

DIBBLER

(*Parantechinus apicalis*)

RECOVERY PLAN

by Tony Friend
for the Dibbler Recovery Team



2004

Wildlife Management Program No. 38



Department of Conservation
and Land Management



Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative



THE UNIVERSITY OF
WESTERN AUSTRALIA

PERTH ZOO

DIBBLER RECOVERY PLAN

July 2003-June 2013

by

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For the Dibbler Recovery Team

July 2003

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FOREWORD

Recovery Plans (RPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos 44 and 50.

RPs delineate, justify and schedule management actions necessary to support the recovery of threatened species and ecological communities. The attainment of objectives and the provision of funds necessary to implement actions are subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. RPs do not necessarily represent the views or the official position of individuals or organisations represented on the Recovery Team.

This RP was approved by The Department of Conservation and Land Management, by the Conservation Commission of Western Australia and by the Minister for the Environment. Approved RPs are subject to modification as dictated by new findings, changes in status of the taxon or ecological community and the completion of recovery actions. The provision of funds identified in this Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

Information in this RP was accurate at July 2003.

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SUMMARY

Parantechinus apicalis, Dibbler

Family:	Dasyuridae
CALM Regions:	South Coast, Midwest
CALM Districts:	Albany, Moora
Shires:	Jerramungup, Ravensthorpe, Albany, Jurien Bay
Recovery Team:	Dibbler Recovery Team
Current status of taxon:	Endangered
Habitat requirements:	Long-unburnt heath, mallee-heath or <i>Banksia</i> woodland with heath understorey

Dibbler Recovery Team

Organisation	Position	Present member
Science Division, CALM WA Threatened Species and Communities Unit, CALM Albany District, CALM	Supervising Scientist, Dibbler Project Representative of WATSCU	Tony Friend (Chair) Nicky Marlow
Moora District, CALM Malleefowl Preservation Group South Coast Community Jurien Community Perth Zoo University of WA La Trobe University University of Sydney University Wales	Senior Operations Officer, Nature Conservation Nature Conservation Coordinator Representative South coast resident Jurien resident Director, Life Sciences and Conservation Research Student supervisor Scientist with expertise in dibblers Scientist with expertise in dibblers Scientist with expertise in dibblers	Mal Grant Rebecca Carter Geoff Burrow Vic Smith Jeremy Carter Colin Hyde Roberta Bencini *Pat Woolley *Chris Dickman *Dorian Moro

* Corresponding member

Recovery Plan criteria

This Recovery Plan will be deemed successful if:

- at least three mainland populations are established or discovered more than 25 km from the Fitzgerald River National Park (FRNP) within 10 years and
- at least one dibbler is captured at three or more sites in FRNP each year and at no less than six sites over any three-year period during the next 10 years or
- population levels on Boullanger and Whitlock Islands remain at no less than 40 per cent of 1998 numbers within the next 10 years.

This Recovery Plan will be deemed to have failed if:

- less than three additional populations are established or discovered on the mainland within 10 years and
- dibblers are captured at less than three sites in FRNP each year and at less than six sites over any three-year period during the next 10 years or
- population levels on Boullanger and Whitlock Islands fall below 40 per cent of 1998 numbers within the next 10 years.

Recovery actions

1. Monitor known populations.
2. Protect existing and reintroduced populations from threatening processes.
3. Survey to locate further populations.
4. Maintain a captive breeding colony to produce stock for translocation.
5. Translocate captive-bred and/or wild stock to establish at least three further self-sustaining mainland populations.
6. Carry out genetic monitoring and management of reintroduced populations.
7. Encourage community involvement in dibbler conservation.
8. Improve knowledge to underpin dibbler recovery.

International obligations

As the dibbler is not listed under any international agreement, the implementation of Australia's international environmental responsibilities is not affected by this plan.

Affected interests

All land on which dibblers are known to survive is under the management of the Western Australian Department of Conservation and Land Management (CALM). This Department is heavily involved in the implementation of this plan, through its commitment to the control of introduced predators, fire management and prevention of the spread of disease in nature reserves and national parks.

Role and interests of indigenous people

CALM is in active consultation with indigenous communities in the regions affected by this plan. Implementation of relevant recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

Benefits to other species

The presence of the dibbler within the Fitzgerald River National Park and on the Jurien Bay Islands has helped to raise community awareness of the importance of these protected areas for the maintenance of biodiversity. Fox control introduced over the Fitzgerald River National Park, with the dibbler as one of the primary species targeted for protection, benefits numerous co-existing medium-sized mammals and ground-nesting birds. These include the brush wallaby, tammar, brush-tailed possum, chuditch, red-tailed phascogale, quenda, heath rat, western mouse, bush rat, malleefowl and ground parrot. Ecosystem services provided by these vertebrate species, such as regulation of insect populations, disturbance and aeration of soil by digging and dispersal of seed and fungal spores, contribute profoundly to the maintenance of biodiversity. Reintroduction of dibblers to other sites, accompanied by fox control and fire management to protect long-unburnt vegetation, will also enhance biodiversity in these areas.

Social and economic impacts

The implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts.

Cost

Total estimated cost: \$ **2,140,453** over 10 years

1. BACKGROUND

History of discovery, taxonomy and relationships

The dibbler was described by Gray (1842) as *Phascogale apicalis*, from a purchased specimen with no location data, but which Gray concluded, through its affinities, was from Australasia. The species was reassigned soon afterwards to another carnivorous marsupial genus, *Antechinus* (Gray 1844; Gould 1863). A number of specimens were collected in Western Australia during the next 62 years, including those provided by the naturalist and collector John Gilbert for the taxonomist John Gould. Gilbert collected dibblers from Victoria Plains, Moore River, Wanneroo and King Georges Sound (Morcombe 1967). Other specimens were provided by George Masters in 1865, from the Pallinup River, and John Tunney, from the Kojonup area, in 1904. There was no subsequent record of the species until 1967, when Michael Morcombe captured two dibblers in traps set on *Banksia attenuata* flowers at Cheyne Beach east of Albany (Morcombe 1967).

A reassessment of standard morphological characters within the carnivorous marsupials led Tate (1947) to suggest splitting *Antechinus* into four smaller genera, placing the dibbler in the new genus *Parantechinus* as the type-species. Subsequent studies supported this concept, including the work of Woolley (1982) using penis morphology. There are, however, various views amongst morphologists on the inclusion of other species within the genus. Molecular systematics has also supported a variety of arrangements within this section of the Dasyuridae, and generic groupings are far from settled (Krajewski and Westerman 2003).

Gould (1863) drew attention to the “peculiarly grizzled” appearance of the species produced by the black and white colour of the longer hairs, and on this basis he dubbed the animal the Freckled Antechinus. In his notebook and letters to Gould, Gilbert recorded three Aboriginal names for the species, *Marn-dern* (Moore River area), *Wy-a-lung* (Perth) and *Dib-bler* (King Georges Sound) (Gould 1863; Whittell 1954; Wagstaffe and Rutherford 1955). In a short paper recommending the use of Aboriginal names for Western Australian marsupials, Glauert (1928) selected “dibbler” for this species and most subsequent authors (Morcombe 1967; Ride 1970) have followed this practice. In compiling his book “The Mammals of Australia”, however, Strahan (2003) introduced the common name “southern dibbler” for *P. apicalis* and “northern dibbler” for the sandstone antechinus, listed in the book as *P. bilarni*. Given the lack of agreement about the inclusion of *bilarni* in *Parantechinus* (Krajewski and Westerman 2003), the well-established use of “dibbler” to refer only to *P. apicalis* is recommended and is followed in this plan.

