

Western Quoll (Chuditch) *Dasyurus geoffroii*

Key Findings

Chuditch, or Western Quolls, disappeared from >90% of mainland Australia after European settlement and the introduction of foxes and feral cats. Chuditch have persisted across in south-western Australia, thanks to broad-scale control of foxes and feral cats. Translocations from these populations to predator managed areas have allowed for reintroduction of the species back into former parts of its range. As these translocated Chuditch establish breeding populations, the population trajectory should continue increasing, if introduced predators are effectively controlled. Photo: Todd R. Soderquist



Significant trajectory change from 2005-15 to 2015-18?

Population trends for the periods 2005-15 and 2015-18 were generally stable, with no significant overall improvement in trajectory from 2005-15 to 2015-18.

Priority future actions

- Maintenance of broad-scale control programs for introduced predators
- Implementation of enhanced control mechanisms for control of feral cats
- Re-introductions to areas within former range with broad-scale introduced predator control

Full assessment information

Background information

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The primary purpose of this scorecard is to assess progress against the year three targets outlined in the Australian Government's Threatened Species Strategy, including estimating the change in population trajectory of 20 mammal species. It has been prepared by experts from the **National Environmental Science Program's Threatened Species Recovery Hub**, with input from a number of taxon experts, a range of stakeholders and staff from the Office of the Threatened Species Commissioner, for the information of the Australian Government and is non-statutory. The descriptive information in this scorecard is informed by the 2012 Recovery Plan and advice provided by contributing experts.

The background information aims to provide context for estimation of progress in research and management (Section 7) and estimation of population size and trajectories (Section 8).

1. Conservation status and taxonomy

Conservation status	2018
EPBC	Vulnerable
WA	Vulnerable
NT	Extinct
SA	Endangered
QLD	Not listed
NSW	Presumed Extinct
ACT	Not Listed
VIC	Not listed

Taxonomy:

Two subspecies have been described: *D. g. geoffroii* from central Australia and *D. g. fortis* from south-western Australia, but the validity of this subspecific differentiation is contested (Jackson and Groves 2015). Some authorities also consider *Dasyurus geoffroii* may be conspecific with the bronze quoll *Dasyurus spartacus* of southern New Guinea, but that treatment is controversial and the relationship is not yet resolved (Jackson and Groves 2015).

2. Conservation history and prospects

The Chuditch (Western Quoll, Idnya) formerly had an extensive range across most of continental Australia other than the tropical north and temperate east. Chuditch declined extensively following European settlement of Australia, and by the 1950s was restricted to south-western Australia, where it occurs mostly in forested and woodland areas. Within this area the species appears to have declined in some parts, but has increased in others. Over the last 20 years it has been re-established through translocations at several other sites in southern Western Australia (WA) and in the Flinders Ranges, South Australia (SA).

The Chuditch is now extirpated from most of its former range. Chuditch recovery formally commenced in 1991 with the preparation of a management plan (Serena *et al.* 1991), with ongoing management continued through subsequent plans (Orell and Morris 1994; Department of Environment and Conservation 2012).

Over recent decades, sustained and intensive management of a major threat, the introduced red fox *Vulpes vulpes*, has resulted in population stability or increase at some sites in south-western Australia (Wayne *et al.* 2017); and translocations over the last 20 years to sites subjected to intensive control of introduced predators are resulting in re-establishment at some formerly occupied sites. In at least one such re-introduction, success has been largely dependent upon effective management of feral cats (Moseby *et al.* 2015).

3. Past and current trends

Following European settlement of Australia, the Chuditch disappeared from >90% of its former mainland range, and was extirpated from the only island on which it was known to occur, Dirk Hartog Island (Algar *et al.* 2011), presumably due to predation by feral cats. It has persisted across a range of forest and woodland habitats in south-western Australia, where populations have remained stable or slightly increased over the last 20 years associated with sustained and broad-scale fox-baiting programs, most notably Western Shield. Some populations in south-western Australia have been re-established through translocations, but some translocations failed. More recently (2015-18) a reintroduction of Chuditch to the Flinders Ranges in SA has been undertaken and this appears to have been successful, due largely to the intensive and varied control programs for foxes and feral cats. A small population has also been re-introduced to an introduced predator free enclosure at Arid Recovery as part of an experiment to investigate interactions between threatened species and predators. Following the recent eradication of cats from Dirk Hartog Island, Chuditch will be re-introduced there once other native mammals have been successfully re-established (Algar *et al.* 2011).

