STATUS AND ECOLOGY OF THE DIBBLER (*PARANTECHINUS APICALIS*) IN WESTERN AUSTRALIA

Project Number 496

1996 ANNUAL REPORT

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1. SUMMARY

The focus of the project will move from mainland to island populations in 1997. Therefore this report summarises all the work done on the mainland since the project commenced in January 1995 so that current knowledge of the species on the mainland will be in one document.

Fieldwork comprised twenty seven field trips to resurvey sites where dibblers had been caught before and seek new populations where the habitat appeared suitable. There are still many unsurveyed areas (particularly along the south coast) where the habitat seems to be suitable for dibblers. We first trapped a dibbler in the Fitzgerald River National Park (FRNP) in November 1995 after 22,357 trap nights. Thirty one more have since been tagged there. Several have been recaptured. Dibblers are probably wide spread within the FRNP, although their distribution may be transient and patchy and populations may persist at low densities. Further work on dibbler distribution within the park will require considerable time and effort. It will be constrained by huge tracts of dense vegetation and access rules imposed to curtail spread of die-back diseases of plants caused by *Phytophthora*.

On the mainland dibblers are difficult to study because they occur at low density and populations seem to be transient, abandoning some sites for years. They are so mobile that radio tracking is ineffective and other methods of following individuals have failed. In the last 20 years most sites have experienced drastic changes because of plant diseases and/or severe wildfire. Critical habitat requirements remain unclear but several significant trends are emerging. They occur in a broad range of floristic communities. Earlier studies suggested they required vegetation more than 25 years old, but they have now been caught at sights burnt seven years previously, albeit near older vegetation.

The two island populations were visited four times in 1995 and twice in 1996. Males did not experience the complete, synchronous die-off at the end of the breeding season that Dickman had recorded in past years (and synchronous male die-off did not occur in the FRNP population in 1996). Male die-off, at least on the islands, may be linked to high population densities. The population on Boullanger Island is smaller than Dickman estimated in the late 1980s. A paper detailing these findings is being prepared.

Habitat management is an important action for dibbler recovery on the islands. Issues include human (including researchers) disturbance, interactions with house mice, burrowing seabirds, weeds, fire and protection from invasion by feral predators. Aspects of the interaction between dibblers, weeds, seabird burrows and mice are among issues that require more research. Next year the project will concentrate on recovery of the island populations.

A grant from the BankWest *Landscope* Conservation Visa Card funded a study of the genetic status of dibblers but the results are inconclusive because technical difficulties were not resolved. The report is attached as Appendix 1. More work is warranted.

A variety of media opportunities were taken. The main aims were to promote the project to scientific groups and the general public. We also brought dibblers to the attention of rural communities (particularly the residents of Jurien) and sought public involvement in the work. The acknowledgements section indicates that many people became directly involved.

2 INTRODUCTION

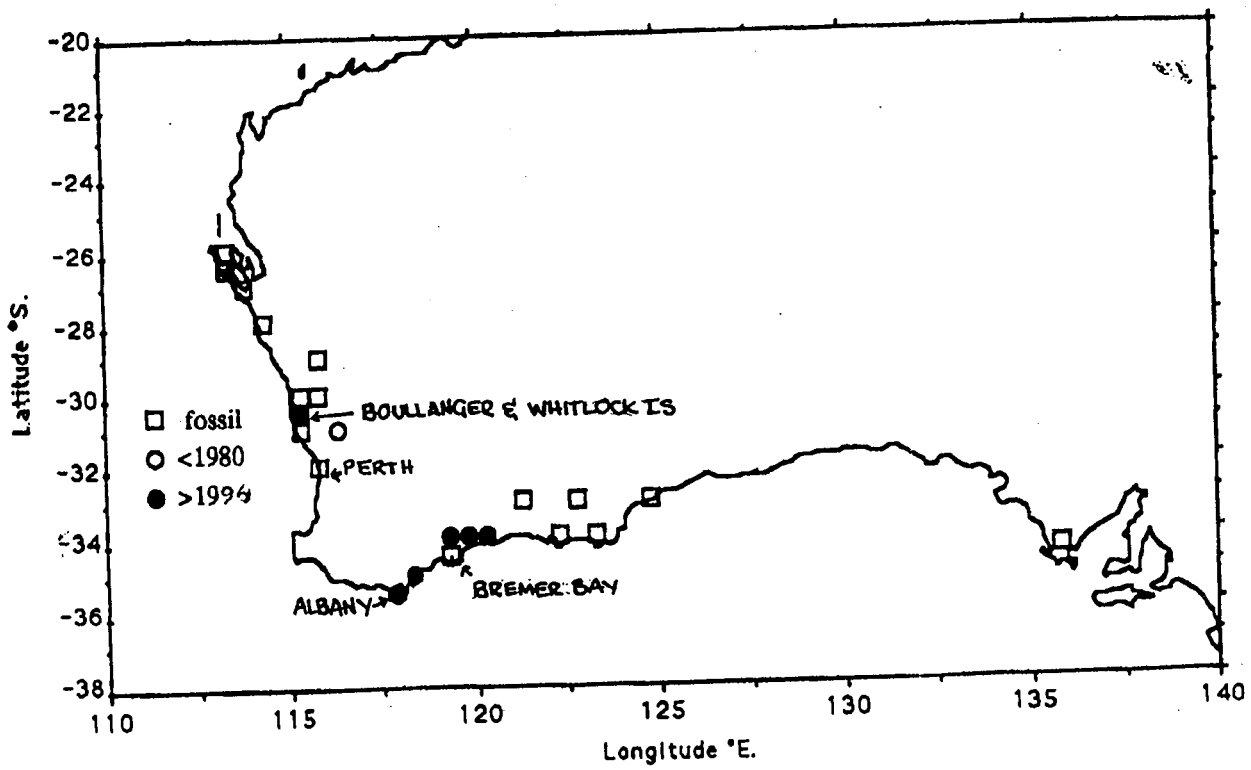
The focus of the project will move from mainland to island populations in 1997. Therefore this report summarises all the work done on the mainland since the project commenced in January 1995 so that current knowledge of the species on the mainland will be in one document.