No subspecies of the dibbler have been described, although mainland specimens are significantly larger than island animals (Woolley 1991). Allozyme electrophoresis showed no genetic differences between island and mainland animals at 46 loci (M. Adams, unpublished) but low levels of variation are commonly reported in dasyurid marsupials (Baverstock *et al.* 1984). An attempt to resolve the question using mtDNA

was thwarted by difficulties in extracting suitable DNA from ear punch material (Cooper and Birrell 1996). Mills *et al.* (in press) carried out a more successful mitochondrial DNA study using liver tissue, showing that the structuring of mitochondrial DNA haplotypes supports two major lineages within dibblers: those from the islands, and those from the south coast. They also used microsatellites to study genetic variation within and between island and mainland dibbler populations, finding that the Fitzgerald River National Park (FRNP) population contains significantly more genetic variation than either Boullanger or Whitlock Island populations.

Distribution and habitat

Recorded distribution and recent survey effort

Knowledge of the former distribution of dibblers comes from sub-fossil remains (Baynes, 1987, 1990, pers. comm.), museum specimens with locality data, and trapping records (published and unpublished). The past and present distribution of the dibbler is shown in Figure 1. The subfossil distribution extends much further north and east than the post-european collections, partly due to limited early collecting but possibly due also to decline since subfossil deposition. Specimens collected during the 19th and early 20th centuries were from the vicinity of the Moore River and nearby Victoria Plains, from Wanneroo just north of Perth, and from the south coast near Kojonup, Albany and the Pallinup River. After Morcombe's rediscovery of the species at Cheyne Beach in 1967, dibblers were collected in 1976 from two sites near Jerdacuttup, 200 km to the east, but despite much effort, no population was subsequently located in that area (Woolley 1977, 1980; Woolley and Valente 1982; Baczocha and Start 1997). There have been several dibbler captures at the Cheyne Beach site since 1967, however, in 1975, 1976 (Woolley 1977) and 1994 (Department of Conservation and Land Management files).

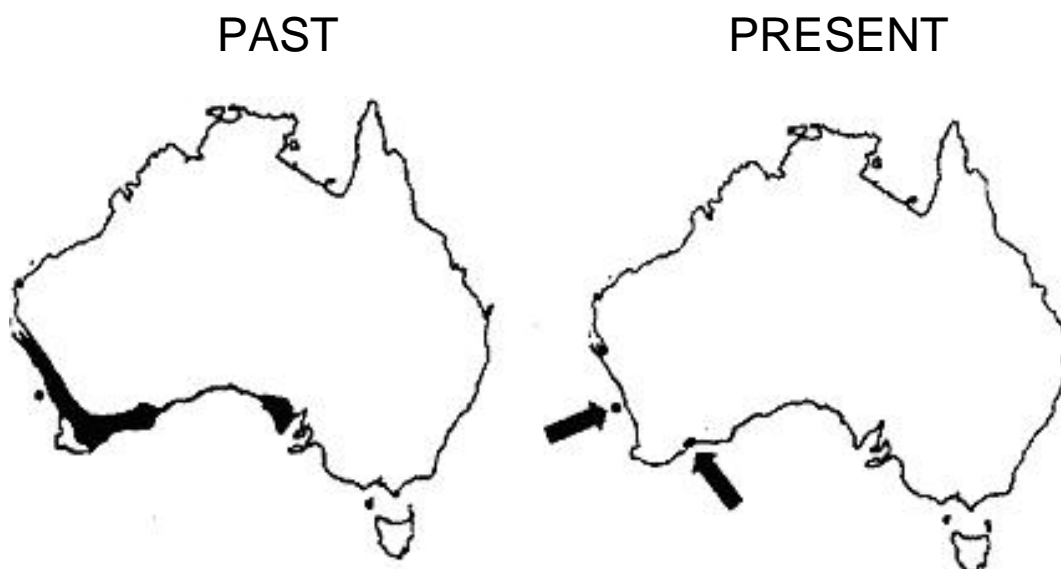


Figure 1. Past and present distribution of the dibbler (*Parantechinus apicalis*), based on subfossil records, museum specimens collected alive and recent captures.

Following the discovery in 1984 of a dead dibbler on a firebreak in the 342,000-ha FRNP, a large-scale biological survey of the park was instigated. Dibblers were captured by Andy Chapman at eight locations in FRNP during the survey, carried out between 1985 and 1987 (Chapman and Newbey 1995). Subsequent survey and monitoring activity has produced dibbler records from at least 10 other sites in FRNP (Baczocha and Start 1997; Sanders 1997; Barrett 1998; Friend 2001a; P. Collins, pers. comm.).

A biological survey of islands off the west coast near Jurien Bay resulted in the discovery of two island populations of the dibbler in 1985 (Fuller and Burbidge 1987). Boullanger (31 ha) and Whitlock Islands (5 ha) are separated by approximately 300 metres of shallow water and both support dibbler populations. Boullanger Island also has a population of grey-bellied dunnarts *Sminthopsis griseoventer boullangerensis* that is apparently endemic, and the house mouse *Mus domesticus* has been introduced to both islands. Ecological studies of the island dibbler populations have been carried out as university research projects and these activities have been supported under the Dibbler Interim Recovery Program. McCulloch (1998) estimated the total population of both islands to be around 180 animals.

Evidence of another south coast population was found in 1987, when an amateur naturalist conducting a pit-trapping study in Torndirrup National Park (3940 ha) near Albany captured two dibblers, followed by another capture in 1988 (Smith 1990). Although this study continued until 2001, no further captures were made at that site or in other parts of the park. The area in which dibblers were found was burnt in 1997. Survey in other parts of the national park is currently under way.

In summary, surviving populations of dibblers (as opposed to reintroduced populations) are currently known only from FRNP and Boullanger and Whitlock Islands. Given the recorded disappearances and rediscoveries of the species it is likely that other populations exist, possibly in western coastal areas between Lancelin and Dongara, but most likely on the south coast between Denmark and Israelite Bay.

Habitat preferences

Dibblers have been recorded over an extensive area and it is likely that they can occupy a diverse range of habitats. Detailed habitat data are available, however, only for some recent south coast and island records. A study of the habitat preferences of island dibblers (Bencini *et al.* 2001) found that on Boullanger Island there was no significant difference between trap success in low-closed heath, foredune heath, open scrubland and *Lepidosperma* thicket. On Whitlock Island, significantly greater capture rates were recorded in dunal scrubland and foredune heath than in succulent heath.

Mainland occurrences of dibblers have been characterised by the presence of long-unburnt heathland. This generalisation applies to records from Cheyne Beach, Torndirrup NP and most records from FRNP. Typically, captures have been on sandy substrates although occasional records are on laterite soils (Baczocha and Start 1996; Barrett 1998). Vegetation structure is the feature providing most similarity between

capture sites and Baczocha and Start (1997) suggested that dibblers “...seem to prefer vegetation with a dense canopy >1 metre high which has been unburnt for at least 10 years”.

