenerational knowledge about culturally significant species.

Population Size and Trends

Population Size

The number of Tjakura across Australia was estimated to be 6,250 in 2001 but it was acknowledged that this estimate had low reliability as there had been little detailed survey work outside of the UKTNP population at that time (McAlpin 2001). In 2017 it was noted that although some new populations had been detected, others had declined since 2001 and the number of individuals was believed to be less than 5000, but again confidence in the estimate was poor (Paltridge *et al.* 2017).

Subsequent surveys of identified sites that obtained detailed information on burrow densities at localised sites (Sangsters Bore area of Tanami Desert, Jamieson site on Ngaanyatjarra Lands, Kiwirrkurra IPA, Newhaven Wildlife Sanctuary Wildlife Sanctuary and Yulara) are not incongruous with early population size estimates. The discovery of additional sites (where broad surveys are yet to be conducted) have increased our current estimate of number of mature adult Tjakura across Australia to 7,500 (Table 1).

As Tjakura can occupy a range of different environments, the potential area of suitable habitat is extensive, but we currently have insufficient knowledge to infer how much of this habitat remains occupied. Population estimates are therefore minimums. However, as most of the remote and inaccessible unsurveyed areas between known subpopulations have been ravaged by unsuitable fire regimes, we are not overly optimistic of finding significant regional subpopulations.

Population Trends

There is no national population monitoring program for Tjakura and no ongoing standardised trend monitoring for this species. Nevertheless, annual Tjakura burrow monitoring programs have been conducted at both UKTNP and Yulara since 2002, Newhaven Wildlife Sanctuary since 2015, Kiwirrkurra IPA since 2017 and another site in the Great Sandy Desert in WA since 2017. These monitoring programs range from meandering searches of specific sites of varying sizes to tightly controlled surveys where a defined set of straight lines are walked in parallel throughout large sites of equivalent area (Table 2).

Results of the monitoring programs have shown stable or increasing population trends at sites where both ongoing fire management and strategic cat control have been conducted, but declines where cats have not been managed. As most subpopulations outside the intensively monitored sites are not managed for predators, we assume there has been an overall

decreasing population trend across the global population between 2001 and 2021. However, the positive response to the combined management of fire and cats at three sites gives us hope that we can change the trajectory of a declining Tjakura population if we can extend the number of sites where both fire and cats are effectively managed.

The longest running monitoring programs have shown major subpopulation fluctuations at UKTNP since 2001 following the impacts of wildfires, but a stable to increasing trend at Yulara over the period 2001-2021. At UKTNP nine irregularly shaped sites of varying size (some up to several square kilometers in area), were surveyed annually until 2017 (Hauselberger, 2017), and at Yulara eleven smaller sites (300m x 200m) have been surveyed annually (Paltridge and Eldridge 2021).

There appears to have been a decline in number of active burrows in UKTNP since 2012 (Bennison and West 2018). Whereas number of active burrows had started to recover at UKTNP within two years of the 2002 fire, there was no such recovery detected between 2012 and 2017. However, as the post-fire decline coincided with the end of the consistent monitoring by a single observer, the long-term impact of the 2012 fires remains unclear.

In contrast, monitoring at Yulara has revealed an increasing subpopulation of *Tjakura* over the past two decades since the fires of the early 2000s (Paltridge and Eldridge 2021). Although nine of eleven monitoring sites have been affected by fire at some stage during the 20 years of monitoring, the network of tracks and presence of a full-time fire control team at Yulara has ensured ongoing fuel reduction management and wildfire suppression, meaning individual fires rarely affect more than one or two sites at a time. Furthermore, intensive cat control conducted at Yulara during 2018-2019 allowed the skink subpopulation to thrive even in the extreme drought conditions.

At Newhaven Wildlife Sanctuary, where Australian Wildlife Conservancy staff monitor eight 50 ha sites through core Tjakura habitat each year, the number of active burrows has been steadily increasing over the past 6 years with the total number of active burrows across the 8 sites doubling to 153 active burrows between 2019 and 2020 (Australian Wildlife Conservancy, unpublished data, 2021). This follows more than 10 years of active fire management and 7 years of targeted cat control (using a combination of traditional hunting and tracking and the use of 'catavaults' and soft jaw leghold traps) around key Tjakura sites at Newhaven Wildlife Sanctuary (Danae Moore, personal communication, 2021).

On the Kiwirrkurra IPA where three sites (1km long by 300m wide) are surveyed annually by a group of 8 rangers walking systematically through each site for 2 hours, the number of active burrows has been gradually increasing over the past 5 years. None of the sites has been affected by fire since monitoring commenced, and cat control (using traditional hunting techniques) has been conducted in the vicinity of the population in most years. In 2021 a total of 71 active burrows was recorded across the three sites (Kiwirrkurra IPA, unpublished data).

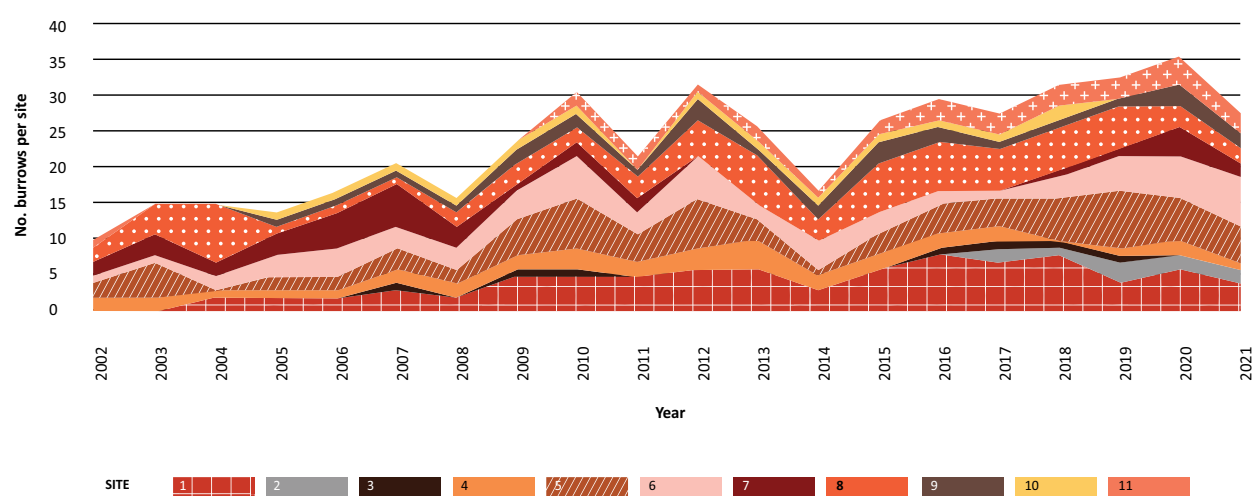
At another site in the Great Sandy Desert in WA, three monitoring sites (500 x 200m) monitored by Rangers since 2017 have shown a decline in the number of active burrows at two of the three sites due to fire, however the total number of active burrows known to occur in the broader area is unchanged, as more burrows have been found outside the monitoring sites.

Table 2. Summary of Tjakura monitoring programs

Population	Years	Survey design	Trends	Extent of management
Newhaven Wildlife Sanctuary	2015-2021 (With current methods, previous data available for some sites with different site design)	8 x 50ha sites Each site = 11x500m precise transects	Increasing trend	Targeted fire management since 2010 and cat control since 2014. Construction of a 9,450 ha fenced area free of introduced predators and herbivores since 2018 protects some GDS burrows
UKTNP	2000-2017	9 x >100ha sites surveyed by meandering search	Decreasing trend	Sporadic cat and fire management
Yulara	2002-2021	11 x 6ha sites 1hr meandering search by 1 person	Increasing trend	20 years of fire management, intensive cat management in 2018-2019
Kiwirrkurra IPA	2018-2021	3 x 30 ha sites searched by line of 8 people for 2 hours	Increasing trend	Ongoing cat control and fire management
Great Sandy Desert	2017-2021	3 x 10 ha sites searched by line of 4 people for 1 hour	Decreasing trend	Sporadic fire management but little cat control in past decade

Figure 3. Example of monitoring data, from Voyages Ayers Rock Resort (Desert Wildlife Services 2021).