2.1. STATUS AND DISTRIBUTION

The dibbler, *Parantechinus apicalis,* was first collected by John Gilbert who encountered it near Moore River and King George Sound (Whittell 1954). Other collectors took several more before 1884 and old specimens are still coming to light; two have been located in the Dublin Museum by C. Fisher[1] in the last year. Even then, the dibbler was considered rare (Gould 1863) but, like so many other species, it has declined in historical times. Eighty three years passed before Morcombe (1967) caught dibblers at Hassell (Cheyne) Beach.

Historical collections and sub-fossil remains show that the species once ranged from Shark Bay to Israelite Bay in south western Australia and to Coffin Bay on the Eyre Peninsular in South Australia (Figure 1). However, it probably did not occur in the forests or wet-coastal areas of the far south west. Dickman used BIOCLIM to predict dibbler distribution and kindly allowed us to use the map. The BIOCLIM prediction corresponds closely to the distribution of sub-fossil and recent specimens in Western Australia. However, BIOCLIM suggests dibblers may have occurred on the Yorke Peninsula and more extensively on the Eyre Peninsula in South Australia.

Figure 1. Distribution of the dibbler



Courtesy A. Baynes, WA Museum (includes unpublished data)

[1] Dr. C. Fisher - Liverpool Museum

Dibblers have remained elusive despite considerable trapping effort at different times by several investigators (Woolley 1977, 1980; Butler unpublished report to the (former) Department of Fisheries and Wildlife; Fuller[2], Alford[3] and Dickman[4] personal communications). Even indirect techniques, such as predator scat analysis, failed to detect more dibblers (Woolley and Valente 1982). However they have turned up at various localities along the south coast (eg, Hassell Beach, Jerdacuttup, Torndirrup National Park and Fitzgerald River National Park; Muir 1985; Smith 1990). A Biological Survey of the FRNP was carried out between 1985 and 1987 by Newbey and Chapman. They caught a total of seventeen dibblers at eight different locations (Chapman and Newbey 1995). They recorded little biological information but published detailed site descriptions. Their site information, augmented by data collected during this project, forms the basis for our assessment of dibbler habitat.

In 1985 dibblers were discovered on Boullanger and Whitlock Islands off Jurien Bay, 175 km north of Perth (Fuller and Burbidge 1987). This led to the first detailed studies of the life history and reproduction of wild dibblers. (Lynam 1987, Dickman and Braithwaite 1992, Dickman personal communication.) Until November 1995 these were the only populations that could be found with any certainty. Each population that had been found on the mainland apparently disappeared soon afterwards and it was not known if they still survived.

2.2. ECOLOGY AND REPRODUCTION

Following his rediscovery of the dibbler, Morcombe (1967) recorded observations on its ecology and behaviour. He suggested that it was semi-arboreal with some dependence on large flowers for nectar and insects. It preferred dense stands of *Banksia*-dominated heath with a thick litter layer through which the animals moved and made their nests. His record, and a later one of Duxbury (Muir 1985), all from long-unburnt stands of vegetation, led to the assumption that dibblers were restricted to older vegetation and that frequent or extensive fire was a serious threat to their survival. This was supported by the findings of Chapman and Newbey (1995). However we found a population in relatively young vegetation (approximately 10 years post fire). The significance of the age of vegetation in dibbler habitat and the ability of dibblers to use fire edges remain unclear.

Dibbler habitat on Boullanger and Whitlock Islands is very different from that on the south coast. However, it may have changed considerably since the islands were formed and so it may not be a useful guide to dibbler habitat on the west coast mainland.

Lynam (1987) examined aspects of inbreeding and juvenile dispersal of the island populations and suggested that reduced genetic variation and developmental instability (indicated by a significant morphological asymmetry) were important factors limiting these populations. He ascribed the persistence of dibblers on the islands to an absence of environmental perturbations like habitat destruction and fire. However the habitat is certainly harsh and is not without considerable ongoing disturbance by humans and, to a greater extent, by burrowing seabirds. The latter may be important and beneficial as dibblers will live in the seabird burrows. There are large populations of *Mus musculus* and several weeds on the islands. These may have adverse effects although dibblers will eat the mice.