Fire age of habitat

Prior to the 1990s, all dibbler captures where detailed habitat data were available came from sites that had not been burnt in more than 15 years, or in most cases, much longer. This includes all records from Cheyne Beach, Boullanger and Whitlock Islands, Torndirrup and FRNP, before that time. The dibbler’s need for long-unburnt vegetation may be related to high invertebrate density in thick leaf litter accumulations. On the other hand, the cover afforded by dense vegetation may provide protection against predators, including birds of prey such as medium-sized diurnal and nocturnal raptors, and at mainland sites in recent times, the introduced fox and feral cat. Wildfire of high intensity in heathland removes all vegetation and restoration of dense cover may take decades if drought follows.

In 1996, dibblers were caught by Natasha Baczocha in an area within FRNP that had been burnt seven years earlier, not far from older vegetation (Baczocha and Start 1997). In 1987, Jack Kinnear commenced a study of mammal response to fox control. Aerial baiting using 1080 in dried meat was carried out over the western half of FRNP twice a year while the eastern half was left unbaited. This baiting regime continued until 1995 (Kinnear *et al.* 2002). In 1996 CALM’s *Western Shield* wildlife recovery program commenced and aerial baiting was extended to the whole of FRNP and increased to four times a year. It may be that the absence of foxes allows dibblers to occupy vegetation at an earlier stage of recovery after fire.

Fluctuations in habitat availability

FRNP provides security to the most genetically diverse populations of the dibbler. However, due to the occurrence of extensive wildfires, large areas of suitable habitat can disappear suddenly. In 1994, seven years after Chapman’s survey, a wildfire burnt 5000 ha including four of the eight sites at which he had recorded dibblers. The fire rendered those sites unsuitable for dibblers. Clearly very rapid reductions in the quantity of old vegetation in the Park occur from time to time. This dynamic process must be taken into account when estimating dibbler numbers or area of occupancy statistics (IUCN 2001).

Biology and ecology

Like all dasyurids, dibblers are seasonal breeders, although they breed in autumn, unlike most other species in the family, amongst which winter breeding is the norm. Research on Boullanger Island has shown that mating occurs in late March, and young are born in late May each year (Dickman and Braithwaite 1992). Studies in FRNP indicate that young are born earlier, from late April to early May (unpublished data). Juveniles are first trapped in September in all populations. On the islands it appears that males disappear from the population after the mating season in some years (Dickman and

Braithwaite 1992), but not in all years (Woolley 1991, Mills and Bencini 2000). This phenomenon has been termed facultative male die-off by Mills and Bencini (2000) who hypothesised that it may be a response to variation in habitat quality and environmental conditions between years or between sites (e.g. in 1999, complete male die-off occurred on Boullanger but not on Whitlock Island). On the mainland, there is much evidence of males surviving well into their second year, but no intensive population studies have yet been carried out.

The diet of island dibblers, determined from scat contents, is dominated by insects, particularly beetles, cockroaches, grasshoppers, ants and termites, as well as spiders and plant material including seaberry saltbush (*Rhagodia baccata*) berries in season, (Dickman 1986; Fuller and Burbidge 1987; Bencini *et al.* 2001; Miller *et al.* 2003) while remains of birds (Fuller and Burbidge 1987; Bencini *et al.* 2001), reptiles (Bencini *et al.* 2001) and mice (Dickman 1986) have also been found.

Dibblers on the islands often enter and spend time in seabird burrows, although it is unclear whether this is for refuge, foraging or rest (Fuller and Burbidge 1987; Dickman, 1986; Baczocha and Start 1997; McCulloch 1998). The importance of seabird burrows for dibblers and the indirect effect of seabirds on dibblers are currently being assessed in a PhD. study by Kristen Wolfe.

Radio-tracking studies of dibblers in FRNP in December 1999 and January 2001 showed that in summer dibblers occupy distinct but overlapping home ranges. Males occupy larger home ranges, on average, than females. Over each two-week study period, no radio-collared dibblers left the study site. As noted in captivity (Morcombe 1967), dibblers were strongly crepuscular, becoming active in the late afternoon until soon after dusk, and from first light for about 2.5 hours. Rest sites during the day and night appeared to be above ground, as dibblers moved away when approached. Two dibblers were found underground. On two occasions one dibbler moved when approached from a rest site to a bush-rat burrow, then entered it. The second burrow was occupied by another dibbler on a daily basis for three days. The burrow was excavated and appeared to have been a natural hollow formed under the roots of a shrub, rather than being purpose-built (Friend 2001a, unpublished data). No nests resembling those described by Gilbert (in Gould, 1863) were found.

While Elliott traps are the best means of capturing dibblers, radio-collared individuals often avoided traps set within their home ranges. This accounts for the relatively low recapture rate for dibblers in FRNP.

Threatening processes

Threatening processes operating within the range of the dibbler are:

Feral predators. Foxes certainly prey on dibblers, as proven by the discovery of the remains of a radio-collared dibbler in a fox scat in FRNP in March 2001 (Friend, unpublished). Foxes arrived in the South West in the 1920s and this coincided with the

decline of dibblers through much of their recorded range. Cats are known to take dibblers (Woolley 1977). Feral cats and foxes are present throughout the known mainland distribution of the dibbler. They are not present on the islands but the possibility of introduction cannot be ignored. It would pose a serious threat.

Fire. The islands have not been burned in recent time and mainland habitats in which dibblers have been found have not been burned for at least 10 years and usually much longer. Frequent or extensive fire in dibbler habitat must be considered a threat.

Phytophthora Dieback. Disease in native plants caused by *Phytophthora cinnamomi* can extensively alter the structure and floristic composition of many heath and mallee-heath communities. Most of the habitats in which dibblers have been recorded on the south coast contain very susceptible plants. The effect of disease-induced changes to the habitats of dibblers is unknown but disease caused by *P. cinnamomi* needs to be considered as a potential threat. The highly calcareous soils of the islands are not conducive to *P. cinnamomi* and the dominant plant species are not known to be highly susceptible to it. Opportunities for the human-assisted vectoring of *P. cinnamomi* onto the islands can be minimised through the rigorous application of simple hygiene measures. The threat posed by *P. cinnamomi* to dibblers is lower on the islands than in mainland habitats.

House mice. Mice are abundant on Boullanger and Whitlock Islands. Dibblers are known to eat mice occasionally (Dickman 1986) but neither Bencini *et al.* (2001) nor Miller *et al.* (2003) detected mice in their diets. Dibblers and mice have co-existed for many years, at least on Boullanger Island, where they were first recorded in 1959-61 (Ford 1963), while Fuller and Burbidge (1987) found them on Whitlock Island in 1985. However, interaction between mice and resources used by dibblers is unknown and the effect of this introduced rodent on the long-term viability of dibblers will be treated as a potential threat. Although mice on the islands appear to be mainly herbivorous, in 2001 mice on Whitlock Island consumed up to 34 per cent animal matter, significantly more than those on Boullanger Island (Stewart 2001a). The importance of animal food to mice may vary between islands and between years so it is possible that mice compete for food with dibblers (and on Boullanger Island, with dunnarts). The interaction of house mice on the islands with dibblers and dunnarts is the subject of a Ph.D. study (Stewart 2001b).