Number of Active Burrows at 11 sites at Yulara, 2002-2021



Recovery

In this Section of the Recovery Plan we present our shared vision for the Recovery of Tjakura, the 10-year goal of this Recovery Plan, and the specific conservation objectives and performance criteria that can be measured to assess our progress towards achieving this goal.

Our Shared Vision:

“In 2050 Tjakura are safe on country, babies are born and survive, Rangers are caring for them, under the guidance of Elders, with the support of the broader community. Our cultural connection to *Tjakura* is strong and sustainable harvesting is possible because populations are healthy, abundant and genetically diverse, thriving in all the subpopulations they were known from in 2022.”

Overall Goal

In 2032 the cultural significance of Tjakura is well known and celebrated, and it is no longer classified as Vulnerable to extinction because the global population continues to increase beyond 10,000 mature individuals, and neither the range or number of known subpopulations are declining because sites are being actively managed by motivated Rangers and other land managers.

Progress towards this goal will be measured using performance criteria associated with two specific Conservation Objectives and one Cultural Objective:

Conservation Objectives (and performance criteria)

- The range of the Tjakura remains stable
 - PC1: The Extent of Occurrence (EoO) in 2032 is at least equal to the EoO in 2023
 - PC2: In 2033 Tjakura occupy all 20 places they were known from in 2023
- The size of the Tjakura population is growing
 - PC3: From 2023- 2033 there is an ongoing increasing trend in the number of known active burrows across the range
 - PC4: The estimated number of active burrows across the range exceeds 10,000

We have used number of active burrows as a surrogate for number of mature individuals. Although burrows may be occupied by 1-10 individuals, each burrow normally only contains 1 or 2 mature animals (e.g., a male who has just established a new burrow, a female and her offspring who is visited by a male who roams between several burrows, or a stable breeding pair and their offspring). We have taken a conservative approach in suggesting that an estimate of 10,000 active burrows will indicate a population size of at least 10,000 mature individuals.

Cultural Objective (and performance criteria)

- Traditional Ecological Knowledge about Tjakura remains strong
 - PC5: In 2033 Tjakura cultural sites, stories and songs and ceremonies are known, documented and maintained across the three States where *Tjakura* occurs.

Recovery Strategies

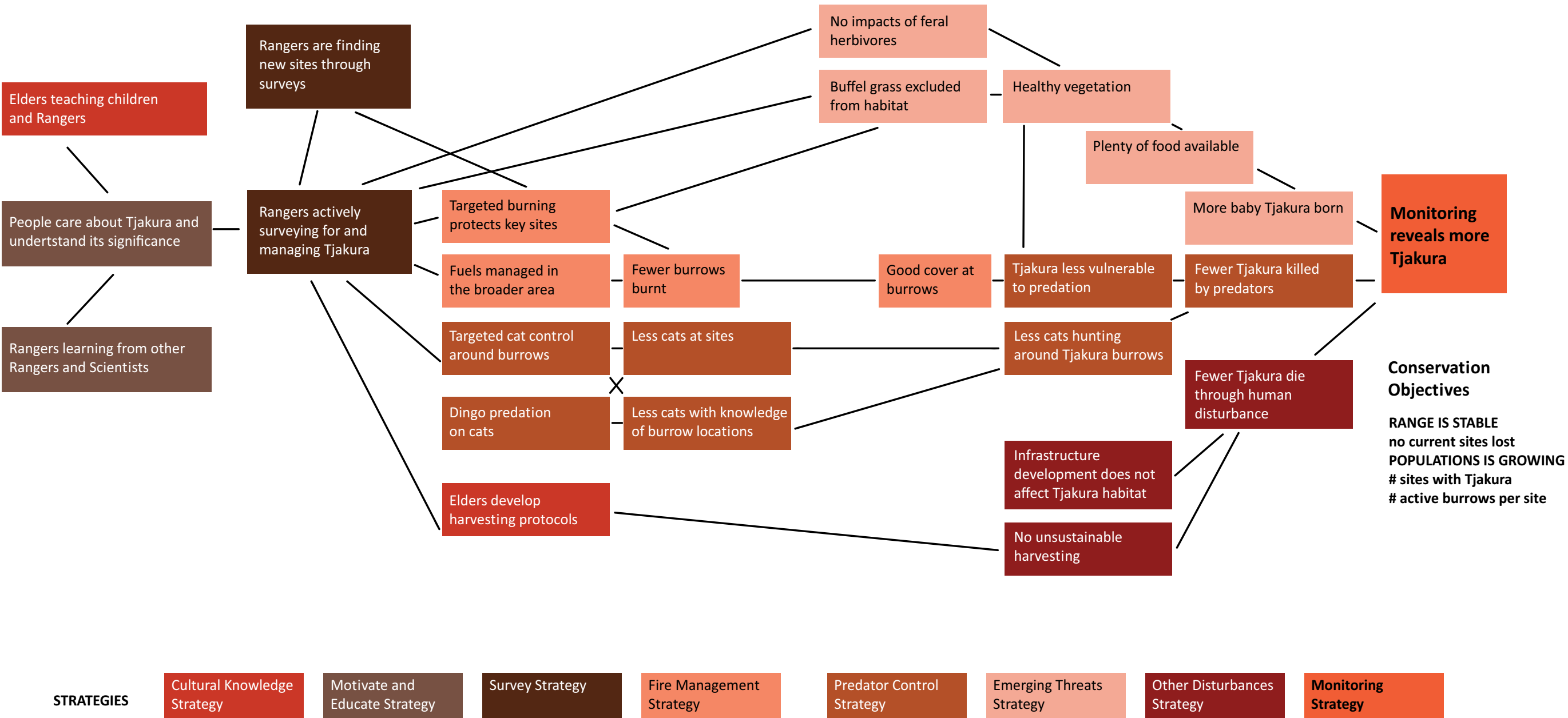
The actions required to meet the conservation objectives are grouped into nine Strategies:

- Document and support cultural knowledge and practices: Recognise culture is at the heart of conservation and support projects to record Traditional Ecological Knowledge and continue to engage in cultural practices.
- Motivate and educate: Increase the motivation to manage Tjakura through activities that promote its cultural and conservation significance and build its charisma and profile amongst the general public, government and scientists to ensure support for the species.
- Survey new areas: Establish current status by conducting additional surveys and consultation (especially around the edge of the range and in key gaps) to determine current distribution and number of subpopulations and identify where management is required.
- Fire management: Protect populations from fire by including specific targeted burns around main burrow areas in annual burning plans and implementing these and broader scale burns in surrounding areas to reduce the chance of wildfire affecting burrows.
- Predator management: Conduct strategic predator control at selected, accessible sites, particularly after a site has been burnt.
- Protect Tjakura habitat from other human disturbances: Protect Tjakura habitat from the impacts of mining, tourism, other infrastructure development, pastoralism, poaching and over-harvesting.
- Address new and emerging threats: Investigate and address any additional threats to *Tjakura* populations including climate change, disease outbreaks and weeds.
- Monitor populations: Establish monitoring at key subpopulations across a geographical spread in NT, WA and SA.
- Share information: Report successes and failures back to other stakeholders to continually refine management techniques and learn from and encourage each other.

Each of the nine strategies has a specific aim, a list of actions required to achieve the aim, and a set of desired outputs, outcomes and measurable indicators.

***Indicators in bold are considered to be the highest priority measures to assess the success of the Recovery Program.**

Figure 4. How our strategies will help us meet our conservation objectives for Tjakura recovery.