Monitoring (existing programs):

Chuditch populations are monitored at 27 sites in south-western Australia, mainly associated with reporting on the efficacy of broad-scale fox-baiting programs, and translocation programs. Monitoring programs undertaken by the WA Department of Biodiversity, Conservation and Attractions (DBCA) include:

- Trapping transects as part of the Western Shield program. Trap success rates (%) used as an index of abundance (1996-ongoing)
- Remote camera trap arrays at Dryandra and in SW forest blocks. Occupancy used as a surrogate for abundance. QSUM analysis (2005-ongoing)
- Remote camera arrays in Kalbarri National Park (2016-ongoing)

The camera trap-based monitoring also reports on trends in abundance of foxes and feral cats, the primary threats to Chuditch conservation.

The reintroduction program for Chuditch (Idnya), from 2015 to 2018, in the Flinders Ranges was intensively monitored by the SA Department of Environment, Water and Natural Resources (DEWNR) through radio-tracking, trapping transects and camera arrays. Trends in the abundance of introduced predators are also monitored, and have been so regionally for many years as part of Operation Bounceback (Brandle *et al.* 2018).

The experimental reintroduced population at Arid Recovery is monitored through radio-tracking to assess survival, health, breeding status and habitat use and to assess the extent to which individuals remain inside the reserve.

Population trends:

Table 1 and 2 summarises the overall trend and status of the Chuditch, with this information derived from the 2012 Recovery Plan, IUCN Red List account (Morris *et al.* 2008) and advice from contributing experts based on new information.

Table 1. Summary of the available information on Chuditch distribution and population size, and (where possible) trend estimates between 2015 and 2018 for each parameter.

Population parameters	Published baseline	2015 Estimate	2018 estimate	Confidence in estimates
WILD*				
Extent of Occurrence	244,000 km ²	332,000 km ²	333,300 km ²	High
Area of Occupancy	1300 km ²	19,200 km ²	20,100 km ²	High
Dates of records and methods used	As per the Mammal Action Plan (2012)	AOO based on 2 km x 2 km grid and using 2000-2015 records		
No. mature individuals	12,000 – 15,000	4400 – 6200	4400 – 6200	Medium (not all populations monitored); the 2012 recovery plan considered that the total population was less than 10,000 individuals, but noted varied estimates from 1368 to 12,500 individuals in jarrah forest.
Any other measure of relative abundance (specify)	Trap success rate shown to be a good indicator of population trends in some SW WA sites			
No. of subpopulations	>10			High (increase due to translocations and broadscale introduced predator control in SW WA)
No. of locations	>10			High (increase due to translocation)
Generation time	2	n/a	n/a	Medium-High (as in MAP)
EXCLOSURES/ISLANDS				
No. mature individuals	0	4	9	
No. locations	0	1	1	Arid Recovery

*Including translocations

Table 2. A summary of the overall trend and status of Chuditch in Australia.

Sub-population	Estimated % of population	Pre-2015 trend	Confidence in pre-2015 trend	2015-2018 trend	Confidence in 2015-2018 trend	Details
SW Australia (series of natural popns and translocations)	>99%		High		Medium	Mostly increases or stable trends to 2015; although some populations have declined in recent years.
Flinders Ranges (reintroduced)	<1%	n/a	High (first introduction in 2015)		High	Series of recent translocation episodes, accompanied by intensive predator control; population generally persisting
Arid Recovery (exclosure)	<<1%	n/a	High (first introduction in 2015)		High	Experimental trial; not yet an established population
Whole population	100				High	Historical trend of sharp decline, but some recovery since about the 1990s; generally stable over the last few years

KEY:

Improving	Stable	Deteriorating	Unknown	Confidence	Description
				High	Trend documented
				Medium	Trend considered likely based on documentation
				Low	Trend suspected but evidence indirect or equivocal

4. Key threats

The threats listed here are informed by the 2012 Recovery Plan with additional advice provided by contributing experts based on new information. Note that this is not a list of all plausible threats, but a subset of the threats that are likely to have the largest impact on populations.

