

Chuditch (*Dasyurus geoffroii*)

Recovery Plan



Wildlife Management Program No. 54
Department of Environment and Conservation



Government of **Western Australia**
Department of **Environment and Conservation**



Australian Government

WESTERN AUSTRALIAN WILDLIFE MANAGEMENT PROGRAM NO. 54

**Chuditch *Dasyurus geoffroi*
Recovery Plan**

July 2012

Department of Environment and Conservation
Locked Bag 104, Bentley Delivery Centre WA 6983

FOREWORD

This is a Recovery Plan prepared within the framework laid down in Department of Environment and Conservation (DEC) Policy Statements Numbers 44 and 50 (CALM 1992; CALM 1994), and the Australian Government Department for Sustainability, Environment, Water, Population and Communities (SEWPAC) Recovery Planning Compliance Checklist for Legislative and Process Requirements (DEWHA 2008), with the assistance of funding provided by the Australian Government.

Recovery Plans outline the recovery actions that are required to address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process. Recovery Plans delineate, justify and schedule management actions necessary to support the recovery of threatened species and ecological communities. This Recovery Plan has been developed with the involvement and cooperation of a range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

Information in this Recovery Plan was accurate at July 2012.

Recovery Plan Preparation: This Recovery Plan was prepared by Judy Dunlop and Keith Morris (Department of Environment and Conservation) for the Chuditch Recovery Team. This plan was reviewed and updated by Holly Raudino and the map was prepared by Amy Mutton.

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SUMMARY

Chuditch (Western Quoll) *Dasyurus geoffroii* Gould 1841

Family: Dasyuridae

DEC Regions: Goldfields, Midwest, South Coast, South West, Swan, Warren, Wheatbelt

Interim Biogeographic Regions: Avon Wheatbelt, Carnarvon, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Swan Coastal Plain, Warren, Yalgoo

Current status of taxon: *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): Vulnerable.

Western Australia Wildlife Conservation Act 1950, Wildlife Conservation (Specially Protected Fauna) Notice 2010: Schedule 1, and ranked as Vulnerable using IUCN criteria.

Habitat critical for survival:

At the time of European settlement, chuditch were present in all mainland Australian States, and the Northern Territory; however they are now only present in approximately 5% of their former range. Most chuditch are now found in varying densities throughout the jarrah forest and south coast of Western Australia. They also occur at lower densities in the goldfields and wheatbelt, as well as in Kalbarri National Park (translocated).

Chuditch use a range of habitats including forest, mallee shrublands, woodland and desert. The most dense populations have been found in riparian jarrah forest. Chuditch require adequate numbers of suitable den and refuge sites (horizontal hollow logs or earth burrows) and sufficient prey biomass (large invertebrates, reptiles and small mammals) to survive. They are capable of travelling long distances and have large home ranges, and even at their most abundant, chuditch are generally present in low numbers. For this reason they require habitats that are of a suitable size and not excessively fragmented.

Recovery plan objective:

To reduce threats to the chuditch and increase population densities to ensure long-term survival.

Performance criteria:

This Recovery Plan will be deemed successful if the chuditch can be delisted from Vulnerable under the EPBC Act and Schedule 1 under the WA Wildlife Conservation Act within 10 years from adoption.

This Recovery Plan will be deemed unsuccessful if the chuditch is still listed as Threatened under either the EPBC Act or Wildlife Conservation Act after 10 years of adoption.

Recovery actions:

1. Retain and improve habitat critical for survival
2. Determine impacts of feral cats on chuditch
3. Determine the impact of feral cat control methods on chuditch
4. Continue, expand and improve baiting foxes and feral cats
5. Determine population abundance and distribution of chuditch populations
6. Establish reference sites for monitoring chuditch population abundance to evaluate the effectiveness of fox and cat control
7. Undertake and monitor translocations to increase the extent of occurrence
8. Increase public awareness through community education and enforcement of regulations
9. Coordinate recovery implementation

Cost:

The estimated cost of implementing this Recovery Plan is \$ 2,570,000 over ten years.

Recovery team:

Recovery teams provide advice and assist in coordinating actions described in recovery plans. Recovery teams comprising representatives from organisations with direct interest in the recovery of the species, including those involved in funding and carrying out, or helping to carry out, actions that support the recovery of the species. The Chuditch Recovery Team may include representatives of the Western Australian Department of Environment and Conservation, Perth Zoo, WWF-Australia, Australian Wildlife Conservancy and other organisations as appropriate.

1. INTRODUCTION

This is the second recovery plan prepared for the chuditch, *Dasyurus geoffroii*. The first was prepared in 1994 (Orell and Morris 1994), based on a management program prepared in 1991 (Serena *et al.* 1991). A recovery team was established in 1992 and assisted in the development of the first recovery plan. Significant progress has been made on the recovery actions identified in the first recovery plan and a summary of these is presented in this plan. However a recent review of the chuditch conservation status (DEC 2007) determined that, despite some successful translocations and increases in natural populations, the chuditch still did not meet the IUCN criteria for downlisting in Western Australia, and its status remains as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* and the *Wildlife Conservation Act 1950*.

2. SPECIES NAME

2.1. History and taxonomic relationships

The chuditch (*Dasyurus geoffroii*) is one of six quoll species native to Australia and New Guinea. Four of these, *D. geoffroii*, *D. hallucatus*, *D. viverrinus* and *D. maculatus*, occur in Australia; *D. albopunctatus* and *D. spartacus* occur in New Guinea. All quoll species in Australia are now listed as threatened species. Both *D. geoffroii* and *D. hallucatus* occur in WA however their current distributions do not overlap (van Dyck and Strahan 2008).

The chuditch was first described by John Gould in 1840 (Gould 1840). Other common names for this species include western quoll or native cat; however the latter is misleading as the chuditch is a dasyurid marsupial unrelated to cats. Abbott (2001) lists a number of different names recorded being used by Noongar people of south-west WA. From words like “djooditj” and “dju-tytch”, early settlers and collectors derived the name Chuditch. These names may mimic the sharp, guttural cry of the animal when threatened (Smith *et al.* 2004; Serena 1987).

Two forms have been recognised based on skull size, skin and fur colour. *Dasyurus geoffroii geoffroii* from New South Wales, Victoria and South Australia is represented by the specimen collected by Gould in 1841, and *D. g. fortis*, from Western Australia later recognised by Thomas (1906). A lack of specimens from eastern Australia has made it difficult to verify these two forms and separate taxonomy has been refuted from both morphometric (Serena *et*

al. 1991) and genetic (Firestone 1999) perspectives. As such the chuditch is currently regarded as a single taxon.