Lynam's conclusions on the genetic relationship of island populations are questionable (Adams[5] personal communication). Another investigation into the genetic relationship of

[2] P.J. Fuller - CALM - Science and Information Division
[3] J. Alford - formerly CALM - Science and Information Division
[4] Dr C.R. Dickman - University of Sydney.
[5] M. Adams - Evolutionary Biology Unit - South Australian Museum.

dibblers from the islands and the mainland was funded by a grant from the BankWest *Landscope* Conservation Visa Card. It is yet to determine if there is any significant difference between populations because the scientists have encountered technical problems that they have not yet overcome. Preliminary results suggest that there are possible nuclear DNA differences between the island and mainland populations (Cooper and Birrell 1996, Appendix 1).

Dickman (personal communication) carried out a three year study of the Boullanger and Whitlock Island population, examining aspects such as population dynamics and the effects of *Mus* removal, reproduction, genetic structure and parasite loads. Unfortunately, his data are still unpublished. No comparable information was obtained for mainland populations during this project.

Woolley (1971) obtained three of Morcombe's specimens for reproductive studies in the laboratory. She found that *P. apicalis* differed from other *Antechinus* species in its group. It breeds once each year, in autumn; the others breed in late winter to spring. Woolley (1991) and we (this study) have shown that males captured on the south coast can survive beyond their first breeding season. There is some evidence that, on the mainland, both males and females can breed in successive years when there is no male die-off. Dickman found that the Boullanger and Whitlock Island populations experienced a complete and synchronous male die-off. However Fuller and Burbidge (1987) and we (this study) found at least two distinct age classes in both males and females on both islands. These data suggest that the life history strategy of *P. apicalis* may be quite variable, both between populations and between years within any one population. A paper on this issue will be published by Baczocha and Dickman.

3 SCOPE ITEMS AND PROGRESS

This research project set out to clarify details of *P. apicalis* distribution and ecology and identify factors that may impinge on its long term conservation. The following scope items were agreed for 1996.

a) ascertain the distribution and conservation status of *P. apicalis* in Western Australia
b) examine the species' population dynamics and habitat relationships through regular monitoring using traps and radio tracking
c) document the species' ecology in relation to potential threats, particularly fire and plant pathogens
d) prepare a draft Recovery Plan for *P. apicalis* and publications detailing the conservation status and ecology of the species

3.1 Scope 1. DISTRIBUTION AND CONSERVATION STATUS OF DIBBLERS

We collated information on sub-fossil distribution and historical collections of dibblers as well as capture/sight records since their rediscovery in 1967. The information was used to create a distribution map and a priority list for the resurvey of sites. Conclusions on the conservation status of dibblers were made after investigating these and other new sites).

3.1.1. Distribution

The sub-fossil distribution of *P. apicalis* (Figure 1) has been determined from bone deposits in caves and the accumulations of owl pellets by Baynes[6]. A paper by Baynes and Baczocha, will include much of this previously unpublished information.

[6] Dr A. Baynes - Western Australian Museum.

The dibbler had an extensive and generally coastal distribution from Shark Bay to Wanneroo (near Perth) on the west coast and from King George's Sound to Israelite Bay along the south coast of Western Australia. It also occurred on the Eyre Peninsula in South Australia (Baynes 1987). The most inland record is from Peak Charles, 200 km north west of Esperance. It is conspicuously absent from the good sub-fossil record of mammals of the south west corner of Western Australia (Archer and Baynes 1972, Baynes personal communication). This suggests that it did not occur in the forests or the wetter coastal heaths between Perth and King George's Sound. All specimens collected by Europeans have come from within the distribution indicated by the sub-fossil record.