Predation by and competition with red foxes and feral cats

Predation by and competition with foxes and feral cats are probably the most significant contributors to the extensive decline of Chuditch across the Australian mainland (Department of Environment and Conservation 2012). Foxes have a direct effect through predation (Glen *et al.* 2010) and probably also an indirect effect by competing for food resources (Glen *et al.* 2009). Research in the northern jarrah forest recorded an increase in the trap success of Chuditch from less than 1% to 2-4% over a seven year

period after the introduction of broad-scale fox baiting (Morris *et al.* 2003). Similar results have been obtained under the Western Shield baiting program which has delivered extensive and sustained benefits to fauna conservation in the south west of WA (Wayne *et al.* 2017).

Predation of Chuditch by feral cats has been recorded historically (Peacock and Abbott 2014) and more recently was demonstrated as a major factor threatening the success of reintroduction of Chuditch to the Flinders Ranges (Moseby *et al.* 2015). Cat predation and food competition is possibly contributing to the slow recovery of Chuditch in some fox baited areas.

Deliberate and accidental mortality from poisoning, trapping, illegal shooting and road kills

Chuditch in south-western Australia (which comprise the entire remnant population) have some natural tolerance to the toxin sodium fluoroacetate, or 1080, used for the management of introduced predators. Consumption of fox and feral cat baits by Chuditch was considered a risk but recent evidence in WA indicates this risk is low to free-ranging Chuditch with adequate food resources (Friend unpublished, Wayne *et al.* unpublished).

More recently research has shown that wide-ranging predators/scavengers that persist in rural and near urban landscapes such as Chuditch, may be at risk from secondary poisoning resulting from the consumption of rodents dying or killed by commonly used rodenticides (Lohr 2018).

Because of their predatory habits and taste for chicken meat, Chuditch were killed in the past by rural land owners to prevent loss of stock. Poisoning with strychnine, arsenic and 1080, and trapping and shooting were employed to remove raiding Chuditch. This practice has certainly reduced over the last 20 years or so with better public understanding about the need for Chuditch conservation, but possibly still occurs in some areas where Chuditch persist in higher densities at the interface of bushland and rural properties.

Chuditch often patrol roads and tracks looking for recently killed fauna on which to scavenge. This behaviour often exposes them to being killed themselves by passing vehicles (Serena *et al.* 1991), and most specimens offered to the WA Museum are derived from this source.

Land clearing, particularly riparian vegetation, and removal of suitable den logs and sites

Chuditch require large areas of uncleared vegetation to provide adequate food and refuge resources. Their current distribution is mostly confined to large conservation reserves, although they are wide-ranging and capable of moving through what would be considered unsuitable habitat. Maintenance of corridors between uncleared reserves will benefit Chuditch.

The impacts of the major threats are summarised in Table 3.

Table 3. The major threats facing the Chuditch and their associated impact scores.

CURRENT THREAT IMPACT			
Threat	Timing	Extent	Severity
1. Predation and competition by foxes	Continuing/ongoing	>90% of range	50-100%
2. Predation and competition by feral cats	Continuing/ongoing	>90% of range	20-29%
3. Non-target consumption of toxic cat baits	Continuing/ongoing	50-90% of range	Not negligible but <20%
4. Increase in fire frequency/intensity	Continuing/ongoing	50-90% of range	Not negligible but <20%
5. Others – habitat clearing, road kill, secondary poisoning, disease	Continuing/ongoing	1-50% of range	Not negligible but <20%

Timing: continuing/ongoing; near future: any occurrence probable within one generation (includes former threat no longer causing impact but could readily recur); distant future: any occurrence likely to be further than one generation into the future (includes former threat no longer causing impact and unlikely to recur).

Extent: <1% of range; 1-50%; 50-90%; >90%.