2.2. Description

The chuditch is the largest carnivorous marsupial (family Dasyuridae) occurring in Western Australia. At maturity it is about the size of a small domestic cat, males weighing an average of 1.3 kg and females an average of 0.9 kg. The chuditch is distinguishable from other mammals within its present range by its white spotted brown pelage, large rounded ears, pointed muzzle, large dark eyes and a non-hopping gait. The tail is about three quarters of the head and body length, and has a black 'brush' over the dorsal surface of the distal portion.

2.3. Distribution, habitat and movements

The chuditch formerly ranged across nearly 70 percent of the continent, occurring in every mainland State and Territory (Figure 1). It was relatively abundant over this large range at the time of European settlement (Collett 1887, as cited by Serena *et al.* 1991; Whittell 1954; Johnson and Roff 1982; Burbidge *et al.* 1988). However, a drastic decline in numbers and a contraction of range has occurred since that time. Specimens were last collected in New South Wales in 1841, Victoria in 1857 and in Queensland between 1884 and 1907. Chuditch were last reported in the arid zone of South Australia in the mid-1950s (Finlayson 1961). In Western Australia, the species was still abundant in the wheatbelt in 1907, but had disappeared from coastal areas north of Geraldton by this time (Thomas 1906; Shortridge 1909). Chuditch had not been recorded on the Swan Coastal Plain since the 1930s, however there have been records in the outer metropolitan areas such as Gooseberry Hill, East Martin and on the Swan Coastal Plain, Upper Swan Valley, High Wycombe, Wandi, Yalgorup National Park and Leschenault Conservation Park.

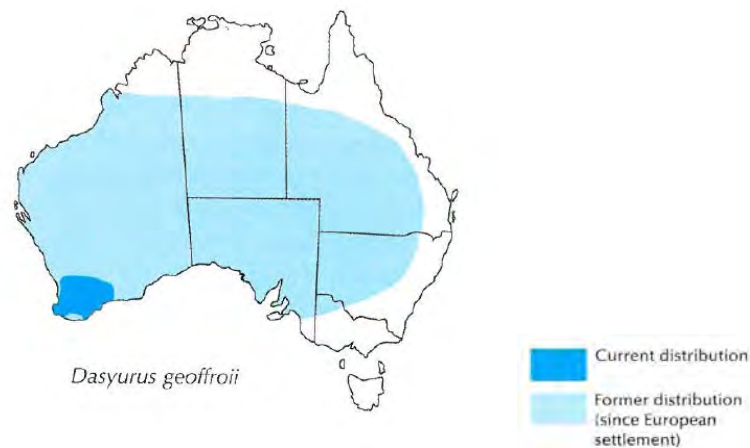


Figure 1. Past and present distribution of the chuditch (from van Dyck and Strahan 2008). Introduced populations are displayed in Figure 2.

Free-ranging populations of chuditch are now restricted to Western Australia, within an estimated 5% of their former range. Some captive chuditch are held at the Desert Park facility in Alice Springs, the Perth Zoo and a number of private wildlife parks in Western Australia. The major portion of the remaining natural populations occur in varying densities in jarrah (*Eucalyptus marginata*) forests and woodlands in the south-west corner of WA, and in woodlands, mallee shrublands and heaths along the south coast, east to the Ravensthorpe area (Figure 2). There are also occasional records from drier woodland and mallee shrubland in the Wheatbelt and Goldfield Regions. Under actions of the first recovery plan, chuditch were translocated to Lake Magenta Nature Reserve, Julimar Conservation Park and Kalbarri National Park, Mt Lindsey and Cape Arid National Parks. The success of translocations will be discussed in more detail in Section 12.4 below.

The total chuditch population as of 2007 was estimated to be less than 10,000 individuals (DEC 2007) with probably 75% of these occurring in the eucalypt forests and woodlands, and mallee heath and shrublands of the south-west and south coast of WA. The present distribution (Fig. 2) is based on Western Australian Museum specimens, reliable sightings and road kill records within the last 16 years. Their solitary and nomadic lifestyle makes populations very difficult to estimate; for example, numbers of mature chuditch present in the jarrah forest has been estimated by various different studies at various dates between 1,368 and 12,500 individuals (Serena *et al.* 1991; Morris 1998; Morris *et al.* 2000; DEC 2007). All populations of chuditch are considered important to the survival of the species.