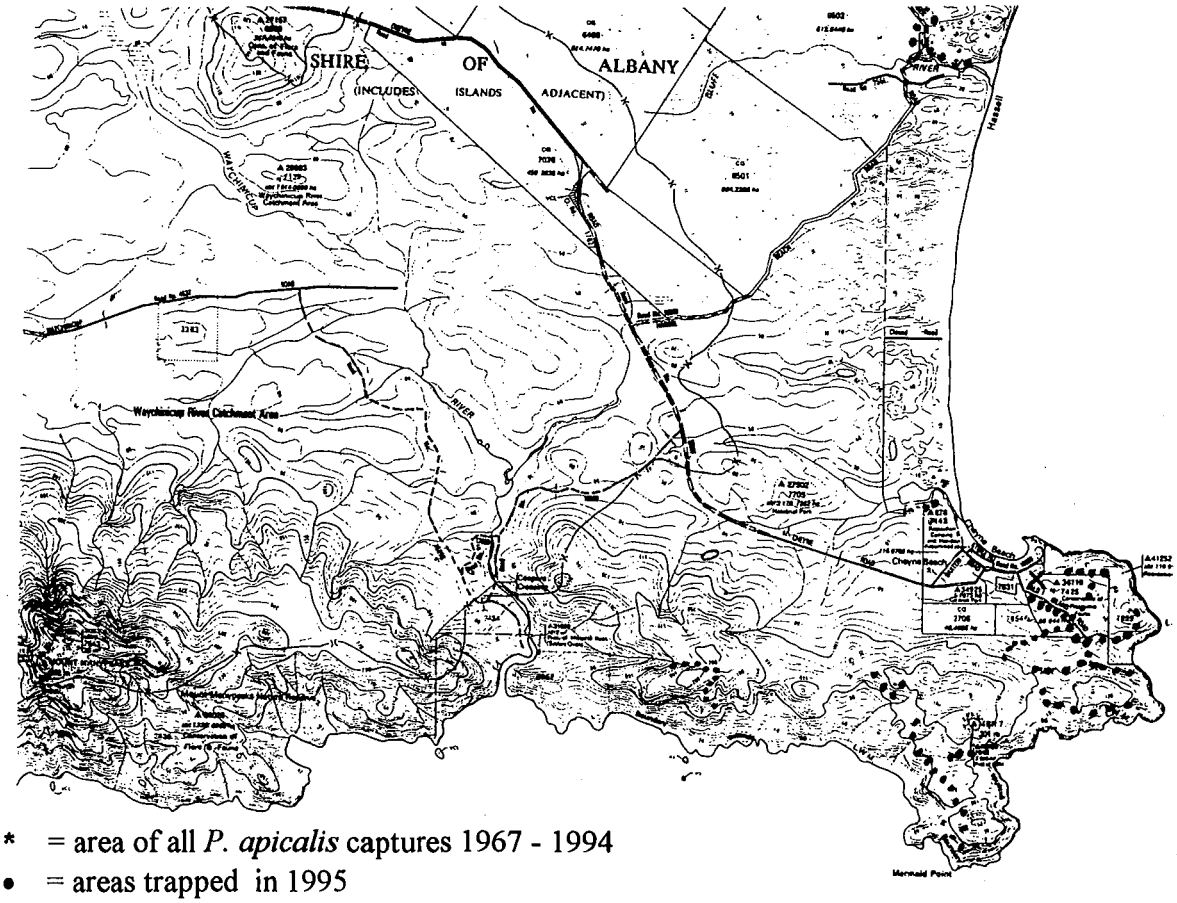
The range once occupied by dibblers encompasses a wide variety of habitats but it seems that they preferred drier, coastal country. It is reminiscent of other species such as *Pseudomys shortridgei* and *Potorous platyops*. Within the fossil deposits, dibbler remains are often less numerous than those of other dasyurid species that suggests that it was less common than the others (Baynes personal communication).

3.1.2. Resurvey of previously known locations

Information about each previous dibbler record was collated and used to develop a priority list for resurvey. Priority was assigned by the age and circumstances of previous records, subsequent changes to habitats, subsequent effort to recapture dibblers there and the logistics of returning to the sites. Maps showing the location of survey traplines are contained in Baczocha (1997) which is lodged in the CALM Library at the Wildlife Research Centre. Fig 2 is an example.

Arpenteur Nature Reserve

Figure 2. Survey locations: Arpenteur Nature Reserve.



* = area of all *P. apicalis* captures 1967 - 1994

• = areas trapped in 1995

This is where Morcombe rediscovered dibblers in January 1967. He captured one male and one female on banksia flowers (Morcombe 1967). All the dibblers caught in this Nature Reserve since then have come from the same general area (Figure 2). In April 1967 Ride (1970) caught another female and in August that year Baynes and Kirsch trapped a female (Baynes personal communication). Several further attempts in 1970 were unsuccessful (Fuller personal communication and Butler unpublished report to the Department of Fisheries and Wildlife). In November 1975 Woolley caught one male and two females (Woolley 1977) and Udinga[7] caught one male in January 1994.

This area was extensively resurveyed in March and September 1995 (Figure 2) but no dibblers were caught (Table 1). The failure to trap *Tarsipes rostratus* probably reflects the low number of pit traps as well as the lack of flowering species at the time. The floristics and vegetation structure in the vicinity of the earlier capture sites have been extensively modified by plant diseases including dieback *Phytophthora cinnamomi* and, probably, stem cankers caused by *Cryptodiaporthe* spp. amongst others. Once-extensive thickets of *Banksia coccinea* and *Banksia baxteri* are now low heaths dominated by sedges. Only a few isolated pockets of *B. baxteri* remain there. Nevertheless there is seemingly suitable habitat in the region that warrants trapping.

Table 1. Trapping results from resurvey of Arpenteur Nature Reserve.

Date	Numbers of Animals Caught								Trap Nights
	Rf		Af		Mm		Ep	Ek	
	new	retrap	new	retrap	new	retrap	total	total	
March 1995	36	59	7	6	7	3	38	1	1,350
Sept 1995	31	26	0	0	0	0	6	0	800
Total	**54**	**85**	**7**	**6**	**7**	**3**	**44**	**1**	**2,150**

Rf = *Rattus fuscipes*, Af = *Antechinus flavipes*, Mm = *Mus musculus*, Ep = *Egernia pulchra*, Ek = *E. kingii*.