Severity: (over three generations or 10 years, whichever is longer) Causing no decline; Negligible declines (<1%); Not negligible but <20%; 20-29%; 30-49%; 50-100%; Causing/could cause order of magnitude fluctuations.

5. Past and current management

Recent and current management actions that support the conservation of the Chuditch are summarised below. Actions detailed in Table 4 are based on the Chuditch Recovery Plan (2012), which guides recovery action (see Section 11).

Table 4. Management actions that support the conservation of the Chuditch.

Action	Location	Timing	Contributors and partners	Outcomes
Retain and improve habitat critical for survival	WA: Dryandra woodland, Upper Warren	Broadscale habitat management commenced 1990s, use of fire to regenerate <i>Gastrolobium</i> commenced 2015.	DBCA	Use of fire to regenerate <i>Gastrolobium</i> thickets (1080 plants) to provide protection for a range of vulnerable fauna species from fox and cat predation.
Determine impacts of feral cats	WA: Dryandra woodland, Upper Warren, SA: Flinders Ranges NP	2000 - ongoing	DBCA, DEWNR	Evidence that feral cat predation can limit Chuditch populations in some areas. Potential to limit success of translocations.
Determine impacts of feral cat control methods	WA: Dryandra woodland, Upper Warren,	2000 -ongoing	DBCA, DEWNR	Development of feral cat control methods (i.e. baiting, trapping) that do not detrimentally impact

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	Fitzgerald River NP			on Chuditch. Chuditch known to remove, and possibly consume cat baits, but no known detrimental population impacts.
	SA: Flinders Ranges NP			
Continue, expand and improve baiting for foxes and feral cats (for more info: http://www.environment.gov.au/biodiversity/threatened/publications/factsheet-tackling-feral-cats)	WA: Western Shield monitoring sites SWWA	Western Shield commenced in 1996, ongoing.	DBCA, DEWNR	Improved Chuditch conservation in WA with 4 x year fox baiting.
	SA: Flinders Ranges NP	Flinders Ranges translocation started in 2015.		Successful establishment of Chuditch at Flinders due to effective fox and cat control.
	WA: Kalbarri, Dryandra, Upper Warren, South Coast	Integrated predator control SW fauna recovery project 2016-2018	DBCA, Cwlth DoEE	More effective control of cats and foxes in SW WA, benefit to Chuditch and other CWR mammals.
Determine population abundance and distribution	WA: Western Shield monitoring sites. SA: Flinders Ranges		DBCA	More rigorous monitoring techniques being developed. Accurate assessment of conservation status
Undertake and monitor translocations	WA: Western Shield monitoring sites SA: Flinders Ranges	1990 - ongoing	DBCA, DEWNR	Establish additional secure Chuditch populations within former range.
Increase public awareness and support	WA: Dryandra, Julimar neighbours SA: Flinders Ranges neighbours	1991-2017	DBCA, DEWNR, WWF, FAME, AWC	Better funding support to implement recovery actions, support for using 1080.
Trial reintroduction of western quolls to Arid Recovery reserve	Roxby Downs, SA	2015-16, 2018-ongoing	Arid Recovery	Considered a successful trial. Breeding occurred. Some individuals persisting.

6. Actions undertaken or supported by the Australian Government resulting from inclusion in the Threatened Species Strategy

Funding arising from the Threatened Species Strategy contributed to the Chuditch reintroduction to the Flinders Ranges, and has focussed attention on establishing populations in other parts of its extensive former range. The Australian Government also contributed \$1.7 million to the WA Government's Western Shield program, to continue, expand and improve baiting for foxes and feral cats across a range of habitats, including areas with Chuditch populations.

7. Measuring progress towards conservation

Table 5. Progress towards management understanding and management implementation for each of the major threats affecting the Chuditch in 2015 (i.e. timing of TSS implementation) and 2018, using the progress framework developed by Garnett et al. (2018).