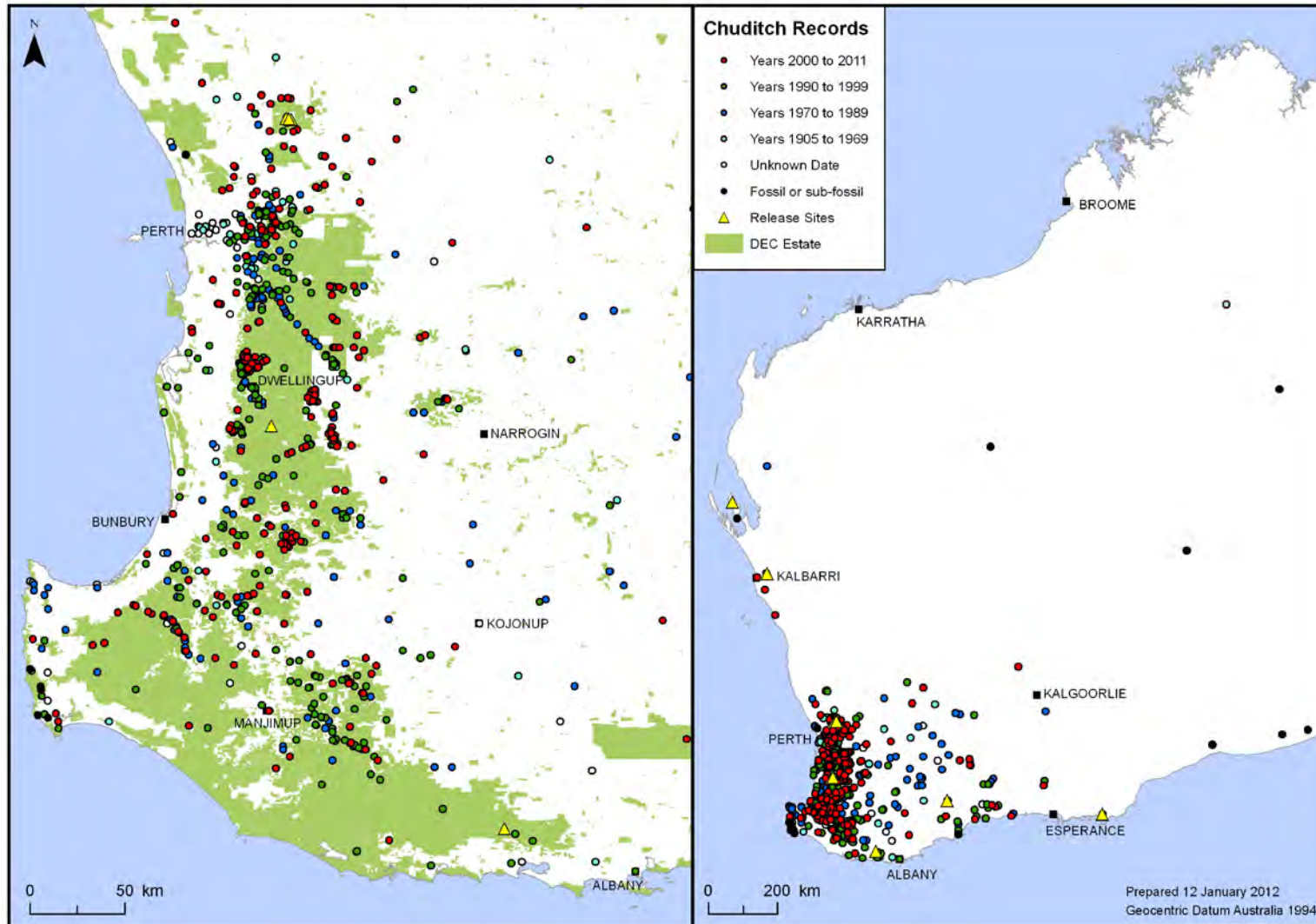


Figure 2. Chuditch locations a) south-west of Western Australia b) State-wide. Sighting data from DEC’s Threatened and Priority Fauna Database.

Chuditch are solitary animals for most of their life. In the absence of foxes, they occupy relatively large home ranges, males ranging over 15 km² and females 3-4 km² (Serena and Soderquist 1989). These home ranges may overlap; however there tends to be a smaller non-overlapping 'core' area defined by den locations. Core areas are 4 km² and 0.9 km² for males and females respectively (Serena and Soderquist 1989). Females tend to be territorial, although some areas may be shared by a mother and her adult daughter (Serena and Soderquist 1989). Male core areas are much larger and overlap broadly with other males as well as female. Both sexes occur at similar densities in the jarrah forest. Home range size may be smaller in areas where foxes are effectively controlled, and where chuditch population densities are higher (Mathew 1996).

2.4. Biology and ecology

Diet and foraging activity

Chuditch are opportunistic feeders, foraging primarily on the ground and at night. They may climb trees to obtain prey or to escape from predators. In the forest, insects and other large invertebrates comprise the bulk of their diet, though some mammals, birds and lizards are also included (Serena *et al.* 1991). The red pulp surrounding *Zamia* (*Macrozamia riedlei*) seeds is sometimes consumed, as well as small fruits and parts of flowers (Hancock 1991). In the arid zone, the diet of chuditch includes live mammals, carrion, lizards, frogs and invertebrates (Johnson and Roff 1982; Burbidge *et al.* 1988). Chuditch will also scavenge for food scraps around campsites and consume the remains of animals killed on roads.

Chuditch are primarily a nocturnal species, although they are sometimes active during the day during the breeding season or when cold, wet weather restricts nocturnal foraging. Food is most limited during the colder months from June to August. They have a keen sense of sight, hearing and smell to locate and capture prey.

Reproduction and mortality

In the south-west and wheatbelt, chuditch are seasonal breeders. Females enter oestrus, and mating occurs, in late April to early July. Chuditch are a supernumerary breeder (Morton *et al.* 1989) and, following a gestation period of about 17-18 days, females can produce up to 50 fetuses, each 5mm long and weighing 9-15 mg. However, only 2-6 young successfully attach to the available six nipples. The young remain in the mother's pouch for about 61 days and

are then left in the den while the mother forages. By 110 days of age they are well furred and begin eating solid food. They are fully weaned at 170 days of age and subsequently disperse. Both males and females are sexually mature and can breed in their first year. Fecundity appears to be highest in first year females, which also comprise more than half the breeding female population. The population sex ratio is close to parity, both in the case of pouch young and breeding adults.

Wild chuditch usually die before their fourth year; the average life span for established adults is two years (Soderquist 1988). Factors contributing to chuditch mortality in the jarrah forest include being hit by motor vehicles, illegal shooting near roads, predation by foxes, raptors and feral cats, injury in rabbit traps, natural accidents and disease. Chuditch commonly forage along dirt roads and tracks, hence many animals are hit by motor vehicles. This behaviour may also serve to increase the frequency of encounters with predators.

2.5. Conservation status

Chuditch have disappeared from approximately 95% of their former range in the last 200 years. The primary causes of this reduction were habitat removal, the spread of introduced predators and active persecution by humans. Although some natural populations have recovered as a result of broad scale fox baiting programs in the south-west of Western Australia, and some new populations have been established through translocations, the chuditch is still regarded as Vulnerable under the EPBC Act and under IUCN criteria (IUCN version 3.1).

In Western Australia, it was gazetted as 'rare or likely to become extinct' in 1983 (*Wildlife Conservation Act 1950*), in recognition of its dramatically reduced range. In 1991 it was listed as Endangered under the Commonwealth *Endangered Species Protection Act 1992*. The 1992 Action Plan for Australasian Marsupials and Monotremes listed the chuditch as Endangered (Kennedy 1992), however a revision of this document in 1996 downgraded the status to Vulnerable using IUCN (1994) criteria (Maxwell *et al.* 1996). The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* listed the species as Vulnerable and a revision of this status in 2006 (DEC 2007) recommended that the status remain the same, largely because of difficulties in monitoring and accurately estimating population size. Table 1 presents the conservation status of the chuditch according to different authorities and changes over time.

Table 1. Conservation status of the chuditch according to different authorities.

Jurisdiction	Legislation/Authority	Conservation Status/Rank	Year listed	Listing Status
International	IUCN	Status inadequately known - survey required or data sought	1965	-
		Endangered	1994	Changed status in 1996
		Vulnerable (VU C1 version 2.3 (1994))	1996	Changed status in 2008
		Near Threatened (NT version 3.1 (2001))	2008	Current
National	<i>Endangered Species Protection Act 1992</i>	Endangered	1992	Replaced by EPBC Act
	1992 Action Plan for Australian Marsupials and Monotremes	Endangered	1992	Superseded by 1996 action plan
	1996 Action Plan for Australian Marsupials and Monotremes	Vulnerable	1996	Current
	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Vulnerable	1999	Current
Western Australia	<i>Wildlife Conservation Act 1950</i>	Second Schedule - Fauna which is rare, or otherwise in need of special protection	1983	Changed status in 1988
		Schedule 1 – Fauna that is rare or likely to become extinct. Ranked as Vulnerable using IUCN criteria C1 version 3.1 (2001)	1988	Current
South Australia	<i>National Parks and Wildlife Act 1972</i>	Endangered	-	Current
Queensland	<i>Nature Conservation Act 1992</i>	Extinct	-	Current
Northern Territory	<i>Territory Parks and Wildlife Act 2000</i>	Extinct	-	Current
New South Wales	<i>Threatened Species Conservation Act 1995</i>	Not listed	-	Current
Victoria	<i>Flora and Fauna Guarantee Act 1988</i>	Not listed	-	Current
Australian Capital Territory	<i>The Nature Conservation Act 1980</i>	Not listed	-	Current
Tasmania	<i>Threatened Species Protection Act 1995</i>	Not Listed	-	Current

Chuditch have a short average life span and, within their present range, are patchily distributed at low densities even in high quality habitat. Chuditch populations are consequently vulnerable to extinction due to chance events or normal environmental fluctuations as well as natural catastrophes and habitat destruction (Shaffer 1981; Soulé 1985).