Strategy 1: Document and support cultural knowledge and practices

Recognise culture is at the heart of conservation and support projects to record cultural knowledge and continue to engage in cultural practices.

Aim: Over the 10-year life of the Recovery Plan there is no loss of cultural knowledge about Tjakura cultural sites, stories, ceremonies, ecology or resource use.

This Recovery Plan is built around the recognition that for many people culture is at the heart of conservation. But as the last of the Elders who grew up walking the Country pass away, there is a significant risk that detailed cultural information will be lost forever.

This strategy emphasises the importance of making funding available to record cultural information, store it safely, and ensure it is accessible and visible to appropriate people so it can continue to be used rather than just locked away, or lost.

In the workshops several groups mentioned the desire to revive the Inma (Traditional dance) for Tjakura. The potential to conduct increase ceremonies for Tjakura could also be investigated. Physically travelling along the Tjakura songlines was suggested as a good way to pass on cultural information to younger generations and could be the basis for a survey.

Strategy 1: Document and support cultural knowledge and practices

Aim	Action	Outputs	Outcomes	Measurable Indicator
Over the 10-year life of the Recovery Plan there is no loss of Traditional Knowledge about Tjakura cultural sites, stories, ceremonies, ecology or resource use.	1.1 Support on Country trips to visit Tjukurrpa sites	Tjakura Tjukurrpa sites are visited and mapped across the range Songline maps produced and followed on the ground	Information about locations of Tjakura cultural sites is not lost when old people pass away	# Cultural sites for Tjakura mapped
	1.2 Support projects to document and archive Tjakura Tjukurrpa stories, songs, ceremonies, traditional resource use and other ecological knowledge.	Songs and stories are recorded across the variety of language groups Cultural information is shared and archived appropriately under the direction of Elders Cultural knowledge recorded through Mind Maps	Cultural information is documented in perpetuity but also remains alive and continues to be utilised	# Language groups with Tjakura Tjukurrpa information recorded and safely archived

Strategy 2: Motivate and educate

Build the motivation and capacity to manage the species through activities that promote the cultural and conservation significance of the species and build its charisma and profile amongst the general public, government and scientists to ensure support for the species.

Aim: Throughout the life of the Recovery Plan Rangers are motivated, skilled and adequately resourced to conduct *Tjakura* surveys, management and monitoring across its range

If we want people to **care for Tjakura**, we need them to **care about Tjakura**. People are more likely to care about Tjakura if they are taught about how special they are by Elders or motivated by the inspiring work of other Rangers who become Tjakura Champions.

Celebrating the significance of Tjakura in art, song, dance or sculpture reminds us why they are important. This could be done locally, and/or at a larger scale with a national Tjakura Festival. Scientists also have a role in motivating people by providing a broader historical and geographical perspective on the status of Tjakura across its range, highlighting the importance of Aboriginal Rangers in looking after them and sharing interesting research findings with Rangers.

In the workshops Rangers described how motivating it is to occasionally see a live Tjakura in the hand “to

see how beautiful they are” which provides a stronger connection with the animal. Camera-traps are also an engaging way to watch the animals at their burrows.

Rangers have also requested better resources (posters, photos) to prompt memories when talking to old people, teach school students, remind Rangers what to look out for when they are out on Country and also engage the interest of staff in land management organisations, mining companies and funding providers. They said watching videos or presentations by Tjakura champions about their success stories in looking after Tjakura is inspiring and motivating. Ranger exchanges are also a good way of supporting peer-to-peer learning.

The idea of a Tjakura Roadshow was suggested by one group, whereby knowledgeable Rangers visit other groups to hold two-way science, Tjukurrpa and art workshops about Tjakura with communities, and assist with field surveys. An exhibition of the resulting art, craft and photographs from the travelling roadshow could be used to raise the profile of Tjakura amongst the wider public.

All groups stressed the importance of working with school students to teach them about *Tjakura* including both the cultural significance as well as how to recognise their signs, and how to survey and manage them.

Figure 5. *Tjakura* drawing by Justin from Mutijulu School



Source: Katiti Petermann IPA

Strategy 2: Motivate and Educate

Aim	Actions	Outputs	Outcomes	Measurable Indicator
Throughout the life of the Recovery Plan, Rangers are motivated, skilled and adequately resourced to conduct Tjakura surveys, management and monitoring across its range	2.1 Elders teach children and Rangers	School trips conducted to Tjakura sites Students are taught both cultural and ecological information Tjakura celebrated in art, sculpture, song, dance	Children across the desert grow up knowing about and caring about Tjakura	# Tjakura sub-populations where schools are engaged in learning about Tjakura
	2.2 Rangers are taught and inspired by other Rangers and scientists	Appropriate and engaging information resources (posters, videos), to help find and manage Tjakura created and disseminated Ranger Exchanges conducted between groups wanting to learn about Tjakura and Expert Rangers	Rangers are motivated to protect Tjakura and have the expertise to conduct surveys and manage fire and cats	Information pack completed # Videos about Tjakura champions # Ranger exchanges to Tjakura sites # Ranger groups with Tjakura projects in their annual workplans
	2.3 Community members reconnect with Tjakura and are inspired to look out for them and look after them	Tjakura Travelling Roadshow developed involving science, art and Tjukurrpa	Community members report new sightings of Tjakura to Rangers Community members understand the risks of overharvesting and burning Tjakura sites	# Communities participating in the Tjakura Travelling Roadshow Tri-state art exhibition held
	2.4 Build the profile of Tjakura amongst the general public	Social media and media stories about Tjakura	Tjakura is regarded as a priority species for funding, regulatory protection and in work programs	# Media articles produced

Photograph 13. Payu West teaching her nieces and granddaughters about Tjalapa on the Kiwirrkurra IPA.



Source: Kiwirrkurra IPA.

Strategy 3: Survey new areas

Establish current status of Tjakura by conducting additional surveys and consultation (especially around the edge of the range and in key gaps) to determine current distribution and number of sub-populations and identify where management is required

Aim: By 2025 sufficient field surveys have been conducted around the edge of the range and in key gaps to determine current distribution and number of subpopulations of Tjakura, to identify where management is required and whether the distribution is continuing to contract.

Our knowledge of the distribution of Tjakura across Australia is constantly evolving as Rangers become more familiar with their signs, and intensive surveys are conducted by scientists. The known distribution has been extended in the south-west since the original Recovery Plan.

More accurate knowledge of where Tjakura live is important for two reasons. At the local level it is important for our fire management programs to make sure we don't burn out key sites, but instead conduct strategic burning to protect the habitat. At a broader level it allows us to get a better idea on how the distribution is changing which influences our knowledge of their status, or how threatened they are.

Old people who grew up on Country, either in pujiman times, or working on cattle stations have good knowledge on where Tjakura used to occur in the 1960s and 70s.

For example, Mickey Bennie recounted how he dug one up east of Balgo in the 1970s while working as a Ringer. They were digging fence posts near Ngulupi at the time when they dug up a lizard, and Mickey said "I didn't know blue tongue lizards dug holes". And Bill Doonday (deceased) said "no, that's a Tjalapa".