Human disturbance. Since European settlement, humans have probably had a catastrophic effect on dibblers through land clearing, introduction of feral animals, weeds and pathogens, and modified burning practices. Humans still pose threats to mainland populations through use of fire and the spread of plant disease. On the islands the potential threats include introduction of feral predators and weeds, misuse of fire, and activities that might cause breeding seabirds to abandon the islands.

Conservation status

The dibbler is listed as “fauna that is rare or likely to become extinct” pursuant to the *Western Australian Wildlife Conservation Act 1950*. It is listed as Endangered under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. It is listed as Endangered in *The 1996 Action Plan for Australian Marsupials and Monotremes* (Maxwell *et al.* 1996) and the *2003 IUCN Red List of Threatened Species* (IUCN 2003), both using the IUCN version 2.3 (IUCN 1994) criteria. This allocation was on the basis of criteria B1 + 2ce.

Strategy for recovery

The dibbler’s recovery depends upon ensuring the persistence of known populations, searching thoroughly for further existing populations and establishing additional populations through translocation of wild and/or captive-bred individuals. Regular monitoring of all existing and reintroduced populations is an integral part of this strategy, as is an adaptive management approach that requires ongoing investigation into the operation of threatening processes affecting the species. Community participation is strongly incorporated into recovery activities, including monitoring existing and reintroduced populations, habitat protection, promoting public awareness of the dibbler and its threatened status and canvassing communities for dibbler sighting reports.

The implementation of this recovery plan is the third part of a three-part recovery process. The first part was the implementation of a Research Plan, which concluded at the end of 1997. The second was the implementation of the Interim Recovery Plan (Start 1998), which ran until December 2001, a year longer than intended due to the lack of funding for one year.

The Dibbler Recovery Team has overseen the recovery process since 1996 and will continue to do so. As of June 2003, it comprised representatives of CALM, Perth Zoo, the University of Western Australia, the Malleefowl Preservation Group and the communities of Albany and Jurien Bay, as well as several members with particular expertise in dibbler biology. The composition of the team may change if further stakeholders are identified.

Significant achievements of the Recovery Team since the writing of the Interim Recovery Plan in mid-1998 are listed below.

- More than 120 dibblers were bred at Perth Zoo and raised to independence for translocation.
- The captive breeding colony at Perth Zoo was converted from Island to mainland stock
- Approval was given for the first island translocation, to Escape Island.
- There was a successful establishment of a new dibbler population on Escape Island off Jurien Bay from island stock (Moro, 2002).

- Radio-tracking studies of dibblers were undertaken at FRNP in December 1999 and January 2001.
- Approval was given for the first mainland translocation, to Peniup.
- The first release of captive-bred dibblers of mainland stock occurred at Peniup (October 2001).
- The Malleefowl Preservation Group was involved in the Recovery Team's activities and in the dibbler reintroduction at Peniup.
- There was a successful application for NHT2 funding for the Dibbler Recovery Plan implementation for 2002/2003.
- A Ph.D. project was completed on the reproductive biology of dibblers (Harriet Mills).
- Two graduate diploma studies were completed on island dibblers (Callum McCulloch, Sue Miller).
- Three undergraduate projects were completed on island dibblers (Kristen Wolfe, Jenny Cheng and Annabelle Stewart).
- Three Honours degree studies were completed on island dibblers or their interactions with other island biota (Kristy Wilcox, Kim Onton and Alice Rawlinson).
- A Ph.D. study began in 2000 on habitat use of dibblers on Whitlock Island and ecological relationships with burrowing seabirds on Whitlock and Boullanger Islands (Kristen Wolfe).
- Funding gained through an ARC SPIRT grant for Ph.D. research on interactions between house mice, dibblers and dunnarts on the islands, commenced in 2002 (Annabelle Stewart).

Benefits to other species

The presence of the dibbler within FRNP and on the Jurien Bay Islands has helped to raise community awareness of the importance of these protected areas for the maintenance of biodiversity. Fox control introduced over the FRNP, with the dibbler as one of the primary species targeted for protection, benefits numerous co-existing medium-sized mammals and ground-nesting birds. These include the brush wallaby, tammar, brush-tailed possum, chuditch, red-tailed phascogale, quenda, heath rat, western mouse, bush rat, malleefowl and ground parrot. Ecosystem services provided by these vertebrate species, such as regulation of insect populations, disturbance and aeration of soil by digging and dispersal of seed and fungal spores, contribute profoundly to the maintenance of biodiversity. Reintroduction of dibblers to other sites, accompanied by fox control and fire management to protect long-unburnt vegetation, will also enhance biodiversity in these areas.

International obligations

As the Dibbler is not listed under any international agreement, the implementation of Australia's international environmental responsibilities is not affected by this plan.

Affected interests

All land on which dibblers are known to survive is under the management of CALM. This Department is heavily involved in the implementation of this plan, through its commitment to the control of introduced predators, fire management in nature reserves and national parks.

Role and interests of indigenous people

CALM is in active consultation with indigenous communities in the regions affected by this plan. Implementation of relevant recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

Spatial data

A description of location and habitat requirements and a distribution map are provided but detailed spatial data/maps have not been included as these are not yet available. Such data will be collated during the first year of the operation of this plan.

Social and economic impacts

The implementation of this RP is unlikely to cause significant adverse social and economic impacts.

Evaluation of the plan's performance

CALM, in conjunction with the Dibbler Recovery Team, will evaluate the performance of this RP. The plan is to be reviewed within five years of its implementation. Any changes to management/recovery actions will be documented accordingly.

2. HABITAT CRITICAL TO SURVIVAL

Critical habitat is habitat identified as being critical to the survival of a listed threatened species or community. Habitat means the biophysical medium or media: (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced (*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)).

In the case of the dibbler, critical habitat comprises:

- areas occupied by dibblers;
- areas not currently occupied by dibblers due to recent fire but capable of supporting dibbler populations when sufficiently recovered;
- areas of natural vegetation through which dibblers can move from one occupied area to another;
- areas of suitable vegetation within the recorded range of the dibbler in which undiscovered dibbler populations may exist, and
- areas of suitable vegetation within the recorded range of the dibbler into which dibblers could be reintroduced.

3. GUIDE FOR DECISION-MAKERS

Possible future actions that may constitute a significant adverse impact on the dibbler include:

- any action that increases the likelihood of wildfire in dibbler habitat;
- any action that increases the spread of *Phytophthora* into dibbler habitat or potential habitat;
- any action that results in the clearing or further fragmentation of dibbler habitat or potential habitat;
- any action that increases the risk of introduction of feral predators onto islands inhabited by dibblers;
- increased human use of islands inhabited by dibblers for recreation or other purposes that may increase the likelihood of introduction of exotic species or increase the likelihood of fire or collapse of seabird burrows, and
- any action hampering the control of feral predators in dibbler habitat.

4. RECOVERY OBJECTIVES AND CRITERIA

Objective

The Objective of the Dibbler Recovery Plan is to conserve known populations of the species, to discover other existing populations, and to establish additional populations.

If known dibbler populations remain stable or grow, and at least two new populations are found or established, downlisting from Endangered B1 + 2ce to Vulnerable D2 (IUCN 2001) will be justified five years after the total number of populations reaches six.

Criteria for success

This RP will be deemed successful if:

- at least three mainland populations are established or discovered more than 25 km from FRNP within 10 years and
- at least one dibbler is captured at three or more sites in FRNP each year and at no less than six sites over any three-year period during the next 10 years and
- population levels on Boullanger and Whitlock Islands remain at no less than 40 per cent of 1998 numbers.