3. INTERNATIONAL OBLIGATIONS

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that convention. The chuditch is not listed under the Convention on the International Trade in Endangered Species (CITES), and this plan does not affect Australia's obligations under any other international agreements.

4. HABITAT CRITICAL TO SURVIVAL AND IMPORTANT POPULATIONS

Habitats critical to chuditch survival and maintenance of important populations comprise:

- Areas currently occupied by chuditch;
- Areas of natural vegetation in which chuditch breed;
- Areas of natural vegetation in which chuditch forage;
- Areas of natural vegetation that chuditch use to move from one area to another;
- Areas of suitable vegetation within the recorded range in which undiscovered chuditch populations may exist;
- Areas not currently occupied by chuditch due to recent fire but are capable of supporting chuditch populations when sufficiently recovered; and
- Areas previously occupied and that still provide suitable habitat and into which chuditch can be reintroduced.

Chuditch have historically been present in a large variety of habitats so it is not possible to list a set of characteristic habitats that should be preserved for chuditch. However, some key aspects are required for chuditch survival in an area. These are: adequate den resources (e.g. hollow logs, burrows or rock crevices), adequate prey resources (particularly large invertebrates) and sizeable areas (> 20 000 ha.). Incorporation of management practices such as the retention of den logs during logging and burning operations, and implementation of fox baiting programs are important to the conservation of the chuditch. Cooler prescribed burning regimes over areas of 2000 – 4000 ha are likely to be beneficial to chuditch populations, because they maintain prey resources and prevent broad scale, high intensity bushfires. Chuditch need large natural areas because of their large home ranges and resource

requirements. Corridors of retained vegetation e.g. road reserves, are also important to chuditch as links between larger reserves.

5. GUIDE FOR DECISION MAKERS

Section 7 provides details of current and possible future threats to chuditch. Developments in the immediate vicinity of the population or within the habitat that is defined as critical to survival may require assessment. Any on-ground works (clearing, firebreaks, road works, burning, drainage, mining etc.) in the immediate vicinity of chuditch habitat may require assessment. Proponents should demonstrate that on-ground works will not have an impact on the species, or on its habitat or potential habitat.

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), or other national environmental legislation as may apply at the time an activity is proposed, any person proposing to undertake actions which may have a significant impact on any listed threatened species or ecological community should refer the action to the Minister for Environment. The Minister will determine whether the action requires EPBC Act assessment and approval. Further advice on the EPBC Act is available on the Department of the Sustainability, Environment, Water, Population and Communities website.

Actions that remove native vegetation (e.g. increased fire frequency, clearing for development, mineral exploration and extraction, forestry) can result in a significant impact on the chuditch, particularly if these actions remove habitat critical for survival, or occur within 15 km of habitat critical to survival.

Such habitat critical to survival includes areas:

- occupied by chuditch;
- utilised by chuditch for movement from one area to another;
- where chuditch are known to breed or forage.

6. MANAGEMENT PRACTICES

Management practices (policies, strategies, plans) that have a role in the protection of the species include but are not limited to the following:

- Project Eden Draft Strategic Plan 2006

- Shark Bay Terrestrial Reserves Management Plan 2000 – 2009 (CALM 2000)
- Western Shield Fauna Recovery Program Draft Interim Strategic Plan 2009-2010
- Minimising Disease Risk in Wildlife Management. 3rd Edition (Chapman *et al.* 2011)
- Policy Statement No. 29 *Translocation of Threatened Flora and Fauna* (CALM 1995)
- Policy Statement No. 33 *Conservation of endangered and specially protected fauna in the wild* (CALM 1991)
- Wellington National Park, Westralia Conservation Park and Wellington Discovery Forest, Management Plan
- Dryandra Woodland Management Plan No. 70, 2011
- Guidelines for Protection of the Values of Informal Reserves and Fauna Habitat Zones, Department of Environment and Conservation, Sustainable Forest Management Series, SFM Guideline No. 4
- Guidelines for the Selection of Fauna Habitat Zones, Department of Environment and Conservation, Sustainable Forest Management Series, SFM Guideline No. 6
- Forest Management Plan 2004-2013
- Morris, K., Johnson, B. and Orell, P. (2006). A review of the conservation status of the chuditch *Dasyurus geoffroii*: Progress Report July 2006. Unpublished Report for the Department of Environment and Conservation, Western Australia.
- Morris, K., Johnson, B. and York, M. (2005). The impact of using Probaits for fox control on Chuditch (*Dasyurus geoffroii*) in the wild. Unpublished Report for the Department of Environment and Conservation, Western Australia.
- South Coast Regional Fire Management Plan 2009-2014
- Walpole Wilderness and Adjacent Parks and Reserves Management Plan 2008
- Perup Management Plan 2012

To minimise the risk of bushfire to chuditch, management practices such as prescribed burning, firebreaks, and back-burning, are required. DEC address this in WA through the Incident Management System and the ‘Master Burn Plan’ and set annual priorities for areas to be burnt prescriptively to reduce fuel loading in an effort to reduce the intensity and frequency

of bushfires. Areas where threatened species persist or have been introduced are considered high priority assets and efforts are made to exclude fire where practicable from these areas.

7. THREATS

Many factors may have contributed to the decline of the chuditch including habitat alteration caused by rabbit and livestock grazing, changing fire regimes, and land clearing; predation by, and competition from, feral dogs, foxes and feral cats; epidemic disease, shooting and poisoning (Shortridge 1909; Marlow 1958; Finlayson 1961; Burbidge and Fuller 1979; Johnson and Roff 1982; Burbidge *et al.* 1988; Abbott 2006). However, decreases in productivity and the diversion of resources to humans, domestic stock and feral animals, associated with habitat alteration and predation by introduced mammals, are probably the primary cause in the decline of many native mammals, including chuditch (Burbidge and McKenzie 1989).