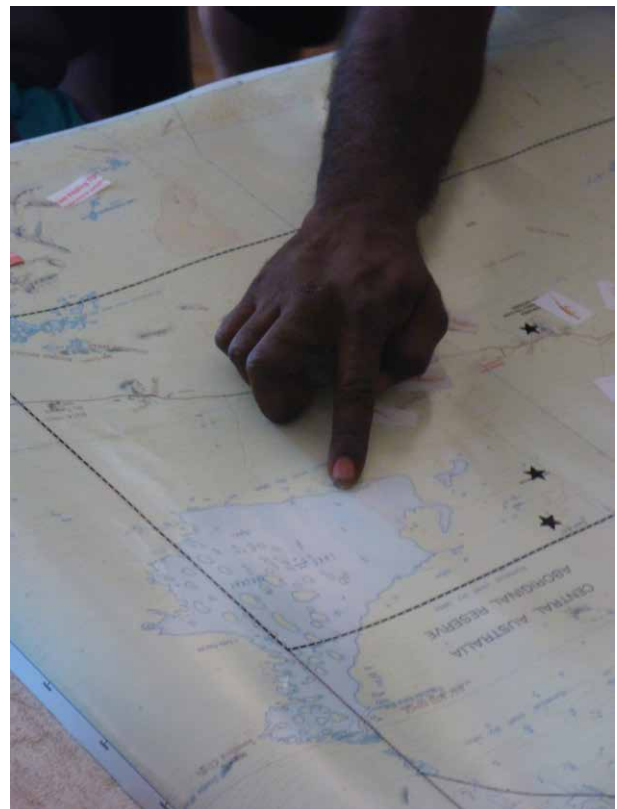
There have been no recent records across this northern part of the range (from WA/NT border across the northern Great Sandy Desert to Broome, Fig. 2). Following up on anecdotal reports from Elders as well as revisiting sites of historical scientific records would help clarify whether Tjakura have actually disappeared from the north-west, or whether the absence of recent records is just due to lack of survey effort. This area (encompassing Ngulupi, Tjurabalan, Ngurra Kayanta, Ngurrura, Karajarri, Nyangumarta Native

Title areas) is a priority for surveys to determine the current distribution.

The southern edge of the range between Warburton, Cosmo, Laverton and Wiluna is also a priority area to survey. On the Eastern edge of the range Angas Downs in the Northern Territory is a priority area with previous records to revisit.

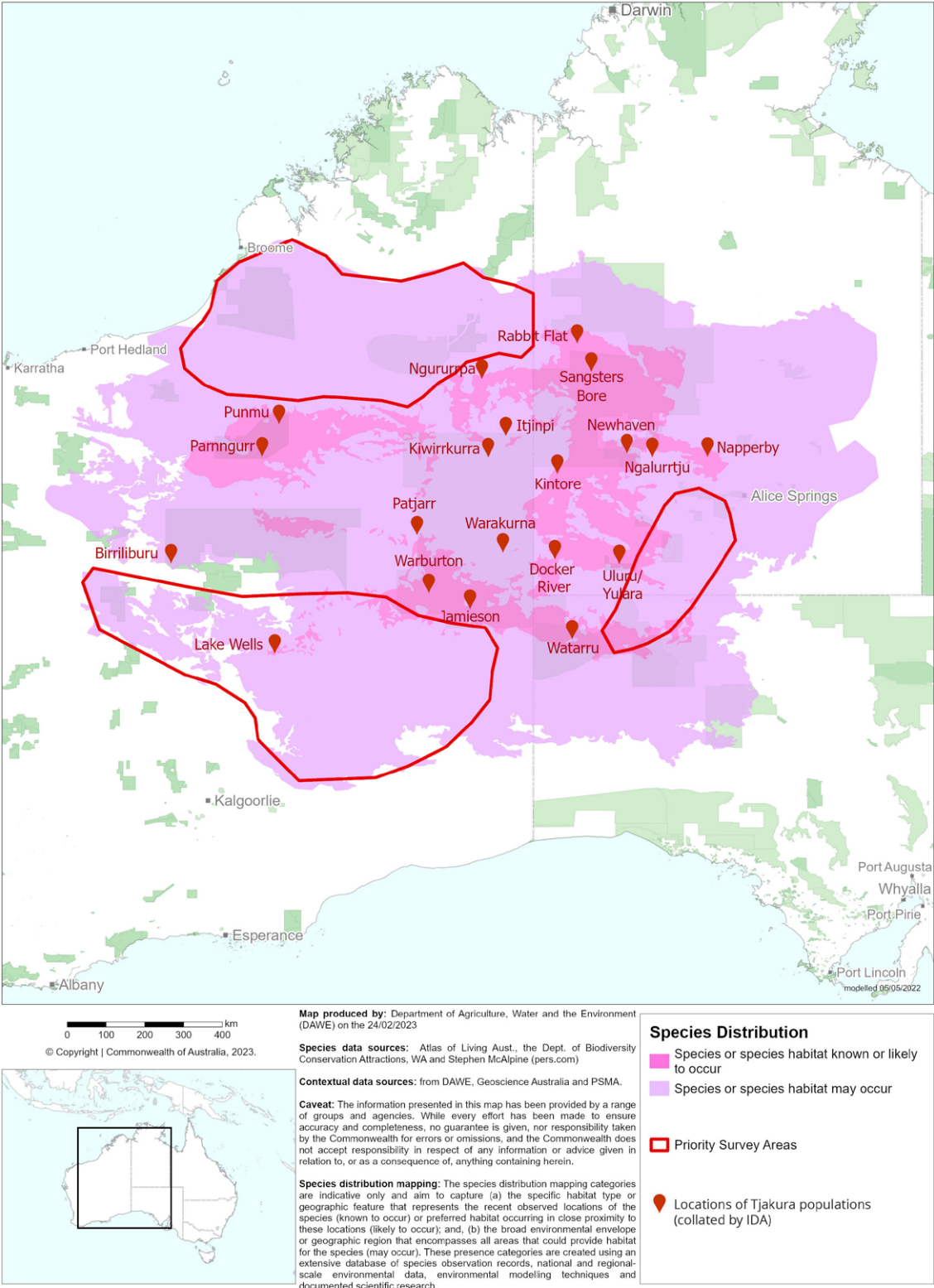
There are also many gaps within the currently known distribution where any additional survey work will be useful to obtain a clearer picture of their current status, and help us prioritise sites to conduct fire management.

Photograph 14. Mapping historical Tjakura locations from senior knowledge holders who grew up in pre-contact time.



Source: Kiwirrkurra IPA

Figure 6. Priority survey areas to determine the distribution of Tjakura in Australia.



Strategy 3: Survey new areas

Aim	Action	Outputs	Outcomes	Measurable Indicator
By 2025 sufficient field surveys have been conducted around the edge of the range and in key gaps to determine current distribution and number of subpopulations of Tjakura, to identify where management is required and whether the distribution is continuing to contract	3.1 Refine historical distribution by consulting senior Traditional Owners	Information collected from northwest, southwest, northeast and southeast edges of range	More accurate map of historical distribution, that can be used to plan future surveys	Refined map of historical range completed by 2025
	3.2 Establish current distribution of Tjakura across Australia by conducting surveys around edge of range	Field surveys conducted at previously known sites or likely habitat outside currently known range in northwest, southwest, northeast and southeast Contribute records to government databases with caveats on how the data can be used after discussion with community members	Baseline map of current distribution	Refined map of current distribution completed by 2025
	3.3 Determine number of known subpopulations by conducting surveys in gaps	Targeted trackplot surveys conducted between known locations Survey data and opportunistic observations of new locations added to state and national databases	Improved knowledge of number of subpopulations for future status monitoring, and to identify key sites for management	# New sites detected Map of all known sub-populations completed by 2025

Strategy 4: Fire management

Protect populations from fire by including specific targeted burns around main burrow areas in annual burning plans, and implementing these and broader scale burns in surrounding areas to reduce the chance of wildfire affecting burrows

Aim: Each year effective fire management protects Tjakura burrows from being burnt

Many monitoring programs have shown that *Tjakura* disappear from sites if their burrows are burnt. We think this is because it becomes too easy for predators to hunt them when the spinifex cover is removed.

Fire management is the most important and achievable conservation action that can be conducted to protect Tjakura. Because populations tend to occur at relatively high densities in discrete areas, targeted burning can be planned to minimise the risk of fires affecting *Tjakura* habitat.