Criteria for failure

This RP will be deemed to have failed if:

- less than three additional populations are established or discovered on the mainland within 10 years or
- dibblers are captured at less than three sites in FRNP each year and at less than six sites over any three-year period during the next 10 years or
- population levels on Boullanger and Whitlock Islands fall below 40 per cent of 1998 numbers.

5. RECOVERY ACTIONS

5.1 Monitor known populations.

It is essential that the Recovery Team remains closely aware of the status of all dibbler populations, as the cause of any serious decline should be investigated and all effort made to remove it. Following Chris Dickman's studies in 1986-1988, and Natasha Baczocha's work in 1995 and 1996, the populations on Boullanger and Whitlock Islands have been the subject of postgraduate research by students from the School of Animal Biology, University of Western Australia (UWA), from 1997 to 2003. Trapping results are provided to the Recovery Team and these constitute high quality monitoring data. All dibblers captured since 1997 have been implanted with Trovan microchips for identification and this practice will continue. Should all research programs involving regular trapping cease, CALM will monitor both island populations at least once a year.

The newly established Escape Island population was monitored by Dr Dorian Moro (CALM and Edith Cowan University) from the first release in October 1998 until October 2001. The Recovery Team then decided that an annual frequency of monitoring would be appropriate unless there was some concern about the status of the population. Monitoring will be the responsibility of CALM, although UWA staff and students will carry it out when possible.

The FRNP dibbler population is monitored by CALM twice a year through the operation of *Western Shield* trapping along two five km transects. These are situated on the “northern fireline” east of Twertup Creek in the north-west of FRNP and on the Moir Track south of the Phillips River near the eastern end of the park. This monitoring is carried out with the assistance of students from Jerramungup and Ravensthorpe Junior High Schools. All dibbler capture data will be reported to the Recovery Team. Additional trapping will be carried out by CALM each year at other sites, chosen to provide a comprehensive picture of dibbler populations within FRNP.

Western Shield trapping is carried out twice a year at Peniup along a five km road transect and this will complement and eventually replace more intensive grid trapping carried out to monitor the recent dibbler reintroduction. Volunteers from the Malleefowl Preservation Group (MPG) and other local community members are involved in all monitoring at Peniup.

Newly discovered dibbler populations will be monitored at least once a year, with community involvement.

Responsibility: Recovery Team through CALM

Participants: CALM, UWA, MPG, local schools, other community groups

Cost: \$ 29,000 per year

Priority: High

Completion date: Ongoing

5.2 Protect existing and reintroduced populations from threatening processes.

The known distribution of the dibbler has contracted to a tiny proportion of its former extent due to the operation of the threatening processes listed earlier. Recovery of the species depends on the removal or amelioration of those processes from known dibbler areas, with the cooperation of the relevant management agency. Habitat management measures required are generally those needed for conservation of a wide range of natural values; these measures are listed below. Where conflicts arise, the Recovery Team will attempt resolution by consultation with the agency or landowner.

The effect of the presence of house mice on dibbler populations on Boullanger and Whitlock islands is poorly understood. Current research (Stewart 2001b) is aimed at clarifying this interaction. If the results of this research indicate that mice are detrimental to dibblers, the practicality of eradicating mice on the islands will be investigated.

5.2.1 Conduct fox control, and if appropriate, feral cat control to protect mainland dibbler populations.

Fox control by aerial and ground baiting is carried out under CALM's *Western Shield* program at FRNP, Peniup and at Waychinicup National Park near the Cheyne Beach dibbler site, but not at Torndirrup National Park. Future mainland reintroduction sites will most likely be in areas already included in this program. Feral cats will be controlled where they may threaten dillers when the technology and resources are available. If additional dibbler populations are discovered on unbaited land, appropriate feral predator control measures will be implemented.

Responsibility: Recovery Team through CALM

Participants: CALM, other land managers

Cost: \$30,000 per year

Priority: High

Completion date: Ongoing

5.2.2 Prevent establishment of exotic predators on dibbler islands.

No exotic predators occur on the islands at present. However, as both Boullanger and Whitlock Islands are both regularly visited by the public, there is a risk of introduction of exotic animals (foxes, dogs, cats, rats) that may pose a threat to dibbler populations. Escape Island is less frequently visited and so such introductions might go unnoticed longer. Researchers and Departmental officers visiting the islands will be alert for signs of introduced mammals. Any indication that exotic mammals (other than house mice) are present will be treated as an emergency and eradication will take priority as an urgent action.

Taking pets to the islands will be discouraged and the potential damage through introduction of exotic mammals will be highlighted through public education (Action 5.2.5).

Responsibility: Recovery Team through CALM, UWA

Participants: CALM, UWA, local community

Cost per year: Covered under other Actions unless predators detected.

Priority: High

Completion date: Ongoing

5.2.3 Investigate the desirability and feasibility of eradicating house mice on Boullanger and Whitlock islands.

The current Ph.D. study into interactions between house mice, dillers and Boullanger Island dunnarts (Stewart 2003b) will provide information to allow further assessment of the desirability of eradicating mice from Boullanger and Whitlock Islands. The Recovery team will consider this question in consultation with researchers and operations personnel with relevant expertise and recommend a course of action. One of the possible outcomes

is that further research will be required. It is anticipated that this recommendation will be made by March 2006.

Responsibility: Recovery Team through CALM, UWA

Participants: CALM, UWA, local community

Cost per year: Covered under other Actions.

Priority: High

Completion date: December 2005

5.2.4 Implement appropriate fire management to protect dibbler populations.

Fire management in FRNP is carried under the FRNP Management Plan (Moore *et al.* 1991), which recognises the needs of dibblers and other threatened fauna requiring long-unburnt vegetation, including western bristlebirds and ground parrots. Fire management of Peniup by CALM's Albany District is aimed at keeping most of the reserve in a long-unburnt state, while recognising the concerns of neighbouring landholders.

The Turquoise Coast Island Nature Reserves Draft Management Plan 2001 (CALM 2001) prescribes total fire exclusion from the islands and lays out a rapid response procedure to extinguish wildfire if it occurs. Public education is the key to preventing fire on the three dibbler islands (Action 5.2.4). If a significant part of either Boullanger or Whitlock Island is burnt, some of the dibblers may be taken into captivity. The number will be determined at the time and will depend on an assessment of the risk of mortality to animals surviving the fire. This will be treated as an emergency.

The Recovery Team will liaise with managers of areas where additional populations of dibblers are discovered to ensure that sufficient long-unburnt habitat is available.

Responsibility: Recovery Team through CALM
Participants: CALM, other land managers
Cost: \$5000 per year
Priority: High
Completion date: Ongoing

5.2.5 Implement appropriate hygiene procedures in *Phytophthora cinnamomi*-susceptible habitat for dibblers.

FRNP has one relatively small area infested by *Phytophthora cinnamomi*. The park management plan (Moore *et al.* 1991) prescribes wide-ranging measures to limit its spread. *Phytophthora cinnamomi* has not been isolated at Peniup, but routine soil and plant tissue sampling is carried out to monitor whether it is present. Hygiene measures are implemented for all management operations within FRNP, Peniup and all other conservation reserves in CALM's South Coast Region in order to minimise the establishment of new infections and the spread of existing infections. If dibblers are found in areas not managed by CALM and the habitat is threatened by *P. cinnamomi*, the land owners and managers will be encouraged to minimise the potential from human vectoring of the pathogen into those areas.