PROGRESS IN MANAGING THREATS			
Threat	Year	Understanding of how to manage threat	Extent to which threat being managed
1. Predation and competition by foxes	2015	6. Research complete and being applied OR ongoing research associated with adaptive management of threat	4. Solutions are enabling achievement but only with continued conservation intervention
	2018	6. Research complete and being applied OR ongoing research associated with adaptive management of threat	4. Solutions are enabling achievement but only with continued conservation intervention
2. Predation and competition by feral cats	2015	1. Research being undertaken or completed but limited understanding on how to manage threat	1. Management limited to trials
	2018	2. Research has provided strong direction on how to manage threat	1. Management limited to trials
3. Non-target consumption of toxic cat and fox baits	2015	6. Research complete and being applied OR ongoing research associated with adaptive management of threat (<i>for baiting for introduced predators – research on non-target impacts of rodenticides, and mitigation of any such impacts, is less well developed</i>)	4. Solutions are enabling achievement but only with continued conservation intervention
	2018	6. Research complete and being applied OR ongoing research associated with adaptive management of threat (<i>for baiting for introduced predators – research on non-target impacts of rodenticides, and mitigation of any impacts, is less well developed</i>)	4. Solutions are enabling achievement but only with continued conservation intervention
4. Secondary poisoning from rodenticides	2015	1. Research being undertaken or completed but limited understanding on how to manage threat	0. No management
	2018	1. Research being undertaken or completed but limited understanding on how to manage threat	0. No management
5. Change in fire frequency/intensity	2015	2. Research has provided strong direction on how to manage threat	2. Work has been initiated to roll out solutions where threat applies across the taxon's range
	2018	2. Research has provided strong direction on how to manage threat	2. Work has been initiated to roll out solutions where threat applies across the taxon's range
6. Other – disease, road kill etc.	2015	1. Research being undertaken or completed but limited understanding on how to manage threat	0. No management
	2018	1. Research being undertaken or completed but limited understanding on how to manage threat	0. No management

> Green shading indicates an improvement in our understanding or management of threats between years 2015 and 2018, while red shading indicates deterioration in our understanding or management of threats.

KEY:

Score	Understanding of how to manage threat	Extent to which threat is being managed
0	No knowledge and no research	No management
1	Research being undertaken or completed but limited understanding on how to manage threat	Management limited to trials
2	Research has provided strong direction on how to manage threat	Work has been initiated to roll out solutions where threat applies across the taxon's range
3	Solutions being trialled but work only initiated recently	Solutions have been adopted but too early to demonstrate success
4	Trial management under way but not yet clear evidence that it can deliver objectives	Solutions are enabling achievement but only with continued conservation intervention
5	Trial management is providing clear evidence that it can deliver objectives	Good evidence available that solutions are enabling achievement with little or no conservation intervention
6	Research complete and being applied OR ongoing research associated with adaptive management of threat	The threat no longer needs management

8. Expert elicitation for population trends

An expert elicitation process was undertaken to assess population trends for the period 2005-2015 and post-2015 under the following management scenarios. Please note that differences between Management Scenarios 2 and 3 (Fig. 1) are difficult to attribute, as it can be difficult to determine whether actions undertaken after 2015 were influenced by the Threatened Species Strategy or were independent of it (see Summary Report for details of methods).

Management Scenario 1 (red line): *no conservation management undertaken since 2015, and no new actions implemented.*

- No re-introductions to Flinders Ranges or Arid Recovery; no enhancement of populations in south-western Australia; cessation of broad-scale introduced predator baiting programs.

Management Scenario 2 (blue line): *continuation of existing conservation management (i.e. actions undertaken before implementation of the Threatened Species Strategy or independent of the Threatened Species Strategy).*

- Re-introductions in Flinders Ranges and Arid Recovery; translocation in the medium term to Dirk Hartog Island; continuation of broad-scale baiting programs for introduced predators (and in some areas, of introduced herbivore); some ongoing enhancements of options for predator control; research being conducted into co-habitation of Chuditch with other threatened mammals inside exclosures.

Management Scenario 3 (green line): *continuation of existing management, augmented by support mobilised by the Australian Government under the Threatened Species Strategy.*

- As for scenario 2, with further support for research and trialing of novel mechanisms for introduced predator control at the landscape scale, and for exclosures and island eradications.