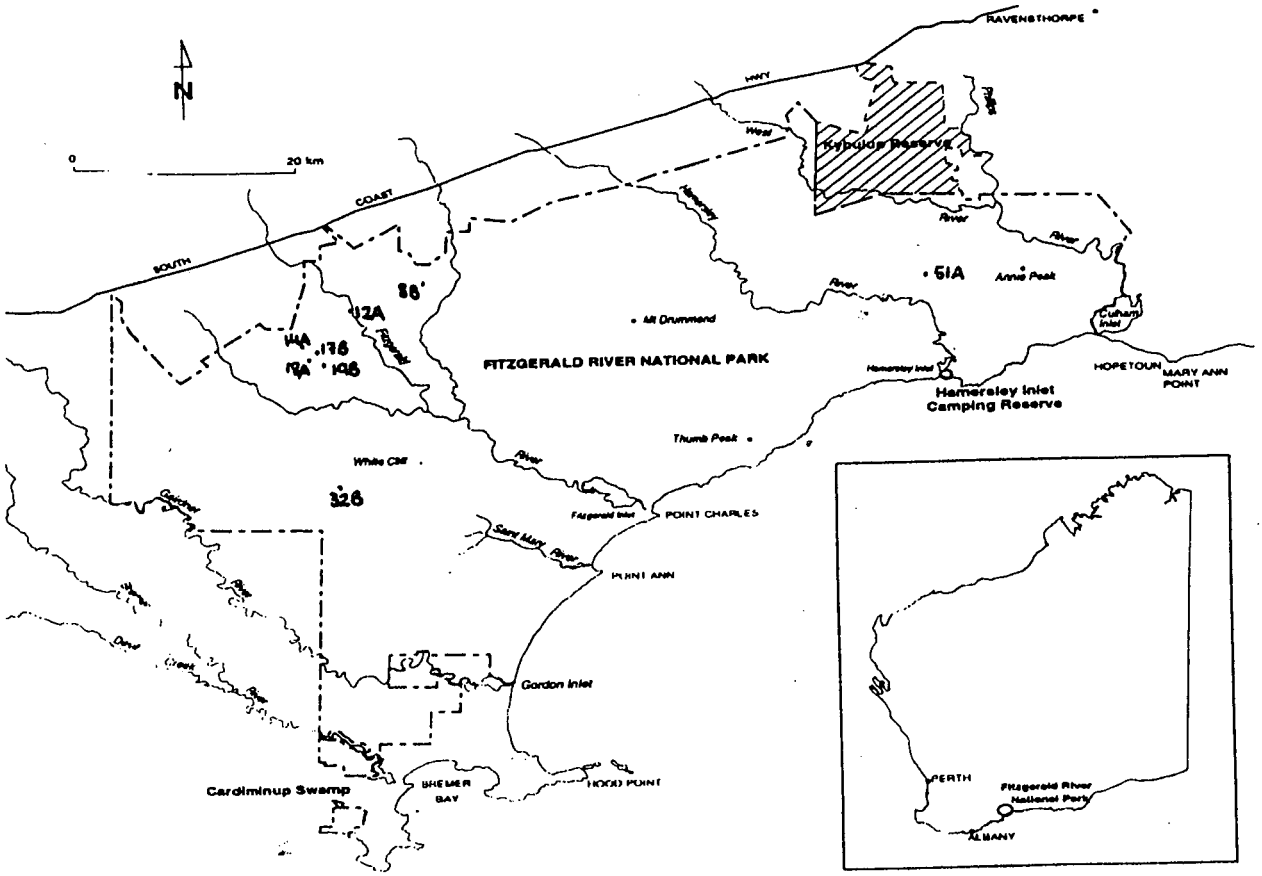
Fitzgerald River National Park

The first dibbler recorded from the park was found, dead, on Hamersley Drive by Ranger G. Duxbury in 1984. A *post mortem* examination concluded that it had probably been dropped by a cat or fox (Muir 1985). The discovery helped to secure funding for a biological survey of Fitzgerald River National Park in 1986 and 1987 (Chapman and Newbey 1995). They caught fifteen dibblers (eight males and seven females) at eight sites (Figure 3 and Appendix 2).

A male dibbler was caught in 1990 at Chapman's site 18A. (L. Whisson[8] personal communication) but since then four of the eight dibbler sites (14A, 17B, 18A and 19B) were burnt in a wildfire that swept through 5000 ha in October 1994. This area was trapped in May 1995 but no dibblers were caught (Table 2.). However, dibblers have been caught on the eastern edge of this burnt area (Site 12A) in November 1994 (Kinnear[9] personal communication) and in November 1996 (Sanders and Baczocha in press). Newbey observed a dibbler in this burnt area whilst conducting a Western Bristlebird survey in December 1996 (Newbey[10] personal communication).

[7] P. Udinga - CALM - National Park Ranger.
[8] Leigh Whisson - CALM - Two Peoples Bay.
[9] Dr. J. Kinnear - CALM - Science and Information Division.
[10] Brenda Newbey - Consultant Ornithologist.

Figure 3. Capture locations: Fitzgerald River National Park biological survey (1986-87).



Between the efforts of this Dibbler Project and CALM's Fitzgerald Biosphere Ecology Program, most of Chapman's dibbler sites were re-trapped in 1995-96. Table 2 represents the combined trapping results of the resurvey of Chapman's dibbler sites. These sites were trapped with varying intensity, and used both Chapman's pit lines as well as Elliott and pit traps in additional trap lines.

Table 2. Trapping results from resurvey of Chapman's dibbler sites in FRNP.