Consideration can be given to maintaining the structure and composition of threatened dabbler habitat by repeated applications of phosphite.

Responsibility: Recovery Team through CALM
Participants: CALM, other land managers
Cost: \$2000 per year
Priority: High
Completion date: Ongoing

5.2.6 Promote understanding and care for dabbler habitat through public education and advice to land managers.

The island dabbler populations are vulnerable to inappropriate human activity such as introduction of animals or plants, disturbing seabird nests or lighting fires. In FRNP, dibblers could be threatened by fires lit accidentally or on purpose, or by spreading plant diseases. The Recovery team will continue to work directly and with community groups to promote local awareness of dibblers and threats to their persistence. High priority will be given to liaison with land managers, residents of Jurien and visitors to Jurien and south coast national parks. Methods will include the production of brochures, signs and media promotion opportunities.

Responsibility: Recovery Team through CALM
Participants: CALM, community groups
Cost: \$1200 per year
Priority: High
Completion date: Ongoing

5.3 Survey to locate further populations.

There are many areas of suitable habitat within the dibbler's former range on the mainland that have not been surveyed. Dibblers are not frequently seen and the possibility of populations existing unnoticed is high. The discovery of another surviving population would be valuable in terms of meeting the criteria for downlisting but even more so for the availability of additional genetic input to the recovery program.

Surveys for dibblers will be carried out using hair-tubing and conventional trapping. Dibblers have distinctive hairs, both in cross-section under a microscope and when viewed side-on. Hair-tubing has not been used extensively in searches for dibblers, but has great labour-saving potential as a survey technique. This technique and skills in recognising potential dibbler habitat can also be taught to persons without a background in wildlife biology, such as volunteers from the community. The materials are relatively inexpensive and the equipment easily constructed. Hair identification techniques require considerable training, but expert assistance is available and the cost of identification is low. Conventional trapping will be used after the recovery of dibbler hairs through hair-tubing, but recent studies have shown that dibblers are not always very trappable and considerable effort may be needed to procure captures.

Search areas will be prioritised according to historic records, habitat quality and previous search history. All available records and sightings of dibblers will be collated during the first year's work and this database will be maintained by project personnel. Community groups will be encouraged to apply for funding and to carry out surveys within their areas. Opportunities for media exposure will be used to appeal to the general public for dibber sighting reports.

Responsibility: The Recovery Team through CALM and community groups

Participants: CALM, community groups, community funding bodies

Cost: \$18,000 per year

Priority: High

Completion date: Ongoing

5.4 Maintain a captive breeding colony to produce stock for translocation.

While it is preferable for genetic and behavioural reasons to use wild-caught animals for translocations, wild populations cannot sustain the removal of sufficient stock for translocations. Captive breeding has the potential to produce large numbers of animals suitable for this purpose, provided that genetic, behavioural and health requirements are met.

Dibblers were first bred in captivity by staff at Perth Zoo's Native Species Breeding Program in 1998. Since then, breeding of dibblers for translocation has become routine (Bradley *et al.* 1999) and 88 dibblers from the breeding program were released during the introduction to Escape Island between November 1998 and June 2001. In preparation for

reintroductions to mainland sites, the breeding program switched to the production of dibblers of mainland stock, through the provision of 11 founder animals by CALM from FRNP between December 1999 and January 2001.

Perth Zoo will continue to breed dibblers to the requirement of the Dibbler Recovery Team as long as resources are available. Currently the Native Species Breeding Program has the capacity to produce and maintain to weaning the young from eight females each year. A breeding group of this size can produce 64 young, a quite adequate number for one annual release during a translocation.

There may be a requirement for display animals for zoo display. Both Perth Zoo and Adelaide Zoo currently have dibblers on display and the Recovery Team sees this as a valid means to raise public awareness of the dibbler, if accompanied by appropriate interpretive material. If possible, post-reproductive or over-represented animals should be selected for this purpose.

Responsibility: Recovery Team through Perth Zoo

Participants: Perth Zoo, CALM

Cost: \$74,000 per year

Priority: High

Completion date: October 2012

5.5 Translocate captive-bred and/or wild stock to establish at least three further self-sustaining mainland populations.

There is an urgent need to increase the number of mainland dibbler populations. While there is a good chance of discovering additional existing populations, this cannot be relied upon as the sole means of improving the conservation status of the dibbler. The captive breeding program is running well and release of captive-bred dibblers has resulted in the establishment of a new population on Escape Island (Moro 2002). Preliminary results of the monitoring of the Peniup translocation indicate a significant chance of successful reintroductions to mainland sites using captive-bred animals. Three releases of 40-60 animals in successive years at reintroduction sites are seen as the minimum necessary to establish a new population. Although most animals released will be captive-bred, it may be desirable to carry out a small number of wild-wild translocations for comparative purposes or to increase genetic input, or to release wild-bred founders from the breeding colony during translocations. There may also be the opportunity to establish further island populations through island-to-island translocation if the Escape Island population grows sufficiently.

5.5.1 Selection of potential reintroduction sites and production of a translocation program.

The Recovery Team used the following criteria in the selection of Peniup for the first mainland reintroduction (Friend 2001b):

- It was within recorded distribution of the species.
- Suitable habitat was present.
- An adequate area of suitable habitat was present.
- There was no recent record of dibblers despite an adequate survey.
- It was close to management resources.
- Land tenure was compatible with the long-term security of a reintroduced population.
- Threatening processes were absent or ameliorated

These criteria will be used, or modified if appropriate, for selection of further mainland reintroduction sites, in consultation with relevant authorities. A translocation program will be produced by the Recovery Team in consultation with the relevant Departmental personnel.

Any new translocation will be subject to approval of a Translocation Proposal in accordance with Departmental policy.

Responsibility: Recovery Team through CALM

Participants: CALM, local residents, community groups

Cost: \$2400 per year

Priority: High

Completion date: January 2010

5.5.2 Implement translocation and appropriate initial monitoring.

Methods of release are subject to modification on the basis of previous experience and results of monitoring. A proportion of released animals will be fitted with radio-tags and initial monitoring will involve radio-tracking, using a light aircraft where animals cannot be located from the ground. Radio-tags will be removed before their batteries fail if possible and subsequent monitoring will be by trapping on grids set up where the animals become established. Trapping will be carried out at least four times during each year after a release. Where possible, local residents and other interested community members will be involved in monitoring dibbler translocations.

Responsibility: Recovery Team through CALM

Participants: CALM, local residents, community groups

Cost: \$19,000 per year

Priority: High

Completion date: January 2012

5.6 Carry out genetic monitoring and management of reintroduced populations.

While the management of the dibbler captive breeding program minimises the inbreeding ratios amongst stock for translocation, the captive breeding founder group includes only a sample of the dibbler's genetic variation. It will be necessary to examine reintroduced

mainland populations in the early stages of establishment to compare genetic variation within and between reintroduced and surviving populations.

If further input is required, action can be taken in the early years, by direct input of wild-bred FRNP animals or by increased wild input into the captive breeding population.

A university student research project will be sought within three years of the establishment of the second reintroduced mainland population.