The major threats to chuditch currently are:

- Land clearing, particularly of riparian vegetation, and the removal of suitable den logs and den sites from chuditch habitat;
- Predation by, and competition from, foxes and feral cats; and
- Deliberate and accidental mortality from poisoning, trapping, illegal shooting, and road kills.

7.1. Land clearing and habitat alteration.

Chuditch require large areas of intact habitat to survive. Chuditch are rarely found where habitat is severely fragmented by clearing, except as transient animals. Loss and fragmentation of quality habitat for agriculture, residential and mining development has contributed significantly to the decline of chuditch populations in the south-west of Western Australia. Chuditch depend on the presence of den sites, protective cover and sufficient prey biomass, all of which are typically removed by clearing. Further mortalities are likely as competition or predation by dogs/foxes and feral cats occur, or as road kills where roads are constructed through or adjacent to habitat.

Clearing is particularly deleterious where:

- the affected land includes or adjoins riparian habitat (Serena and Sodequist 1989);

- it creates new gaps in otherwise homogeneous habitat;
- it leads to progressive fragmentation of habitat; or
- it necessitates the construction of roads (especially sealed roads) through, or adjacent to, uncleared habitat (Serena *et al.* 1991).

Fire may have the same medium term impact as clearing due to its destructive nature. Broad scale, high intensity fires destroy den logs, protective cover and remove prey biomass (particularly large invertebrates) and homogenise large areas of habitat.

Maintenance of habitat corridors which allow the movement of animals between smaller reserves is beneficial for species such as the chuditch. Research indicates that connected habitats allow a significant degree of genetic flow over large distances (Spencer *et al.* 2007; Cardoso 2011).

7.2. Predation by, and competition from, introduced foxes and cats

Foxes have been shown to have a negative effect on chuditch populations in the WA jarrah forest (Morris *et al.* 2000). In a study at Batalling, the introduction of fox baiting increased the trap success of chuditch from less than 1% to 2-4% over a seven year period. Trap success of other mammal fauna correspondingly increased during this time (Orell 2004). Foxes may have a direct effect on chuditch populations in the form of predation of young animals, or indirect effect, by competing with chuditch for food resources.

Feral cats are also believed to compete with chuditch for food, and probably predate young chuditch.

7.3. Deliberate and accidental death

Historically, chuditch have been seen as pests in agricultural and populated areas where they were destructive to poultry (Shortridge 1909). As a result they were likely targeted and destroyed by shooting, trapping and poisoning. These activities probably occur to a much lesser extent today due to increased public awareness and changed behaviours, however isolated incidents of land owners deliberately killing chuditch are still reported. Designs for chuditch (and fox) proof chicken pens are available.

A significant number of chuditch presented as museum specimens are animals that have been hit by cars. Chuditch appear to use roads regularly either to move along, or to feed on carrion

and this increases their risk of contact with foxes as well as road traffic. Serena *et al.* (1991) identified road kills as a major source of death of translocated chuditch at Lane Poole Conservation Park.

8. AFFECTED INTERESTS

Western Australian government agencies and instrumentalities: Department of Environment and Conservation, Perth Zoo, Water Corporation / Department of Water, Western Power and associated companies (Synergy Energy, Verve etc), Alinta Gas, Forest Products Commission and Western Australian Museum.

Other State and Territory agencies: SA; NSW; NT could become involved in the event of translocations to the wild occurring in these jurisdictions.

Commonwealth agencies: Department of Defence; Department of Sustainability, Environment, Water, Population and Communities.

Non-government organisations: Australian Wildlife Conservancy; WWF-Australia.

Industry: including mining exploration and mining companies.

9. INDIGENOUS PEOPLE

The chuditch formerly had a wide distribution across Australia, and as such it is known by many different names by different Aboriginal groups (Burbidge *et al.* 1988; Abbott 2001). The cultural significance of the animal to the people also varies between areas. Quolls were regarded as an important totemic animal throughout central parts of Australia. They are present in dreamtime stories (Johnson and Roff 1982; Tunbridge 1988) and are associated with some culturally significant sites (Wilson *et al.* 2005). Aboriginal groups from Lake Frome in South Australia tell the story of Idnya, the quoll (probably *D. geoffroii* as *D. hallucatus* ranged further north) and Vardna, the goanna, who were punished by their tribe for eloping together (Tunbridge 1988). The story describes how the quoll obtained its spots and the goanna its spotted body and striped tail, and also explains the sandy ground in the area east of Lake Frome. Angas Downs, south west of Alice Springs in the Northern Territory features Tjilpa Rock, a women's culturally significant site associated with the chuditch (Wilson *et al.* 2005).

Elderly men from the Walpiri, Pintupi, Aranda and Pitjantjatjara tribes tell (Johnson and Roff 1982) of their experiences with quolls as young boys, before their disappearance around the

mid 1930s to late 1940s. Some recognised the specimen shown (a skin) by recalling dreamtime stories rather than living memory. Quolls were locally known as Jajirdi, Tjilpa and Parrtjata. No distinction was made by Aboriginal people between *D. geoffroii* and the Northern Quoll *D. hallucatus* (Johnson and Roff 1982). Quolls were said to be “good tucker” and frequently dug out of burrows and eaten because they were common. The people respected the powerful jaws of the chuditch and preferred to first subdue the animal by smoking out its burrow with burning spinifex (Johnson and Roff 1982).

The Department of Environment and Conservation has consulted with relevant Indigenous communities within the DEC Regions identified in this plan. Implementation of recovery actions under this plan will continue to include the role and interests of Indigenous communities in the region, and this is discussed in the recovery actions. Engagement with Indigenous groups that have an active interest in areas that are habitat for chuditch will continue. The Aboriginal Heritage Sites Register, maintained by the Department of Indigenous Affairs, will be used to identify significant sites in the vicinity of any chuditch populations identified as important. However, not all significant sites are listed on the Register.

10. SOCIAL AND ECONOMIC BENEFITS AND IMPACTS

Chuditch have an attractive and distinctive appearance and have been used as an icon species for the forest in the south-west of Western Australia. At sites where higher densities of chuditch occur and they are more visible (e.g. around campsites at Lane Poole and Collie River), chuditch can add to the “natural” experience of the public. *Landscape* expeditions to the south-west in the past have focused on assisting with research on chuditch ecology and provided some members of the public with a greater understanding of mammal conservation issues in Western Australia. Proposed fauna reconstruction sites in Western Australia may also provide the opportunity for commercial tourism ventures to interact with chuditch and a range of other rarely seen medium-sized mammals. The development of tourism is particularly important for economic development in regions of the south-west where the logging industry has declined.