Date	Location	Dibblers Caught	trap- nights
November 1994[a]	12A	1	unknown
May 1995	18A	0	4,222
	19B	0	
	17B	0	
November 1995	7A	5	350
December 1995	7A	0	200
February 1996	7A	1	150
May 1996	7A	0	200
October 1996	7A	0	150
November 1996[b]	12A	2	unknown
	51A	1	
	31	0	

[a] Kinnear personal communication. [b] Sanders personal communication

Between 1985 and 1991 dibblers were frequently seen during the day, or caught in Elliott traps at night, around the ranger residence at Jacup in the north western corner of the park. They were sometimes very conspicuous, fossicking among pot plants and in the yard at all hours. Most observations were said to be around September in years following wet winters (Lloyd, Hart and McQuoid[11] personal communications). However written records were not always kept. A dead dibbler was found on a fire break just south of the residence in 1989. Like the animal found by Duxbury on Hamersley Drive, it may also have been dropped by a fox or cat.

Dibblers have not been sighted around the residence since 1991 (McQuoid personal communication). Nevertheless the area at Jacup was resurveyed during 1995 and 1996 without success (Table 3). In anticipation of dibblers recolonising this area, a set of permanent pit lines has been installed.

Table 3. Trapping results from resurvey of the Jacup area.

Date	Animals Caught						Trap nights
	Rf	Po	Tr	Ha	Mm	L	
May 1995 - Oct 1996	2	1	7	4	4	6	305

Rf = *Rattus fuscipes*, Po = *Pseudomys occidentalis*, Tr = *Tarsipes rostratus*, Ha = *Heleioporus albopunctatus*, Mm = *Mus musculus*, L = small lizards

Torndirrup National Park

During the period December 1987 to December 1988 Smith caught two males and one female in Torndirrup National Park (Smith 1990). This area had been trapped previously for more than 5000 trap nights and has been regularly trapped since. No other dibblers have been captured in this location or surrounding bushland. Smith noted that all individuals were caught in dense *Banksia* thickets at the time of heavy flowering. All animals were caught in 60 x 150 mm deep pits, but the female was recaptured in an Elliott trap 200 metres from the point of original capture.

Because of Smith's ongoing study, the dibbler locations in Torndirrup National Park were not resurveyed. However adjoining bushland was investigated as part of the survey for other sites where dibblers may occur.

Jerdacuttup River area

Two dibblers have been recovered from this area. One was caught south of Kundip Nature Reserve in a cow barn in December 1976. A cat brought in another from the Jerdacuttup River area in January 1976. Woolley (1980) and Woolley and Valente (1982) have extensively surveyed the area but caught no more dibblers.

Nearby there are large expanses of bushland that join the FRNP. Given that dibblers are highly mobile, individuals could have travelled from a source population in the park in search of new territory and ended up in this farmland. Seemingly suitable habitats in Vacant Crown Land on the eastern boundary of the park were trapped without success and the paucity of other vertebrates was notable (Table 4).

Boullanger and Whitlock Islands

Dickman worked on these islands about ten years ago. They were first resurveyed in November 1994. Dibblers persist on both islands and the density on Whitlock is similar to that observed by Dickman but trap success on Boullanger (Table 5) was lower than expected from Dickman's work. The population there has probably declined by about 50%.

[11] M. Lloyd, C. Hart and N. McQuoid - CALM - National Park Rangers.

Table 4. Trapping results of resurvey in the Jerdacuttup River area. August 1995

Site	Animals Caught			Trap Nights
	Rf	Mm	Tr	
Laurina Rd.	3	0	1	520
Jerdacuttup River Reserve	5	0	0	220
Bandalup Hill	18	12	3	600
Total	26	12	4	1,340

Rf = *Rattus fuscipes*, Mm = *Mus musculus*, Tr = *Tiliqua rugosa*

Table 5. Trapping results from resurvey of Boullanger Island. November 1994

Animals Caught						Trap Nights
Dibbler	Mm	Ek	Ep	Em	Ct	
7 male, 6 female	264	14	20	6	13	496

Mm = *Mus musculus*, Ek = *Egernia kingii*, Ep = E. *pulchra*, Em = *E multiscutata*, Cf = *Ctenotus fallens*

Monitoring grids were established with care because monitoring can cause significant damage if workers crush vegetation while laying and checking traps (traps often have to be checked twice a day because of high temperatures). In 1996 four one-week trips produced fairly good data on population numbers, breeding, juvenile survival rates and related issues such as male die-off. All trap results are summarised in Appendices 4 and 5.

The cause of the decline on Boullanger Island (if it is real) is unknown but it is not likely to be genetically linked (Cooper[12] personal communication). Competition for food or shelter with other species such as house mice (but they will eat mice), or the decline in nesting seabirds are possibilities. In 1996 there were very few active seabird burrows on Boullanger Island. When Dickman was there, the whole island was being used by seabirds (Dickman personal communication). He identified the burrows as potential shelter sites for dibblers, but gathered no evidence on where nesting females deposit their young. Circumstantial evidence suggests that there may be a link between a decline in burrowing seabirds and a decrease of the dibbler population.

3.1.3. Search for new populations

The Management Team decided that, during 1996, priority should be given to learning as much as possible from a population that was located in the Fitzgerald River National Park. Therefore searches for new populations did not proceed as far as was originally planned. Table 6 summarises all the surveys that have been made and Table 7 lists some areas that warrant searching. Factors used to develop priorities included proximity to other dibbler records, vegetation age, structure and floristics, fox control and logistical constraints such as access problems, risk of spreading plant diseases and land tenure.