Responsibility: Recovery Team through CALM and universities

Participants: CALM, universities

Cost: \$10,000 p.a. in 2012 and 2013

Priority: Moderate

Completion date: June 2013

5.7 Encourage community involvement in dibbler conservation.

The dibbler's survival depends as much on an informed and supportive public as it does on the activities of land management agencies. Many recovery activities can be carried out very efficiently and cost-effectively with community participation. Education and public awareness-raising actions driven by community members are extremely effective, and the collection of sighting reports within communities can complement similar work through agency channels. Through the involvement of community groups, volunteers can be encouraged to help the recovery effort, resulting in growing local ownership of the recovery program. The Malleefowl Preservation Group has given its support to the Dibbler Recovery Program, focussing on recovery activities in the area east of Albany. Involvement of other community groups will be encouraged, particularly in the Jurien Bay and other west coastal areas.

Public outreach will be carried out initially by means of public displays and liaison with community groups.

Responsibility: Recovery team through CALM

Participants: CALM, community groups

Costs covered under other Actions

Priority: High

Completion date: Ongoing

5.8 Improve knowledge to underpin dibbler recovery.

Despite the emphasis of the Research Plan and the Interim Recovery Plan on acquiring knowledge for management, a number of questions remain. During the operation of the Dibbler Interim Recovery Plan (1998-2000), the Recovery Team supported student research on the biology of the island populations and this has resulted in a significant contribution to the understanding of dibbler ecology. The island populations are attractive for student projects as they provide easy year-round access to high-density

dibbler populations. Bearing in mind the fragility of the island environment, the Recovery Team will support a limited number of student projects that have direct input into dibbler conservation management.

Research in FRNP is more difficult due to the sparse dibbler populations and seasonal access restrictions due to plant disease hygiene considerations. Recent specially funded research programs run by CALM have been short-term and have involved large volunteer teams. Student projects that can operate within the local constraints of FRNP and that will assist dibbler recovery management will be supported. Reintroduced populations may offer better opportunities for research that will assist in dibbler recovery.

The Recovery Team will work with university staff to devise research projects that contribute to the conservation management of dibleers. Departmental scientists or external scientists under contract will carry out research investigations unsuited to student projects.

Responsibility: The Recovery Team through CALM, universities

Participants: CALM, UWA

Cost: \$40,000 per year

Priority: Moderate

Completion date: June 2012

ACKNOWLEDGMENTS

The success of the dibbler recovery process so far has been due to the hard work and diligence of many people. Dr Tony Start made a huge contribution between 1996 and 1998 in establishing the Recovery Team, finalising the research phase, writing the Interim Recovery Plan, involving university research students and organising the first translocation of captive-bred animals and this gave the program tremendous momentum that continues today. This plan borrows much from Tony's Interim Recovery Plan (Start 1998) and builds on it to bring the recovery of the dibbler closer to reality. I would also like to acknowledge the enthusiasm of the Recovery Team members, and the particular contributions of Cathy Lambert, Dorian Moro, Roberta Bencini and Harriet Mills.

REFERENCES

Baczocho, N. and Start, A.N. (1996). Status and ecology of the dibbler (*Parantechinus apicalis*) in Western Australia. Half-yearly report, August 1996. Report to Australian Nature Conservation Agency. Department of Conservation and Land Management, Perth.

Baczocho, N. and Start, A.N. (1997). *Status and ecology of the dibbler*, (*Parantechinus apicalis*) in Western Australia. 1996 annual report. Unpublished report to Environment Australia. Department of Conservation and Land Management, Perth

- Barrett, S. (1998). *A biological survey of mountains in southern Western Australia*. Report on Project No. AW03 to Australian Nature Conservation Agency National Reserves System Cooperative Program. Department of Conservation and Land Management, Perth.
- Baverstock, P.R., Adams, M. and Archer, M. (1984). Electrophoretic resolution of species boundaries in the *Sminthopsis murina* complex (Dasyuridae). *Australian Journal of Zoology* **32** : 823-32.
- Baynes, A., (1987). The original mammal fauna of the Nullarbor and southern peripheral regions: Evidence from skeletal remains in superficial cave deposits. Pp 401-2 in: McKenzie, N.L. and Robinson, A.C. (Eds) *A biological survey of the Nullarbor region South and Western Australia in 1984*. S.A. Department of Environment and Planning, Adelaide and W.A. Department of Conservation and Land Management, Perth.
- Baynes, A. (1990). The mammals of Shark Bay, Western Australia. Pp 313-25 in: Berry, P.F., Bradshaw, S.D. and Wilson, B.R. (Eds) *Research in Shark Bay. Report of the France-Australe Expedition Committee*. Western Australian Museum, Perth.
- Bencini, R., McCulloch, C., Mills, H.R. and Start, A.N. (2001). Habitat and diet of the dibbler (*Parantechinus apicalis*) on two islands in Jurien Bay, Western Australia. *Wildlife Research* **28**, 465-468.
- Bradley, M.P., Lambert, C., Power, V., Mills, H., Gaikhorst, G., and Lawrence, C. (1999). Reproduction and captive breeding as a tool for mammal conservation: the role of modern zoos. *Australian Mammalogy* **21** : 47-54.
- CALM (2001). *Turquoise Coast Island Nature Reserves Draft Management Plan 2001*. Department of Conservation and Land Management & Conservation Commission Western Australia, Perth.
- Chapman, A. and Newbey, K.R. (1995). A biological survey of the Fitzgerald area, Western Australia. *CALMScience Supplement 3*: 1-258.
- Cooper, S. and Birrell, J. (1996). *A population genetics study of Parantechinus apicalis using DNA sequence markers*. Unpublished report. Evolutionary Biology Unit, South Australian Museum, Adelaide.
- Dickman, C.R. (1986). Return of the phantom dibbler. *Australian Natural History* **22** : 33.
- Dickman, C.R. and Braithwaite, R.W. (1992). Postmating mortality of males in the dasyurid marsupials, *Dasyurus* and *Parantechinus*. *Journal of Mammalogy* **73** : 143-7.
- Ford, J. (1963). The reptilian fauna of the islands between Dongara and Lancelin, Western Australia. *The Western Australian Naturalist* **8** : 135-42.

- Friend, J.A. (2001a). *Medium-term radio-tracking of dibblers, Fitzgerald River NP*. Unpublished report on Bankwest Landscape Conservation Visacard Grant project, Department of Conservation and Land Management, Perth.
- Friend, J.A. (2001b). *Translocation proposal: Dibbler (Parantechinus apicalis) from Perth Zoo to Peniup proposed nature reserve, October 2001*. Department of Conservation and Land Management, Perth.
- Fuller, P.J. and Burbidge, A.A. (1987). Discovery of the dibbler, *Parantechinus apicalis*, on islands at Jurien Bay. *The Western Australian Naturalist* **16** : 177-81.
- Glauert, L. (1928). Popular names for marsupials. Museum Leaflet No. 1. Public Library, Museum and Art Gallery of Western Australia, Perth.
- Gould, J. 1863. *The Mammals of Australia*. Taylor and Francis, London.
- Gray, J.E. (1842). A new species of Tapering-tailed Phascogale in the collection of the British Museum. *Annals and Magazine of Natural History* **IX** : 518.
- Gray, J.E. (1844). List of the mammals in the collections of the British Museum of Natural History, p99.
- IUCN (1994). *IUCN Red List Categories*. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland.
- IUCN (2001). *IUCN Red List Categories: Version 3.1*. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.
- IUCN (2003). *2003 IUCN Red List of Threatened Species*. <www.redlist.org>. Downloaded on 01 December 2003.
- Kinnear, J.E., Sumner, N.R. and Onus, M.L. (2002). The red fox in Australia – an exotic predator turned biocontrol agent. *Biological Conservation* **108** : 335-59.
- Krajewski, C. and Westerman, M. (2003). Molecular systematics of Dasyuromorpha. Pp. 3-20 in: Jones, M., Dickman, C. and Archer, M. (Eds) *Predators with Pouches*. CSIRO Publishing, Collingwood.
- McCulloch, C. (1998). *The demography and habitat use of the dibbler (Parantechinus apicalis) on two islands in Jurien Bay, Western Australia*. Thesis for Graduate Diploma of Natural Resource Management, Faculty of Agriculture, University of Western Australia.