Overall estimated population trajectories subject to management scenarios considered

The Chuditch is currently being managed under Scenario 3 (green line).

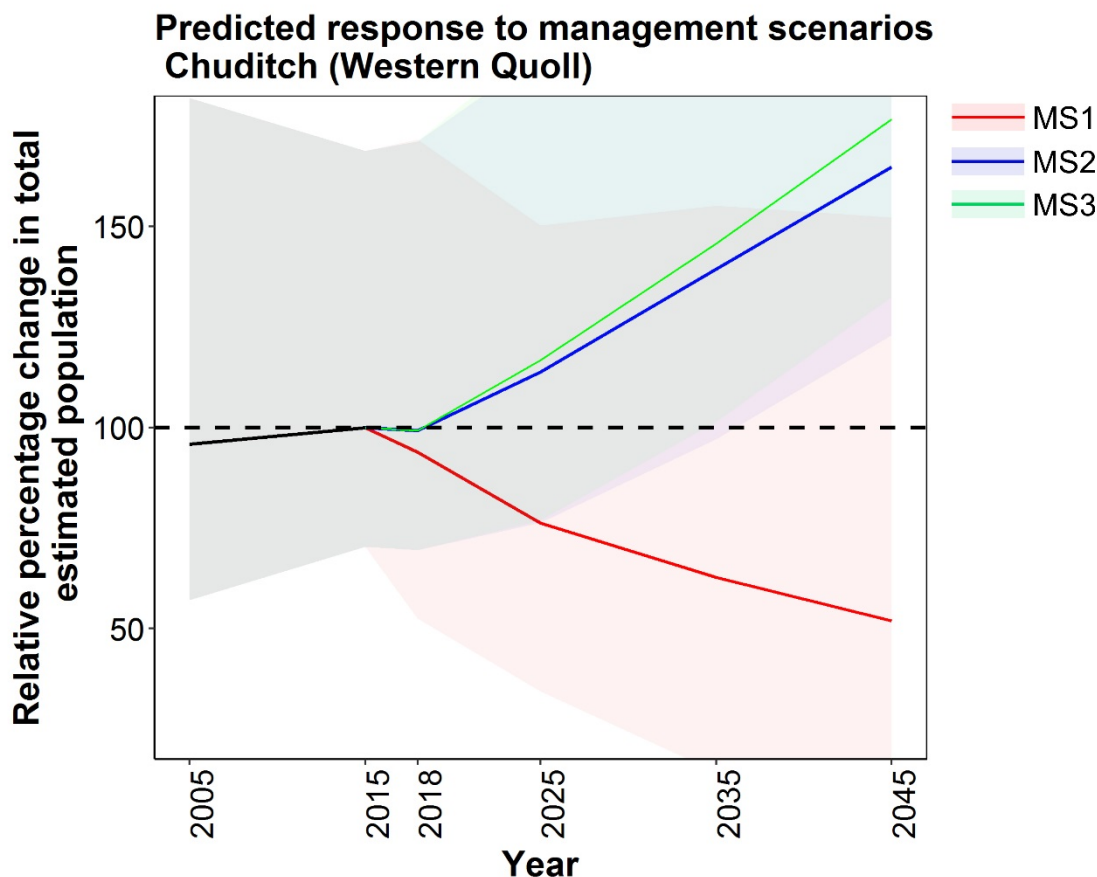



Figure 1. Estimated relative percentage change in population under each of the management scenarios described above. Data derived from 7 expert assessments of Chuditch expected response to management, using four-step elicitation and the IDEA protocol (Hemming et al. 2017), where experts are asked to provide best estimates, lowest and highest plausible estimates, and an associated level of confidence. The dashed line represents the baseline value (i.e. as at 2015, standardised to 100). Values above this line indicate a relative increase in population size, while values below this line indicate a relative decrease in population size. Shading indicates confidence bounds (i.e. the lowest and highest plausible estimates). NB: upper bounds wider than what is shown in top graph.