“We don’t want to make a fire next to the piti (burrow) where that Tjakura is, we want to burn long way from their ngurra (home), because they need protection too, you know. Don’t destroy their ngurra”

Annette Williams, Wiluna, October 2021

At Newhaven Wildlife Sanctuary, intensive fire management has successfully kept fire out of the main Tjakura sites for the past 15 years. On the Kiwirrkurra IPA traditional burning has maintained a finescale fire regime where mean fire size over the past 40 years is 125 ha and the median fire size is only 5ha. The Tjakura Rangers conduct night burning to establish fire breaks to protect burrows on the Katiti Petermann IPA. At Punmu rangers use rake-hoes or drag car tyres around burrows to create narrow fire breaks within Tjakura habitat.

Photograph 15. Conducting burning to protect Tjakura sites on a cold winter night when fires are easiest to control.



Source: Katiti Petermann IPA

Strategy 4: Fire Management

Aim	Action	Outputs	Outcomes	Measurable Indicator
Each year effective fire management protects Tjakura burrows from being burnt	4.1 Incorporate burns to protect Tjakura sites in fire management plans each year	Annual fire management plans include targeted management for at least 8 Tjakura sub-populations	Reduced threat of fire burning burrows in at least 8 subpopulations	# Fire management plans that include strategic burns to protect Tjakura sites
	4.2 Conduct strategic cool season burning around priority Tjakura sites	Burning conducted around at least 8 Tjakura sites each year. Large sites may also require careful burning within sites.	Reduction in number of burrows going inactive as a result of being burnt	% Burrows at monitoring sites remaining unburnt each year # Active burrows at monitoring sites
	4.3 Reduce fuel loads in surrounding area with a combination of aerial and ground burning, to prevent wildfires encroaching on Tjakura habitat	Area burnt by prescribed burning in the surrounding area for each sub-population	Low risk of fires in Tjakura habitat because fuel loads in the surrounding area are being actively managed	# Subpopulations negatively affected by wildfire each year

Strategy 5: Predator management

Conduct strategic predator control at selected, accessible sites, particularly if sites get burnt

Aim: Effective predator management reduces the number of *Tjakura* killed by predators

As predation is considered to be the major source of mortality for *Tjakura*, reducing the predation pressure on populations should result in fewer deaths and increased abundance.

Healthy *Tjakura* populations can coexist with low densities of cats, foxes and dingoes in unburnt habitat. However very small, isolated populations could be eliminated by an individual predator and *Tjakura* are particularly vulnerable to predation by cats, foxes and dingoes after fires have removed their vegetation cover. Predator management in these situations can save local populations from extinction. Another critical time to reduce predation pressure is straight after a small mammal boom when high densities of predators are left hungrily seeking alternative prey when the mammals crash.

Removing cats any time over the summer is beneficial but *Tjakura* are particularly active when they first emerge from hibernation in September-October, when the males are busy cleaning out their burrows and moving between burrows to look for females, so a blitz on cats at this time is recommended. Young *Tjakura* start appearing after Christmas until March, so another control period in February would also be beneficial.

Predator management is really only feasible in accessible areas that can be regularly patrolled. Trapping a cat can take many days or even weeks, so can usually only be done at sites close enough to commute to twice a day to check the traps. Other techniques such as Traditional hunting, or spotlighting may achieve results with a couple of 4-5 day field trips each year. Felixer Grooming Traps are a target specific cat control method yet to be trialled in *Tjakura* habitat, but have the potential to provide ongoing cat control.

As *Tjakura* burrows are often clustered within the landscape into fairly high density living (up to several hundred animals per square kilometre) even maintaining 5 square kilometres of prime *Tjakura* habitat free of predators, can protect a large number of skinks.

Cat control options include baiting, shooting, traditional hunting, cage trapping, and leghold trapping.

Baiting is not recommended because it will affect the dingo population, and in sandy spinifex country where *Tjakura* occur, dingoes can eat a lot of cats, and are an important animal to people.

Traditional hunting of cats can be a very effective method of removing cats from key *Tjakura* areas, if the hunting is targeted and regular. Some cats become

specialist hunters of *Tjakura*, learning where the burrows are, regularly travelling between them, and removing a disproportionate number of skinks from the area. An advantage of the Traditional hunting method is that the particular cats that are visiting *Tjakura* burrows can be targeted, tracked down and removed.

Tracking down cats requires a high level of tracking skill and good fitness as it can take many hours to track down a cat. This technique is often more efficient in the summer months as cats have little stamina in hot weather.

If tracking efforts do not result in the capture of a cat, rangers may choose to try trapping the cat, once they have a good understanding of its movement patterns.

Cage traps are the simplest traps to use, as they do not require much training or experience. Cage traps are most effective in areas close to human habitation where cats are already familiar with human infrastructure and may be already accustomed to scavenging. In more remote areas cage trapping is rarely effective, except during periods of drought which has led to extreme food shortages.

Kentucky Fried Chicken is a recommended bait for cage trapping, but other meats such as rabbit or kangaroo meat may also entice a cat into a trap. Unfortunately cage traps will also attract non-target species such as birds and goannas. While these animals can generally be released unharmed from a cage trap, it is very important that traps are checked daily, and heavy shade is provided over the traps. In hot summer conditions, cage traps should be closed during the day as animals such as goannas can overheat very quickly.

If cats appear to be avoiding cage traps, soft-jaw leghold traps may be more suitable, as if set properly they are invisible to the cats (but note different states have different legislation related to using leghold traps for cats). Leghold trapping requires training from an expert and is most successful if you spend time tracking the cat first to get to know its behaviour and movement patterns. Traps can then be set in pairs or groups of three along a cat's regular pathways, using vegetation such as spinifex to channel the cat through the area with the traps buried under the sand. Food based lures tend to attract dingoes, birds and other non-target species so leghold trapping relies more on strategic placement of traps in areas where the cat is likely to walk, sometimes with the addition of a territorial lure such as cat urine. If dingoes are captured in leghold traps, a catch-pole noose can be used to immobilise the animal while the trap is released from its foot. Leghold traps need checking twice a day. It is important to keep good records about where traps are set to make sure none are missed or forgotten about. The Newhaven Wildlife Sanctuary Rangers are experts in leghold trapping feral cats.

Strategy 5: Predator management

Aim	Action	Outputs	Outcomes	Measurable Indicator
Effective predator management reduces the number of Tjakura killed by predators	5.1 Monitor predator visitation to Tjakura burrows by deploying cameras at burrows in the spring	Number of subpopulations where camera trap monitoring occurs	Improved understanding of status of predator pressure to guide predator control efforts	Number of subpopulations where camera trap monitoring occurs
	5.2 Conduct cat control at priority sites when and where required, prioritising sites that get burnt	Ongoing targeted cat control conducted at a minimum of 5 subpopulations Number of cats killed at Tjakura sites	Reduced Predation pressure at Tjakura burrows Improved survival of skinks in cat-managed areas	At cat control sites: # Cat visitations per month # Cats removed each year #Number of active burrows at monitoring sites

Photograph 16. Cat captured in a leghold trap by CLC rangers in the Tanami Desert



Source: Desert Wildlife Services.

Photograph 17. Stomach contents of a cat captured at Newhaven Wildlife Sanctuary, showing the remains of a Tjakura.



Source: Desert Wildlife Services/Australian Wildlife Conservancy

Strategy 6: Protect from other disturbances

Protect Tjakura populations from other human disturbances such as mining, tourism, other infrastructure development, pastoralism, poaching and over-harvesting

Aim: Throughout the life of this Recovery Plan, no subpopulations decline due to increased mortality resulting from destruction of warrens, roadkill, poaching or harvesting

In areas with heavy traffic use, collisions with vehicles are a known source of mortality for Tjakura. Ensuring new roads do not traverse priority Tjakura burrow sites is therefore important. Because Tjakura are rarely detected by conventional trapping, spotlighting and camera surveys, it is also critical that Environmental Impact Assessment surveys are conducted by consultants that are well trained and experienced in searching for burrows.