There is a lot of biologically unexplored coastal bushland between Cheyne Beach and Fitzgerald River National Park that probably has harboured dibblers. Most of it is Vacant Crown Land (VCL) with little active management. As a result, many of the *Banksia* stands have been used by wildflower pickers and exposed to die-back disease. Wildfires are also common along this coastline. Although this land represents possible dibbler habitat, it is generally more degraded and fragmented than land in managed reserves. Therefore, survey

[12] Dr S. Cooper - Evolutionary Biology Unit - South Australian Museum.

effort was concentrated on areas with a higher level of management. These were often areas managed by CALM's South Coast Region.

Table 6. Summary of the survey for new populations on the south coast

Location	Date	Trap Nights	Animals Caught[a]			
			Dibbler	Ro	Ma	Re
Waychinicup NP	March 95	1,050	0	60	34	52
Two Peoples Bay NR	May/June 95	1,105	0	40	8	3
Waychinicup NP	September 95	1,560	0	134	16	18
Bluff Creek	September 95	200	0	23	2	2
Gull Rock NP	October 95	260	0	28	0	5
TNP - Stony Hill	May/June 95	1,274	0	82	5	0
TNP - Sharp Point	October 95	1,045	0	41	6	6
TNP - Austin Road	January 96	825	0	19	4	2
FRNP - Thumb Peak	January 96	636	2	49	1	0
FRNP - Quaalup	February 96	440	0	33	0	0
FRNP - Bell Track	February 96	540	0	3	0	0
Quaranup	March 96	250	0	25	0	0
Cape Riche	March 96	800	0	32	0	0
SRNP - NE corner	May 96	300	0	3	1	3
Total		**10,285**	**2**	**572**	**77**	**91**

TNP = Torndirrup National Park, FRNP = Fitzgerald River NP, SRNP = Stirling Range NP.
Ro = rodents, Ma = other mammals, Re = reptiles
[a] Excluding recaptures

Table 7. Priority list of sites to be surveyed for dibblers

Location	Comment
Jurien	Two unconfirmed, recent sightings in daylight: In VCL north of Jurien Townsite and crossing a road east of the town. Upright carriage of tail reported both times (see below).
Lesueur National Park and adjacent uncleared land	Despite some trapping, there are large areas of seemingly suitable habitat that are not yet surveyed.
Cape Arid National Park/ Israelite Bay	Sub-fossil material exists from Cape Arid. There are large areas of seemingly suitable habitat that is not yet surveyed
Waychinicup N.P. and Mt. Manypeaks	Many extensive areas of seemingly suitable habitat near to previously recorded capture sites.
"Sandpatch" and Quaranup Peninsula (both VCL adjacent to Torndirrup N.P.)	Near to previously recorded capture site in Torndirrup N.P. Large areas of coastal heath; some is long unburnt and there are some very old *Banksia* stands..
Cape le Grand/Stokes N.Ps. and intervening VCL	Many areas with long unburnt vegetation that seems to be structurally similar to that in Arpenteur N.R. in the 1960s.
Fitzgerald River National Park.	There are many unsurveyed areas with potentially suitable habitat including land near Quaalup[1] and East Mt. Barren as well as along the Drummond and Telegraph tracks that are within wilderness zones.

[1] There has been a lot of work on honey possums in this area but the traps are unlikely to hold healthy dibblers.

In most areas managed by CALM (and this includes most previous dibbler capture sites) access is controlled to reduce the introduction and spread of the plant pathogen, *Phytophthora*

cinnamomi. Access to high risk areas is restricted to times when the soil is dry. This is a considerable, but essential constraint on field work in the wetter months.

Waychinicup National Park
It would seem that Cheyne Beach has suffered a serious decline in habitat quality over the past 10 years (see chapter 3.1.2). However the likelihood of surrounding areas, particularly in Waychinicup National Park, still providing habitat for dibblers is very high. Since dibblers occur in a variety of habitats they may persist at Cheyne Beach but, perhaps, only in low numbers.

Many different plant communities were trapped in this area. Cankers and die-back diseases have changed some sites. However, considerable areas of uninfected vegetation remain and we consider that the area from the Waychinicup River west to Two Peoples Bay Nature Reserve is very likely to contain dibblers.

Bluff Creek area
A site around the mouth of the creek and along the adjacent dune was trapped briefly. This area was selected because of its proximity to Cheyne Beach, its intact stands of *Banksia* similar to that which grew at Cheyne Beach several years ago. However, it has not been baited for foxes. (There is little evidence that foxes are significant predators of dibblers but they may be competing for similar resources. Common fox prey items, such as invertebrates (large beetles, spiders etc), small mammals, lizards and small birds, are also eaten by dibblers.) Further work in this area could locate dibblers.