Population size projections based on expert elicitation are extended here to 2025, 2035 and 2045 (i.e. 10, 20 and 30 years after the establishment of the Threatened Species Strategy) on the grounds that some priority conservation management actions may take many years to achieve substantial conservation outcomes. However, we note also that there will be greater uncertainty around estimates of population size into the more distant future because, for example, novel threats may affect the species, managers may develop new and more efficient conservation options, and the impacts of climate change may be challenging to predict.

Improved trajectory:

The primary purpose of this scorecard is to assess progress against achieving the year three targets outlined in the Australian Government’s Threatened Species Strategy, i.e. a demonstrated improved trajectory for at least half of the priority species (10 birds and 10 mammals). To assess this, we first use the expert-derived trend between 2005-15 (i.e. 10 years prior to implementation of the TSS) as a baseline for assessing whether there has been an improvement in trajectory in the time since implementation of the TSS (i.e. 2015-18). Table 6 below summarises this information, where negative values indicate a declining population, and positive values indicate an increasing population. We used Wilcoxon match-paired tests to compare trajectories for these two periods; a significant result (probability <0.05) indicates that there was a high concordance amongst experts that their trajectory estimates for 2005-15 were different to their estimates for 2015-18.

Table 6. A comparison of the relative annual percentage population change for the periods 2005-2015 and 2015-2018.

	Pre-TSS trend (2005-2015)	Post-TSS trend (2015-2018)	Year 3 target met?	Significant concordance among elicitors
Annual percentage population change	0.41	-0.26		Elicitors did not consistently conclude that there was any difference in trajectory for the periods 2005-15 and 2015-18.

Following an extensive historical decline, intensive management (mainly through translocations and broad-scale baiting of introduced predators) over nearly 30 years has led to notable improvement in the conservation outlook for the Chuditch. This recovery has been framed by successive recovery plans, and most of the recovery has been planned and implemented by the WA Department of Biodiversity Conservation and Attractions. The Threatened Species Strategy has contributed to the recovery effort, most notably through contributions to the recent reintroduction of Chuditch (Idnyia) to the Flinders Ranges.

Additional actions that could improve trajectory

The potential impact of carrying out specific additional conservation measures on the population trajectory of the Chuditch was also evaluated through expert elicitation. Additional actions that could further improve the population trajectory of the Chuditch include:

- increased unfenced areas exposed to broad-scale baiting of introduced predators;
- implementation of novel predator management mechanisms; and
- further re-introductions to appropriately managed unfenced areas more broadly across Australia.

9. Immediate priorities from 2019

Identification of these priorities in this document is for information and is non-statutory. For statutory conservation planning documents, such as Recovery Plans or Conservation Advices, please see Section 11. The priorities listed here are informed by the 2012 Recovery Plan and advice from contributing experts based on new information.

Broad-scale control of introduced predators (i.e. feral cats and foxes) continues to be the highest priority conservation action for this species. Species' recovery requires management over large areas as it is a wide-ranging, low density species. This requires significant ongoing commitment to control predators and, in some areas, to restore understorey through herbivore control (rabbits, goats, kangaroos).

This species can persist and increase in abundance in areas where foxes and feral cats are effectively controlled. Their conservation is not dependent on fenced enclosures and the management of free-ranging, unfenced populations within former range should be the priority. The establishment of a population on Dirk Hartog Island is planned for 2025-2026, and there are proposals for the establishment of populations within enclosures in NSW and NT.

Ongoing research is required into the impact of any novel cat or fox control techniques, such as Felixer grooming traps, on Chuditch. Research is also required on the impact of rodenticide secondary poisoning on Chuditch in semi-rural and rural areas.

Data collection:

- Development and implementation of an effective monitoring program, linked to assessments of management effectiveness (especially baiting of introduced predators)
- Research into threshold abundances of introduced predators above which Chuditch populations can be viable
- Research into interactions and impacts of co-habiting Chuditch and other threatened species across a range of species' compositions and habitats

Management actions:

- Maintenance of broad-scale control programs for introduced predators
- Implementation of enhanced control mechanisms for control of feral cats
- Re-introductions to locations within the species former range where broad-scale introduced predator control is undertaken.

10. Contributors

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11. Legislative documents

SPRAT profile: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=330

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13. Citation

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