As demonstrated by the Ngaanyatjarra Rangers, sub-contracting this aspect of an environmental survey to a local Ranger group can provide excellent results.

For some people, the opportunity to occasionally eat Tjakura ensures a continued connection to the species, and may be a major motivation for increasing population size at local sites. Environmental legislation does not prevent the customary harvest of Traditional foods by Indigenous people. While harvesting Tjakura for food is not a major issue at most locations, for some particularly small remnant subpopulations that have already been decimated by unmanaged fire and cat predation, hunting can cause local extinctions. This can be a delicate subject for respectful discussion with Traditional Owners. Collecting monitoring data to demonstrate trends and measure extent of harvesting within local populations will be a good start to aid future conversations on this topic. When such data are available it is recommended that Traditional Owners are provided with the opportunity for a forum to develop their own “Manners” for sustainable harvesting, based on actual data from their local situations.

Strategy 6: Protect from Other Disturbances

Aim	Action	Outputs	Outcomes	Measurable Indicator
Throughout the life of this Recovery Plan no sub-populations decline due to increased mortality resulting from destruction of warrens, roadkill, poaching or harvesting	6.1 Prevent disturbance to burrows from any proposed developments by ensuring adequate surveys are conducted prior to development and working with regulators to ensure appropriate controls are put on applications	Expert Rangers contracted to assist with surveys for Development Applications in Tjakura habitat Appropriate controls on any developments devised to limit disturbance	Limited impact of mining, tourism, pastoral or other infrastructure development on Tjakura populations	# Burrows go inactive due to trampling by feral herbivores # Burrows lost due to habitat clearance for roads or other infrastructure Guidelines for limiting impacts of development on Tjakura document developed
	6.2 Traditional Owners develop harvesting guidelines to ensure any Traditional harvesting is sustainable	Sustainable harvesting guidelines developed	No sub-populations decline due to harvesting	Sustainable harvesting guidelines document developed

Strategy 7: Address new and emerging threats

Address new and emerging threats to Tjakura populations such as climate change, disease outbreaks, weeds and feral herbivores

Protect Tjakura populations from other human disturbances such as mining, tourism, other infrastructure development, pastoralism, poaching and over-harvesting

Aim: By 2032, no sub-populations have suffered declines due to encroachment of weeds, pests, pathogens, feral herbivores or cattle and populations and their habitats are healthy enough to be resilient to climate change

Numerous other threats may have negative impacts on Tjakura populations.

Buffel grass is not currently a major threat to any populations, but it could potentially spread along transport routes through Tjakura habitat, which may lead to more frequent fires.

It is important to remain vigilant for any buffel grass incursions into Tjakura sites, and immediately deal with any weed infestations detected, ideally by spraying outbreaks along vehicle tracks.

Buffel grass loves expanding into disturbed habitat, so avoid making tracks through Tjakura habitat wherever possible. Where buffel grass does occur, avoid burning the buffel grass/spinifex boundary as this will only encourage the buffel to spread further into the spinifex habitat.

Strategy 7: Address new and Emerging Threats

Aim	Action	Outputs	Outcomes	Measurable Indicator
By 2032 no subpopulations have suffered declines due to encroachment of weeds, pests, pathogens, feral herbivores or cattle and subpopulations and their habitat are healthy enough to be resilient to climate change	7.1 Always be on the lookout for Buffel grass and other weeds in <i>Tjakura</i> habitat and immediately remove if detected	Weed surveys conducted Weed control conducted if required	No increase in weeds at <i>Tjakura</i> sites	# Burrows that go inactive as a result of weed incursion
	7.2 If burrow monitoring reveals any negative impacts of feral herbivores or cattle on Tjakura, conduct feral herbivore control or reduce stocking rates	Feral herbivores controlled if required Grazing regimes managed if required	No increase in sign of feral herbivores or grazing or trampling impacts at monitoring sites	# Burrows lost as a result of trampling by feral herbivores, cattle or colonisation by rabbits

Strategy 8: Monitor Tjakura Populations

Establish monitoring at key populations across a geographical spread of sites in NT, WA and S

Aim: Tjakura monitoring is conducted at enough sites over appropriate time periods to identify trends in population size at both local and national scales, and monitoring data informs local management.

Monitoring is important to determine whether Tjakura subpopulations are increasing, stable, or continuing to decline under current management. Such information is used to determine the conservation status of Tjakura at a local, regional and national level.

At a local level, monitoring helps us work out if our current management is adequate to prevent Tjakura going extinct in our area. Although population fluctuations are normal in desert environments, healthy resilient populations can bounce back after poor seasons. If a population continues to decline in successive years, even after an improvement in climatic conditions, we might need to change our management practices.

Monitoring data that show improvement in a species status provides encouragement and motivation for managers to continue their hard work, and evidence that can be shared with other land managers to inspire them to try a similar approach to management.

More strategic monitoring can address specific research questions about which habitat is best for the species, and how the population responds to fire or different management regimes. To answer specific research questions a more complex experimental design may be required with randomized site selection and adequate replicates and controls.

At key sites such as Yulara, UKTNP, Katiti Petermann IPA, Punmu, Kiwirrkurra, rangers are conducting annual monitoring surveys to determine subpopulation trends. Regular monitoring is also conducted at Newhaven Wildlife Sanctuary with the frequency of these surveys increased after significant impact, such as wildfire. The number of active burrows in an area is used as an index of abundance for subpopulations because this is a non-invasive, rapid method of quantitative monitoring that builds on the good tracking skills of Indigenous rangers. The large multi-entranced burrows, usually with an obvious latrine, are conspicuous and easily identifiable to a trained observer.

Monitoring surveys usually count the number of active (inhabited) burrows in a designated area, or along a defined transect. The presence of Tjakura tracks and fresh scats in the communal latrine can confirm that a burrow is inhabited by one or more Tjakura and the size of the scats indicates the different age-classes

of Tjakura living in that burrow, and whether it is a breeding burrow. Information can also be collected on any disturbance evident at the burrow such as if it's been affected by fire, predators (including people), trampling by feral herbivores, run over by vehicles, or infested with weeds.

To detect whether a population is changing from year to year it is necessary to apply consistent monitoring effort, i.e. searching exactly the same area, for approximately the same time period, in the same month of the year, ideally with the same number of people, and making sure experienced people are always present to teach other people what to look for. Monitoring should be conducted when skinks are active (October-March), as its necessary to be able to see the fresh tracks and scats to get an accurate burrow count for that site.

Number and size of monitoring plots will depend on how extensive a population is and how much effort can be put into it. Ideally plots will be small enough that they can be searched comprehensively (i.e. without missing burrows inside the plot) in about 1-2 hours with the number of people available, but big enough that they encompass a good representative sample of burrows in that area to determine trends. A group of 8 people can usually search a site in the order of 1 km x 250 m within a 2-hour period by walking up and back through the site in an emu parade type fashion.

Because the monitoring needs to be conducted in the hot season, and involves walking on foot, most Ranger groups only search one site per day, but if a single site is surveyed each day, ideally 4-5 sites could be surveyed over a week.

It has been suggested that Ranger groups could coordinate their monitoring to occur simultaneously. Designating a set month such as "Mulyamiji March" could provide added motivation for Rangers to get the work done, if they feel part of a larger collaboration of groups inspiring each other, potentially even introducing some friendly rivalry to spur groups on to find as many burrows as they can.

Camera trap monitoring at burrows is also a useful monitoring technique, particularly to assess the predation pressure at burrows. Setting up cameras at burrows for 1-2 months in the spring can provide information on how often cats are visiting burrows, and motivate rangers to conduct cat control. Coat patterns of cats captured in the vicinity of sites can be compared with burrow-camera photos to determine whether the specific cats hunting Tjakura have been targeted. Furthermore, watching sequences of photos of Tjakura interacting with each other at their burrows is highly engaging and also helps build a passion for the species.