The presence of chuditch has the potential to have an economic impact on development and mining where clearing of chuditch habitat is proposed. This is becoming apparent in the south-west where extensive mining tenements exist in significant forest habitat. Exploration

for bauxite in these tenements has commenced but currently no new mining operations have been approved.

Baiting of foxes may have a social impact if domestic pets ingest toxic baits that have been laid for the *Western Shield* fauna recovery program. However, DEC implements both media releases warning the public of the risk that baits pose to domestic animals and signage denoting baited areas as a part of this program.

Significant adverse impacts will be minimized through negotiations with land managers including land acquisition processes, off-reserve programs such as Land for Wildlife and Conservation Covenants. Where there is conflict between chuditch and poultry, exclusion devices are encouraged. Where impacts cannot be avoided translocations of individual chuditch from inhabited areas to release sites with suitable habitat where foxes and cats are managed may be considered.

11. ENVIRONMENTAL BENEFITS OF IMPLEMENTING THE RECOVERY PLAN

Chuditch occupy the higher trophic levels in the forest, woodland and shrubland communities of south-west WA and may be regarded as an indicator species (i.e. presence of chuditch indicates high productivity within the lower trophic levels). Maintenance of den and refuge sites may benefit other species with similar requirements. Conservation efforts which are beneficial to the chuditch (e.g. broad scale fox baiting, fire management) are likely to also benefit other species. Furthermore, regular monitoring of the chuditch involves cage trapping which catches a variety of other medium-sized mammals and consequently these surveys will increase the knowledge of other native fauna (e.g. woylie, brushtail possum and quenda). Translocations of chuditch as part of fauna reconstruction programs will also ensure that a natural predatory component will be reintroduced.

12. REVIEW OF EXISTING CONSERVATION MEASURES

The wildlife management program (Serena *et al.* 1991) and previous recovery plan (Orell and Morris 1994) outlined a number of actions for the conservation and management of chuditch populations. The recovery plan objectives were to:

- Maintain or increase average daily trap success rates above 1% at monitoring sites in the jarrah forest (trap success rates in the jarrah forests during the 1980s were generally < 0.5%);
- Maintain a chuditch population in at least one semi-arid monitoring site; and
- Establish at least one self-sustaining population outside the geographic range as known in 1992.

The six actions considered necessary to achieve these objectives, and the progress to date against each of the actions are as follows.

1. *Research the impact of timber harvesting in the jarrah forest on chuditch populations*

A large proportion of the jarrah forest is managed by DEC (formerly CALM) for multiple uses, including timber harvesting. Under current forest management, habitat trees and suitable logs and stumps are retained during timber harvesting operations to provide refuge sites for fauna.

The impact of timber harvesting in the jarrah forest on chuditch and other mammals was studied as part of the “Kingston Project” (Burrows *et al.* 2002). The method and design for this experiment are detailed in Morris *et al.* (2000). Chuditch populations were monitored by trapping before, during and after timber harvesting, and at undisturbed control sites.

Measurements were taken relating to condition, breeding status and population abundance to determine effect of timber harvesting on chuditch. There was no significant decline in the condition of the animals after logging had occurred, and no negative effect on the seasonal breeding pattern of chuditch was observed. No radio collared chuditch were killed during logging operations. Estimates of population abundance were confounded by trap saturation by woylies (Morris *et al.* 2003), however chuditch were found to remain in areas of timber harvesting and persist at trap success rates of ca. 1% 13 years after the logging disturbance ceased.

2. *Research into the effects of foxes and cats and the control programs*

The European red fox has been responsible in part for the decline of many Australian mammals since its introduction into the south-west of Western Australia in the 1920s (Christensen 1980; Burbidge and McKenzie 1989). In Western Australia considerable success has been achieved in recovering native mammal populations through fox control

using the toxic 1080 (sodium monofluoroacetate) impregnated meat baits (Kinnear *et al.* 1988; Kinnear 1998; Kinnear *et al.* 2002 and Kinnear *et al.* 2010). Foxes and other introduced animals are highly susceptible to 1080, while most native species, particularly from Western Australia, are somewhat tolerant to this poison (King *et al.* 1978; 1989; McIlroy 1986). While chuditch are partially tolerant to 1080, they are more susceptible than some native herbivores (King *et al.* 1989) and it has been estimated that an adult chuditch would only need to consume 2-3 baits to obtain a lethal dose of 1080. (King *et al.* 1989; Soderquist and Serena 1993). Laboratory cafeteria trials identified chuditch as potentially vulnerable to 4.5mg dried meat baits and 3.0 mg Probait used in fox control (Martin *et al.* 2002). For this reason, it was necessary to determine if broad scale aerial fox baiting was potentially harmful to wild chuditch populations.

Trials at Batalling forest (Morris *et al.* 2003) and Julimar Conservation Park (Morris *et al.* 2005) have demonstrated that although chuditch do consume toxic fox baits in the presence of natural food sources, there is no negative effect on the populations. In both studies animals were radio collared and monitored before, during and after the toxic baiting sessions. None of these animals were found to have died as a result of ingesting toxic baits. Other species such as woylie, quenda and brushtail possum also benefited from these fox control programs, although woylie populations at Batalling and other south-west sites have recently declined significantly (Wayne 2006). Ongoing monitoring at Batalling and Julimar has shown that the chuditch populations have continued at trap success rates of 2-4%, higher than before fox control was implemented.

As a result of these and earlier trials, broad scale aerial fox baiting was implemented over 3.5 million hectares of conservation estate in the south-west of WA as part of the Western Shield fauna recovery program (Armstrong 2004).

Feral cat control techniques are currently being developed. A sausage bait, Eradicat®, has been shown to be effective at controlling feral cats, but it is also smaller and moister than fox baits currently used in WA. These may be more attractive to chuditch and there is the possibility that they may consume a lethal dose (2-3 cat baits @4.5mg / bait). Trials are underway to develop a bait with the toxin encapsulated in a hard pellet which would be rejected by chuditch (and other potential non-target species). Trapping for feral cats using leg-hold traps can also be an effective control method, however these also catch chuditch with sometimes fatal consequences. One of the actions of this recovery plan will be to assess

chuditch vulnerability to cat baits, and the development of more chuditch friendly cat trapping techniques.

3. *Research the impact of prescribed burning in jarrah forest on chuditch populations*

Prescribed burning occurs throughout the south-west forests to reduce forest fuel loads and the subsequent risk of bushfire. Chuditch have been reported to survive prescribed burns (Serena *et al.* 1991). A study at Batalling in 1994 (Morris *et al.* 2003) was undertaken to determine the impact of autumn (hotter) burns on chuditch. Animals were radiotracked before, during and after the prescribed burn. No mortalities of radio-collared animals were directly attributed to the fire and no known den logs were destroyed. However, 35% of the radio collared chuditch died as a result of fox predation after the fire. Despite these mortalities, trap success rates increased from 5.2% pre- to 7.6% post-burn (Morris *et al.* 2003). Chuditch were observed to use a greater number of burrows in burnt areas compared to unburnt areas after the autumn burn destroyed some den logs (Mathew 1996).