Maxwell, S., Burbidge, A.A. and Morris, K.D. (Editors) (1996). *The 1996 Action Plan for Australian Marsupials and Monotremes*. Wildlife Australia, Endangered Species Project Number 500. Environment Australia, Canberra.

Miller, S., Bencini, R., Mills, H.R. and Moro, D. (2003). Food availability for the dibbler, *Parantechinus apicalis*, on Boullanger and Whitlock Islands, Western Australia. *Wildlife Research* **30** : 649-54.

Mills, H.R. and Bencini, R. (2000). New evidence for facultative male die-off in island populations of dibblers, *Parantechinus apicalis*. *Australian Journal of Zoology* **48** : 501-10.

Mills, H. R., Moro, D. and Spencer, P. B. S. (in press). Conservation significance of island versus mainland populations: a case study of dibblers (*Parantechinus apicalis*) in Western Australia. *Animal Conservation*.

Moore, S., Cavana, M., Gillen, K., Hart, C., Hopper, S., Orr, K. and Schmidt, W. (1991). *Fitzgerald River National Park Management Plan; 1991 - 2001*. Department of Conservation and Land Management, Perth.

Morcombe, M.K. (1967). The rediscovery after 83 years of the dibbler *Antechinus apicalis* (Marsupialia, Dasyuridae). *The Western Australian Naturalist* **10** : 103-11.

Moro, D. (2002). Translocation of captive-bred dibblers *Parantechinus apicalis* (Marsupialia: Dasyuridae) to Escape Island, Western Australia. *Biological Conservation* **111**: 305-15.

Ride, W.D.L. (1970). *A guide to the native mammals of Australia*. Oxford University Press, Melbourne.

Sanders, A. (1997). *Monitoring in the Fitzgerald Biosphere Reserve*. Report to Environment Australia, Department of Conservation and Land Management, Perth.

Smith, V. W. (1990). The terrestrial vertebrate fauna of the Torndirrup National Park. *The Western Australian Naturalist* **18** : 82-92.

Start, A.N. (1998). *Dibbler, Parantechinus apicalis, Interim Recovery Plan*. Interim Recovery Plan No. 18. Department of Conservation and Land Management, Perth.

Stewart, A. (2001a). *Does Competition For Food With House Mice Threaten The Dibbler?* Thesis for Bachelor of Science in Natural Resource Management, Faculty of Agriculture, University of Western Australia, Perth.

Stewart, A. (2001b). *Ecological relationships between island populations of dibblers (Parantechinus apicalis), house mice (Mus domesticus) and Boullanger Island dunnarts*

(*Sminthopsis griseoventer boullangerensis*). Ph.D. Project Proposal, Department of Animal Science, University of Western Australia, Perth.

Tate, G.H.H. (1947). Results of the Archbold Expeditions. No. 56. On the anatomy and classification of the Dasyuridae (Marsupialia). *Bulletin of the American Museum of Natural History* **88** : 97-156.

Wagstaffe, R. and Rutherford, G. (1955). Letters from Knowsley Hall, Lancashire. *North Western Naturalist* **26 (March 1955)** : 9-22.

Whittell, H.M. (1954). John Gilbert's notebook on marsupials. *The Western Australian Naturalist* **4**: 104-14.

Woolley, P.A. (1977). In search of the Dibbler, *Antechinus apicalis* (Marsupialia: Dasyuridae). *Journal of the Royal Society of Western Australia*. **59** : 111-17.

Woolley, P.A. (1980). Further searches for the Dibbler, *Antechinus apicalis* (Marsupialia: Dasyuridae). *Journal of the Royal Society of Western Australia* **63** : 47-52.

Woolley, P.A. (1982). Phallic morphology of the Australian species of *Antechinus* (Dasyuridae: Marsupialia): a new taxonomic tool? Pp. 767-81 in: Archer, M. (Ed.) *Carnivorous Marsupials*. Royal Zoological Society of New South Wales, Mosman, Sydney.

Woolley, P.A. (1991). Reproductive behaviour of captive Boullanger Island dibblers, *Parantechinus apicalis* (Marsupialia: Dasyuridae). *Wildlife Research* **18** : 157-63.

Woolley, P.A and Valente, A. (1982). The Dibbler, *Parantechinus apicalis* (Marsupialia: Dasyuridae): Failure to locate populations in four regions in the south of Western Australia. *Australian Mammalogy* **5** : 241-45.

DURATION AND COSTS

Action	Responsibility	Cost										
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
1. Monitor known populations	CALM, RT, community	29160	29160	29160	29160	29160	29160	29160	29160	29160	29160	29160
2. Protect existing and reintroduced populations from threatening processes	CALM, RT	37575	38575	37575	37575	37575	37575	37575	37575	37575	37575	37575
3. Survey to locate further populations	CALM, RT	18270	18170	18170	18170	18170	18170	18170	18170	18170	18170	18170
4. Maintain a captive breeding colony to produce stock for translocation	PZ, RT	73600	73600	73600	73600	73600	73600	73600	73600	73600	73600	
5. Translocate captive-bred and/or wild stock to establish at least three further self-sustaining mainland populations	CALM, RT, community	21400	14500	14500	14500	14500	14500	14500	14500	14500	14500	14500
6. Carry out genetic monitoring and management of reintroduced populations	CALM, RT, universities										35000	35000
7. Encourage community involvement in dibbler conservation	RT, community	0	0	0	0	0	0	0	0	0	0	0
8. Improve knowledge to underpin dibbler recovery	CALM, RT, universities	40600	40600	40600	40600	40600	40600	40600	40600	40600	40600	40600
Annual cost		220605	214605	213605	213605	213605	213605	213605	213605	213605	248605	175005
Total cost (10 years)	2140453											



Australian Government

Department of the Environment and Heritage

ADDENDUM

DIBBLER (*Parantechinus apicalis*) RECOVERY PLAN

In adopting this plan under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Minister for the Environment and Heritage has approved the addition of the following information.

Critical Habitat

The plan identifies critical habitat as including broad areas around known populations which contain habitat similar to that in which the species occurs, as well as areas that do not currently contain the species but may have done so in the past. These areas identified in the plan do not represent areas of critical habitat as defined under section 207A of the EPBC Act, nor do they represent habitats that are critical to the survival of the species identified pursuant to Section 270(2)(d) of the EPBC Act. Habitats identified in Section 270(2)(d) are limited to the area of occupancy of known populations.