Strategy 8: Monitor Tjakura Populations

Aim	Action	Outputs	Outcomes	Measurable Indicator
Tjakura monitoring is conducted at enough sites over appropriate time periods to identify trends in population size at both local and national scales, and monitoring data informs local management.	8.1 Continue annual burrow monitoring at Kiwirrkurra, Yulara and Punmu and establish annual burrow monitoring programs in one area of SA and at least 2 new sites in both NT and WA. Continue regular monitoring at Newhaven Wildlife Sanctuary .	Annual burrow surveys conducted at multiple sites Data collated on trends in number of active burrows per site per year Local trend data reviewed annually in relation to site-based information on seasonal conditions, and threats including fire, predators, harvesting	At the local level, monitoring data is used to measure the effectiveness of management, and inform future management	Number of subpopulations with annual monitoring data
	8.2 Coordinate collaborative “Mulyamiji March” monitoring program across Ranger teams	Online meetings held between Ranger teams to coordinate monitoring and inspire rangers Social media/media posts promoting #Mulyamiji March	Consistent population monitoring occurs at a range of sites across the geographical range	Number of groups collaborating in Mulyamiji March monitoring
	8.3 Conduct camera trapping at burrows in spring to monitor predator visitation	Predator visitation data collected from multiple monitoring sites	Information on predation pressure at burrows is used to inform predator management at sites	Number of sites where annual camera trapping is conducted
	8.4 Collate monitoring data across all sites every 5 years to determine national trends	Review of <i>Tjakura</i> status in relation to Recovery Plan implementation produced every 5 years	Improved understanding of the status of <i>Tjakura</i> at the national level	National review of <i>Tjakura</i> status completed every 5 years

Photograph 18. Central Land Council Rangers conducting burrow monitoring at Yulara, November 2021.



Source: Nicolas Rakotapare

Figure 7. Example of a data sheet used by Desert Rangers to monitor the Great Desert Skink.

Tjakura **Monitoring Datasheet** Name: _____ Date: _____
 Site Location: _____
 Start wpt: _____ End wpt: _____ Site Dimensions: _____
 No. observers: _____ Searchtime: _____

Wpt	Is it Active / recently active or long unused?	How many active holes ?	Breeding Burrow? What sized scats can you see?	Has the burrow been burnt in last year?	Any cat , fox or dingo sign?	Has anyone dug it up?
Total number of active burrows:			Total breeding:	Total burnt:	Total with cat tracks:	Total dug up:

****** Active – fresh GDS tracks and/or burrow maintenance activity and/or fresh black intact scats; recently active – open burrows and intact older scats but no GDS tracks; long unused - scats broken down, burrows collapsed or filled with debris. **Note:** If detection surveys are conducted within the winter months ‘burrow system activity’ may be difficult to determine while skinks are hibernating.

******* Approximate scat size:

adult >35 mm

sub-adult 20-30 mm

juvenile <15mm



Figure 8. Example of a Fulcrum sequence for burrow monitoring (Desert Rangers use Fulcrum, a field data collection application to support better conservation efforts).

Apps

Setup

Tjalapa Monitoring Kiwirrkurra

VIEW RECORDS

FIELDS

Basic

Text

Numeric

Yes / No

Date

Time

Choice

Single Choice

Multiple Choice

Classification Field

Design

Section

Repeatable

Label

Media

Signature

Photos

Videos

Audio

File Attachments

LAYOUT (FIELDS: 15)

Native Title Area

Transect number/name

Has burrow been recorded before?

Burrow Name

Burrow system

Number of active entrances

Tracks

Latrine site

Scat Sizes

Disturbance

Habitat description - soils, shrubs, fire

Rangers

Rangers1

Notes

Photos

Strategy 9: Share information

Report successes and failures back to all interested people to continually refine management techniques and learn from and encourage each other.

Aim: To ensure that Tjakura management is not limited by lack of knowledge because land managers are kept up to date with the latest information on monitoring methods and results, best practice management techniques and the outcomes of research projects.

Information sharing is an important aspect of any Recovery Plan.

Progress towards the recovery of a threatened species is much more efficient and effective when land owners and managers have access to all available knowledge on the status of a species, results of research, and best practice monitoring and management techniques. This prevents people from reinventing the wheel and allows groups to learn from each other's successes and mistakes.

Information can be shared through social media, traditional media, reports and scientific papers.

However, for many Rangers, information sharing is more successful at meetings with their peers, when they have the opportunity to watch and discuss engaging presentations from other rangers and other land managers. Workshops on country are even better for immersive learning and sharing and bringing issues to life. However, because of the vast distances people from remote communities need to travel, these events can be expensive and time consuming, so online video meetings are also important for catch-ups between the events where people physically get together.

In addition to sharing knowledge and data between each other, it is important to share data with government agencies who are responsible for making decisions about development applications (when targeted surveys should be conducted, appropriate controls, useful offsets), and allocating funding. It is possible to share location data with government agencies with caveats about who else can access the data, if people are worried about poachers accessing their sites.

Strategy 9: Share Information

Aim	Action	Outputs	Outcomes	Measurable Indicator
Tjakura management is not limited by lack of knowledge because land managers are kept up to date with the latest information on monitoring methods and results, best practice management techniques and the outcomes of research projects on Tjakura	9.1 Re-establish a Recovery Team for Tjakura and hold at least 2 online Ranger-friendly meetings per year	Online meetings held to discuss Tjakura work	All stakeholders kept up to date with information about monitoring, management, funding opportunities and support for Tjakura work.	Number of meetings held
	9.2 Organise an annual face-to-face information sharing meeting at an IDA conference or other Ranger meeting to share information about Tjakura	Face-to-face meeting held annually	Rangers inspire each other with success stories, and learn from each other's mistakes, leading to best practice management	Number of ranger groups represented at meeting
	9.3 Hold a larger on-Country information sharing event – Tjakura Festival	One-off on-Country Tjakura focussed event involving multiple stakeholders	Profile of Tjakura is elevated and opportunities provided for practical training in recognising and interpreting Tjakura sign, monitoring and management techniques	Tjakura Festival held on Country
	9.4 Survey data shared to state and commonwealth government databases with appropriate controls on public access	New locations shared to government databases	Policy makers have up to date maps on where Tjakura live to ensure appropriate advice is given on development applications	Government satisfied with availability of information Knowledge holders satisfied that data submitted is being treated cautiously and respectfully

Cost and Timeframe of the Recovery Plan

Successful implementation of this Recovery Plan is contingent upon ongoing funding to both the Indigenous Ranger Program and IPA program. Increasing and enduring support for Rangers to continue managing Country, conduct general surveys and pass on knowledge to younger generations is critical for the maintenance of biodiversity across the desert.

Although we can rely on Indigenous Rangers to conduct general land management, the nature of competing priorities means extra support is required to ensure targeted management of Tjakura occurs because Indigenous estates are vast, and the workforce remains relatively small. This is particularly important in the initial years of this Recovery Plan while surveys are conducted to identify priority management sites, monitoring regimes are established and the momentum builds. Recording cultural knowledge is also viewed as an urgent priority in the initial stage of the Recovery Plan due to the ongoing loss of Senior Knowledge Holders. We have therefore budgeted for numerous field trips in the first three years to record cultural knowledge and visit cultural sites and carry out field surveys around the edge of the distribution and in key gaps.

Once priority sites have been identified and motivation is built to monitor and manage Tjakura, it is hoped that the annual monitoring and localised fire management around priority sites would be incorporated into the annual work programmes of a number of Ranger Teams, however predator management is an additional skill and effort that is beyond the scope of most ranger programs and requires dedicated funding to do properly.

It is anticipated that the implementation of this Recovery Plan would be coordinated by an Indigenous land management organisation with good networks across the desert, and steered by a National Recovery Team comprising government representatives, scientific researchers, Indigenous Knowledge holders and other land management practitioners. We have therefore budgeted for a part-time (0.3 FTE) Project Coordinator position to keep the project running, liaise between partners, provide two-way Science resources, training and management advice, coordinate the annual monitoring program, collate data and assist in the administration of project grants.