Prescribed burning over relatively small areas (< 4000 ha) most likely benefits chuditch through creating a mosaic of vegetation ages which support a greater diversity of prey species. This is preferable to large scale, hot summer bushfires which destroy den sites and homogenise the landscape over large areas.

4. *Monitor existing populations in the jarrah forest*

With the implementation of the Western Shield program in 1996 a more systematic monitoring program was developed and chuditch are recorded at 25 of the 45 sites monitored (Orell 2004). Chuditch are also monitored at other research and translocation sites and the trends in trap success rates at these sites were reviewed by DEC (2007). The data show that there was an initial increase in trap success rates from < 0.5% before fox control to 2 – 2.5% in the period 1994-1996. Since then however, trap success rates have declined to 1 – 1.5%, however there is a large amount of variation around these averages. This is due largely to the variation in trapping technique and timing that has occurred over the last 15 years or so. There is a need for a more standardised monitoring protocol to be implemented so that more accurate estimates of population density can be determined and more meaningful comparisons made. Trap competition also varies across sites, which contributes to the difficulty of developing standard protocols.

5. *Commence and maintain a captive breeding program*

Chuditch occur naturally at low densities, and therefore, it is difficult to trap the numbers required to provide enough founders for translocations. Captive breeding was used as a means of producing sufficient numbers of founders for translocations. Chuditch were found to be relatively easy to breed in captivity (Serena *et al.* 1991) and between 1990 and 2000 over 330 chuditch were bred at Perth Zoo for translocation programs (Morris *et al.* 2003). However, the Perth Zoo no longer maintain a captive breeding colony. In 2005, four chuditch were translocated from Julimar in Western Australia to the Desert Park facility in Alice Springs, Northern Territory. A small colony is maintained at the Desert Park facility with a view to release them into a predator free area in the future.

Further chuditch translocations are proposed in WA and possibly other States. If these are to proceed, a captive breeding colony may need to be re-established, where provenance, habitat suitability and genetic divergence can be considered.

6. *Translocate chuditch to areas where they once occurred*

Translocations of captive bred chuditch have been undertaken to six areas of WA where they formerly occurred: Lane Poole Conservation Park, Julimar Conservation Park, Lake Magenta Nature Reserve, Cape Arid National Park, Mt Lindsey National Park, and Kalbarri National Park. Details on these are found in Morris *et al.* (2003). The first experimental translocation to Lane Poole Conservation Park in 1987 was unsuccessful. Only nine animals were translocated, of which seven were killed or died within a few months of release (Serena *et al.* 1991). This area had, and still has, a chuditch population and this trial was undertaken to test translocation techniques rather than to establish a chuditch population. All other translocations were undertaken to establish populations. Of these, Julimar, Lake Magenta and Kalbarri are considered to be successful, and Cape Arid and Mt Lindsey unsuccessful (DEC 2007). Provenance of translocated animals may influence the degree of success of translocations and should be considered in future translocation planning.

Translocated chuditch populations have been found to have a level of genetic diversity similar to that found in naturally occurring populations (Spencer *et al.* 2007; Cardoso 2011). This is a reflection of good management of breeding stock at Perth Zoo. There is evidence of gene flow between the Julimar / Bindoon and Dwellingup populations, however Lake Magenta and Kalbarri are geographically isolated populations potentially at risk of loss of genetic diversity. Additional chuditch may be required to be translocated to these areas to maintain or increase

genetic diversity and will incorporate an assessment of the genetic risks and benefits associated with the translocation (Weeks *et al.* 2011).

Additional translocations are proposed under this recovery plan. If these are successful within 10 years of adoption of the plan, and other populations are maintained or increased, it is likely the chuditch could be delisted at this time, and the recovery plan considered successful.

13. RECOVERY OBJECTIVE AND CRITERIA

Recovery objective: To reduce threats to the chuditch and increase population densities to ensure long-term survival.

13.1. Criteria for success

This Recovery Plan will be deemed successful if the chuditch can be delisted from Vulnerable under the EPBC Act and Schedule 1 under the WA Wildlife Conservation Act within 10 years from adoption, using IUCN criteria, version 3.1 (2001).

13.2. Criteria for failure

This Recovery Plan will be deemed unsuccessful if chuditch are still listed as Vulnerable under the EPBC Act and Schedule 1 under the WA Wildlife Conservation Act (or a higher category) after 10 years of adoption.

13.3. Evaluation

The Department of Environment and Conservation, in consultation with the Chuditch Recovery Team, will evaluate the performance of this Recovery Plan. The plan will be reviewed at five and ten years after its implementation. The recovery actions carried out and any changes to management and recovery actions will be documented accordingly.

In order to be delisted, it must be demonstrated that there are more than 10,000 mature individuals in the population, and that there are no overall declining trends in key populations. Due to the sparse and dispersed nature of this specie it is difficult to define key populations. As such one of the actions of this recovery plan is to develop a monitoring protocol capable of accurately estimating chuditch population density at the current and future range of chuditch, and define key populations and their trends.

14. RECOVERY ACTIONS

The following recovery actions are presented roughly in order of descending priority but this should not prevent the implementation of 'lower' priority actions where opportunities arise and funding is available. Where chuditch occur on lands other than those managed by DEC, permission has been or will be sought from the managers prior to recovery actions being undertaken.

Action 1. Retain and improve habitat critical for survival

Tasks:

- Identify areas of remnant vegetation that can be protected or enhanced through re-vegetation.
- Continue covenants and off-reserve programs (e.g. Land for Wildlife).
- New areas of suitable habitat acquired through land acquisition process.
- Habitat identified through Environmental Impact Assessment and negotiated through off-set.

Completion date: commence by 2013, ongoing

Cost: \$500 000 over 10 years

Action 2. Determine impacts of feral cats on chuditch

There is evidence to suggest that effective fox control may lead to an increased abundance of feral cats (mesopredator release). Feral cats are considered a threat to chuditch through direct predation and competition for food resources. Research is underway to determine whether feral cats are more abundant in the presence of fox control and if so, how this influences populations of chuditch. The aims are to investigate:

- 1) differences in population density, habitat use, foraging behaviour, diet and survivorship of chuditch between areas with and without fox control; and
- 2) overlap in resource use (diet, home range and habitat) between chuditch, foxes and feral cats.

Future research may also investigate the effects of multi-species predator control, in which foxes and feral cats are controlled simultaneously. The outcomes of this research will help to guide future control strategies for introduced predators.

Tasks:

- Complete research into impacts of feral cats on chuditch abundance.
- Develop strategies for integrated fox and feral cat control at chuditch sites.

Completion date: 2015

Cost: \$200 000

Action 3. Determine the impact of feral cat control methods on chuditch

The Western Shield fox baiting program does not control feral cats and since 1993 a research program has been underway to develop an effective cat control method. A sausage bait (with the toxin 1080) has been developed (Eradicat®), and this has been shown to be effective at controlling feral cats in the arid zone (Algar and Burrows 2004), particularly when supported by a targeted trapping program. However this bait is also more palatable to a range of non-target native fauna, including chuditch (D. Algar unpublished data). Research is also underway examining the effectiveness of using an alternative toxin, Para-aminopropiophenone (PAPP), for feral cat control, and encapsulating the toxin to reduce uptake by non-target fauna. Chuditch are also known to be fatally trapped by current cat trapping methods using leg hold traps.

Tasks:

- Determine the impact of cat baits (e.g. Eradicat and PAPP) on free-ranging chuditch.
- Develop supplementary cat trapping methods that are chuditch friendly.
- Implement appropriate feral cat control methods within chuditch distribution.

Completion date: 2014

Cost: \$100 000

Action 4. Continue, expand and improve baiting of foxes and feral cats**Tasks:**

- Monitor abundance of foxes and feral cats.
- Determine the optimal deployment strategy of baits for foxes and feral cats.
- Encourage baiting programs on other land tenures.

- Effective baiting programs (e.g. Western Shield Program¹) for feral cats and foxes.

Completion date: annually, ongoing

Cost: \$2 000 000 (already funded)

Action 5. Determine population abundance and distribution of chuditch populations

Chuditch are presently monitored annually at 25 of the 45 Western Shield fauna monitoring sites, using trap success rates as a measure of abundance. In order to be delisted, it must be demonstrated that there are more than 10,000 mature individuals in the population, and that there are no overall declining trends in key populations. Due to the sparse and dispersed nature of this species it is difficult to accurately estimate abundance and/or density, and to define key populations. More reliable methods need to be developed to measure and monitor populations and intensive monitoring should be undertaken at multiple strategically selected sites (key populations) across their range. As such one of the tasks of this recovery plan is to develop a monitoring protocol capable of accurately estimating chuditch population density at the current and future range of chuditch, and define key populations and their trends. Other factors that may influence chuditch abundance should also be monitored including fox and feral cat activity and density, rainfall, habitat / vegetation characteristics and disease / health status.

Tasks:

- Develop and implement standard chuditch monitoring protocols including monitoring factors that may affect chuditch abundance.
- Identify, develop protocols and implement monitoring at ‘key populations’.
- Use Fauna File database as the system for managing and reporting monitoring data.

Completion date: commence by 2013, ongoing

Cost: \$350 000.

¹ The Western Shield Fauna Recovery program traditionally focused on those species most threatened by introduced predators, specifically foxes and feral cats. This has seen the focus placed on mammal species in the ‘Critical Weight Range’ (CWR) or those that have a mean adult body weight of between 35g and about 5,500g (Burbidge and McKenzie 1989). Western Shield also aims to arrest the decline of ground nesting birds and reptiles through ameliorating the threat of introduced predators.

Action 6. Establish reference sites for monitoring chuditch population abundance to evaluate the effectiveness of fox and cat control

Dedicated chuditch surveys are required to assess chuditch distribution and abundance in areas where fox and cat control are undertaken.

Tasks:

- Identify reference sites spread across the range of chuditch which incorporate where fox and potentially cat control will take place.
- Monitor chuditch populations at reference sites to determine the effectiveness of fox and cat control.

Completion date: commence by 2015, ongoing

Cost: \$15 000 per year

Action 7. Undertake and monitor translocations to increase the extent of occurrence

In order to improve the conservation status of chuditch it will be necessary to establish additional populations in the semi-arid and arid zone, and possibly in other States, to restore the distribution to the original range. This will likely incorporate both augmentation of existing populations and reintroductions. A translocation strategy that considers source populations (including captive breeding programs), provenance and genetic divergence, and identifies future release sites will be developed.

Tasks:

- Develop a translocation strategy.
- Re-establish captive breeding programs if necessary.
- Monitor the success of past and future translocations.

Completion date: commence by 2015, ongoing.

Cost: \$1 300 000 over 7 years

Action 8. Increase public awareness through community education and enforcement of regulations

Tasks:

- Identify and implement strategies to reduce road kill (e.g. erect signage).

- Media publications on translocations to encourage reporting of chuditch sightings.
- Investigate illegal shooting and poisoning, and enforcement of regulations.
- Mitigation through education (e.g.DAFWA publications and advice to chuditch proofing your chicken coupe).
- Implement a chuditch awareness program to support behaviour change toward the species.

Completion date: commence by 2013, ongoing

Cost: \$50 000

Action 9. Coordinate recovery implementation

Recovery teams provide support to DEC, with participation from stakeholders associated with management, research and community, to implement recovery plans. A chuditch recovery team operated until 2000 and oversaw the implementation of the first recovery plan. This team needs to be reformed.

Tasks:

- Involve relevant stakeholders in the coordination and implementation of this recovery plan through their participation in the Chuditch Recovery Team.

Completion date: Ten years from finalization of the recovery plan.

Cost: \$ 50 000 over 10 years to run recovery team, includes support to team members.

15. SUMMARY OF RECOVERY ACTIONS

Recovery Action	Year/ Estimated Cost (\$)										
	20012/13	2013/14	2014/15	2015/16	2016/17	2017/ 18	2018/ 19	2019/ 20	2020/ 21	2021/ 22	Total
1. Retain and improve habitat critical for survival	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	500 000
2. Determine impacts of feral cats on chuditch	25 000	25 000	25 000	25 000							100 000
3. Determine impacts of feral cat control methods on chuditch	60 000	40 000									100 000
4. Continue, expand and improve baiting program of feral cats and foxes	Already funded										Already funded (2 000 000)
5. Determine population abundance and distribution of chuditch populations.	35 000	35 000	35000	35 000	35 000	35 000	35 000	35 000	35 000	35 000	350 000
6. Establish reference sites for monitoring chuditch population abundance to evaluate the effectiveness of fox and cat control			15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	120 000
7. Undertake and monitor translocations to increase the extent of occurrence				140 000	180 000	180 000	180 000	180 000	220 000	220 000	1 300 000
8. Increase public awareness through community education and enforcement of regulations	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	50 000
9. Coordinate recovery implementation	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	50 000
TOTALS	180 000	160 000	135 000	275 000	290 000	290 000	290 000	290 000	330 000	330 000	2 570 000

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