One-off costs to develop and implement a Tjakura Roadshow, hold an on-Country festival, and facilitate a smaller workshop to develop sustainable hunting practices are also included in this budget.

2022-2023 The first two years of this Recovery Plan focusses on establishing an updated national distribution of Tjakura and collecting baseline population data from a range of sites to monitor trends through the life of the Recovery Plan.

This will also involve making resources available to conduct surveys and talk to old people about historical sightings, and general promotion of Tjakura and the Recovery Plan.

Existing monitoring programs will continue and we will start to establish new monitoring programs at additional sites.

We will also focus on recording cultural knowledge about Tjakura in this first phase.

The number of sites where targeted fire management is conducted will gradually increase from **2023**.

From **2024** the Recovery effort will switch from fewer surveys of new areas to more strategic consolidated management of existing populations.

In **2027** all data will be collated to conduct a 5-year Review of the Recovery Plan. This will assess how many Outputs have been achieved each year, the degree to which Actions have led to improved outcomes and ultimately whether we are on track to achieve the specific Conservation Objectives of maintaining a stable range and demonstrating an increase in number of active burrows across the range by 2032.

Results of the 5-year Review will inform refinements to management priorities for the second half of the Plan.

Table 3. Cost of achieving the actions

Action	Cost (\$K) per 2 years				
	2022-23	2024-25	2026-27	2028-29	2030-31
1.1 Support on Country trips to visit Tjukurrpa sites (2 groups per year @ \$10K per trip)	40	40	40	40	40
1.2 Support projects to document and archive Tjakura Tjukurrpa stories, songs, ceremonies, traditional resource use and other ecological knowledge (up to 5 Tjukurrpa's at \$30K each)	60	60	30		
Cost of Strategy 1	100	100	70	40	40
2.1 Elders teach children and Rangers	10	10	10	10	10
2.2 Rangers are taught and inspired by other Rangers and scientists (1 Ranger Exchange per year x 5 years)	20	20	10		
2.3 Community members reconnect with Tjakura and are inspired to look out for them and look after them (Roadshow)	50				
2.4 Build the profile of Tjakura amongst the general public (0.5 coordinator includes sourcing and administering funding)	10	10	10	10	10
Cost of Strategy 2	90	40	30	20	20
3.1 Refine historical distribution by consulting senior Traditional Owners					
3.2 Establish current distribution of Tjakura across Australia by conducting surveys around edge of range (\$15K x 5 surveys)	45	30			
3.3 Determine number of known sub-populations by conducting surveys in gaps (\$15k x 5 surveys)	45	30			
Cost of Strategy 3	90	60			
4.1 Incorporate burns to protect Tjakura sites in fire management plans each year					
4.2 Conduct strategic cool season burning around priority Tjakura sites	20	20	20	40	40
4.3 Reduce fuel loads in surrounding area with a combination of aerial and ground burning, to prevent wildfires encroaching on Tjakura habitat					
Cost of Strategy 4	20	20	20	40	40
5.1 Monitor predator visitation to Tjakura burrows by deploying cameras at burrows in the spring (0.1 project coordinator to collate data and provide management recommendations + field equipment)	50	20	20	20	20
5.2 Conduct cat control at priority sites when and where required, prioritising sites that get burnt	20	30	40	40	40

Action	Cost (\$K) per 2 years				
	2022-23	2024-25	2026-27	2028-29	2030-31
Cost of Strategy 5	70	50	60	60	60
6.1 Prevent disturbance to burrows from any proposed developments by ensuring adequate surveys are conducted prior to development and working with regulators to ensure appropriate controls are put on applications					
6.2 Traditional Owners develop harvesting guidelines to ensure any Traditional harvesting is sustainable (workshop and pilot study)		20			
Cost of Strategy 6	0	20	0	0	0
7.1 Always be on the lookout for buffel grass and other weeds in Tjakura habitat and immediately remove if detected					
7.2 If burrow monitoring reveals any negative impacts of feral herbivores on Tjakura, conduct feral herbivore control					
Cost of Strategy 7					
8.1 Continue annual burrow monitoring at Kiwirrkurra, Yulara and Punmu and establish annual burrow monitoring programs in one area of SA and at least 2 new sites in both NT and WA (\$10K per trip x 5 to establish new monitoring regimes). Regular monitoring to continue at Newhaven.	30	20			
8.2 Coordinate collaborative "Mulyamiji March" monitoring program across Ranger teams (0.2 project coordinator)	40	40	40	40	40
8.3 Collate monitoring data across all sites every 5 years to determine national trends			20		20
Cost of Strategy 8	70	60	60	40	60
9.1 Re-establish a Recovery Team for Tjakura and hold at least 2 online Ranger-friendly meetings per year (\$10K per year for secretariat)	20	20	20	20	20
9.2 Organise an annual face-to-face information sharing meeting at an IDA conference or other Ranger meeting to share information about Tjakura (\$5K travel assistance per year)	10	10	10	10	10
9.3 Hold a larger on-country information sharing event – Tjakura Festival		100			
9.4 Survey data shared to state and commonwealth government databases with appropriate controls on public access					
Cost of Strategy 9	30	130	30	30	30
Total cost per two years	470	480	250	230	250

Research Priorities

This Recovery Plan has been written as a practical on-ground management plan that prioritises actions required to achieve our objectives of demonstrating an increasing number of sites where Tjakura occur and an increasing number of Tjakura at each site.

Research priorities identified during the consultation phase identified three areas of research that are relevant to our management actions (for fire, predators and feral herbivores), one area that will help us understand the significance of Tjakura in the broader ecosystem and a final aspect that will help us understand and categorise its national status.

Fire – Although it has been clearly demonstrated that Tjakura decline after their habitat has been burnt, we are still unsure on the ideal fire regime for Tjakura, and whether there is a particular age of spinifex that is optimal for their persistence. For example, how does fire age affect food availability for Tjakura?

When conducting burning to protect burrows from wildfire, it would be very useful to know how much unburnt spinifex we need to leave around their burrows. Although one study has shown that Tjakura do not move after a fire, this study could be replicated in a better season to investigate whether Tjakura can relocate to unburnt areas and create new burrows if their burrows are burnt, and if so, how far can they disperse?

Predators – Predator control is difficult to sustain for most land managers, so information on when predator control is most critical is an important research question. What are the triggers for increased predation on Tjakura and when is predator control most crucial? Are there certain times of year (life cycle stages) when predation is most damaging to the population?

There is also the potential to conduct a collaborative predator surveillance project across the distribution using cameras set on active burrows. By comparing the types of predator, and frequency of visitation to burrows in declining versus healthy Tjakura populations we could investigate the relationship between predator composition and abundance and the status of Tjakura populations. Results of this study could inform experimental predator control manipulations.

Introduced herbivores – can Tjakura coexist with introduced herbivores such as cattle, camels and horses? Do we need to make sure no stock are introduced to sites supporting Tjakura populations, or is there a certain low stocking rate they can tolerate? Is it still worth surveying areas around the edge of the range where there is a history of grazing impacts?

Interactions with other species – Are interactions between Tjakura and woma pythons, and Tjakura and mulgara positive, negative or neutral? Are these uncommon native prey more abundant where they can take refuge in Tjakura burrows (or are goanna burrows just as good), and do mulgara, womas and goannas enter Tjakura burrows for shelter or to eat Tjakura?

Relatedness – A current study aims to use genetic data obtained from Tjakura scats to determine abundance of animals in a burrow and relatedness of individuals between burrows and sites. If successful this genetics study could be expanded across the range of the Tjakura to examine whether there is connectivity between sites, how many subpopulations exist and whether some of the small subpopulations are suffering from inbreeding.

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