Torndirrup National Park
The following areas were trapped.

a) Stony Hill
Traps were set on Stony hill because it has the oldest vegetation in the park, including good *Banksia* stands. *Rattus fuscipes* were very common; 82 were tagged. Foxes and cats often interfered with traps. Future trapping in this habitat would be fruitless unless rat numbers could be offset by large numbers of traps.

b) Sharp Point
No dibblers were caught at Sharp Point but the area still holds promise as extensive tracts of undisturbed coastal vegetation extend beyond the park westwards towards West Cape Howe. However, rainfall increases rapidly to the west of Torndirrup and there is no sub-fossil or recent evidence of dibblers west of Torndirrup National Park.

c) Austin Road
This site, on the north eastern side of the hill on which Smith (1990) caught three dibblers in 1988-89, contains many patches of various *Banksia* sp.. It was not surveyed in the follow-up to Smith's dibbler captures (Alford personal communication). It was probably good dibbler habitat until it was burnt by wildfire in January 1997. Smith will continue to monitor the area as part of his ongoing studies.

It is possible that dibblers are no longer extant in Torndirrup National Park. However there is still much undisturbed habitat to be surveyed.

Fitzgerald National Park
The following areas were trapped.

a) Quaalup
Following a reported sighting by Brown[13] in October 1994, *Banksia baxteri* stands along Quaalup road were trapped. Despite many years of research on Honey possums, *Tarsipes rostratus,* Wooller and Richardson[14] (personal communication) have not caught any dibblers. However their pit-traps are shallow enough to allow even a juvenile dibbler to escape. The vegetation seems to be suitable for dibblers. Only a small area was surveyed, and further work would be worthwhile.

b) Thumb Peak
Following the capture of a male dibbler by Barrett[15] in November 1995, this site was trapped in January 1996. Six hundred and thirty six trap nights yielded two more males. The habitat differed from other sites where dibblers have been caught in the park; the vegetation was more sparse and it grew in shallow lateritic soils. The track into this area is rough and access is restricted to prevent spread of plant diseases. Therefore the Management Team decided that the site would not be intensively studied.

c) Moir Track
The prospects of capturing dibblers at this site were considered high because one of Chapman's capture sites was near by and there was an extensive area of unburnt *Banksia* and mallee over heath vegetation. It was trapped (this study) in August 1995 and by Sanders[16] (personal communication) in November 1996. No dibblers were caught and other vertebrate animals were scarce. This is puzzling as the quality of the vegetation would suggest that the site should have had a more prolific vertebrate population.

d) Bell Track
Vegetation at this site suggested that dibblers should have been present but it has been severely affected by dieback disease. Extensive trap lines were placed through the diseased area. *R. fuscipes* was the only mammal caught and there were no visible signs of other rodent species. *Pseudomys occidentalis, P. albocinereus, Mus musculus, Sminthopsis griseoventer*, and dibblers have been caught at adjacent sites (Newbey and Chapman 1995). The die-back infection may have had a substantial impact on these species but the factors limiting their ranges remain unknown.

Two Peoples Bay Nature Reserve
Sub-fossil dibbler bones have been recovered from the area between Rocky Point and the Lakes (Hopkins and Smith in prep.). This area was trapped twice but no dibblers were caught. It is unlikely that dibblers will be found in the wetter areas of the nature reserve. The most suitable vegetation is heathland near the lakes area and towards Rocky Point. Hair tubes were used for a preliminary survey on Coffin Island but there was no follow up because the island appeared to have no small mammals on it. Scales from *Egernia kingii* and sea bird feathers were the only material found in the hair tubes.

[13] L. Brown - CALM - National Park Ranger.
[14] Ron Wooller and Ken Richardson - Murdoch University.
[15] Sarah Barrett - CALM - South Coast Region.
[16] A Sanders - CALM - South Coast Region.

Gull Rock National Park
Traps were set in *Banksia coccinea* stands but no dibblers were caught. This vegetation is similar to that in which dibbers were caught at Cheyne Beach. However the abundance of *R. fuscipes* made the detection of any other species difficult. Similar vegetation occurs in the Water Corporation Catchment Area, adjacent to Two Peoples Bay Nature Reserve. There are many other areas within this park, particularly closer to the coast, that could support dibblers. We recommend further work.

Quaranup Peninsula
The stretch of heath and low Banksia woodland bordering Torndirrup National Park was identified as potential dibbler habitat. Since dibblers had been found in Torndirrup in the recent past, they might still be in nearby areas of long undisturbed habitat. Quaranup provides good quality habitat protected from fires. It is now being baited for foxes. The location of this peninsula provides a unique chance for species to persist within close proximity to urban districts. Time constraints did not enable the survey to reach the end of the peninsula, however it would be a prime location for dibblers and should be a target for any future searches.

Cape Riche, Mettler Lake and Basil Road Nature Reserves
Cape Riche supports a large expanse of possible dibbler habitat but the quality is slowly degrading. Past surveys by local groups revealed few native species. The fire history is one of frequent and often hot burns. The northern end of Mettler Lake Nature Reserve has large stands of long unburnt *Banksia baxteri.* Trap success was disappointing and further survey is probably of limited value.

Basil Road Nature Reserve and Vacant Crown Land on the coast opposite Haul Off Rock and around Cheyne Bay were not trapped because of their fire history. Some long unburnt patches still exist near Mt Melville and elsewhere. They would be worth further study.

3.2. Scope 2: POPULATION DYNAMICS AND HABITAT RELATIONSHIPS

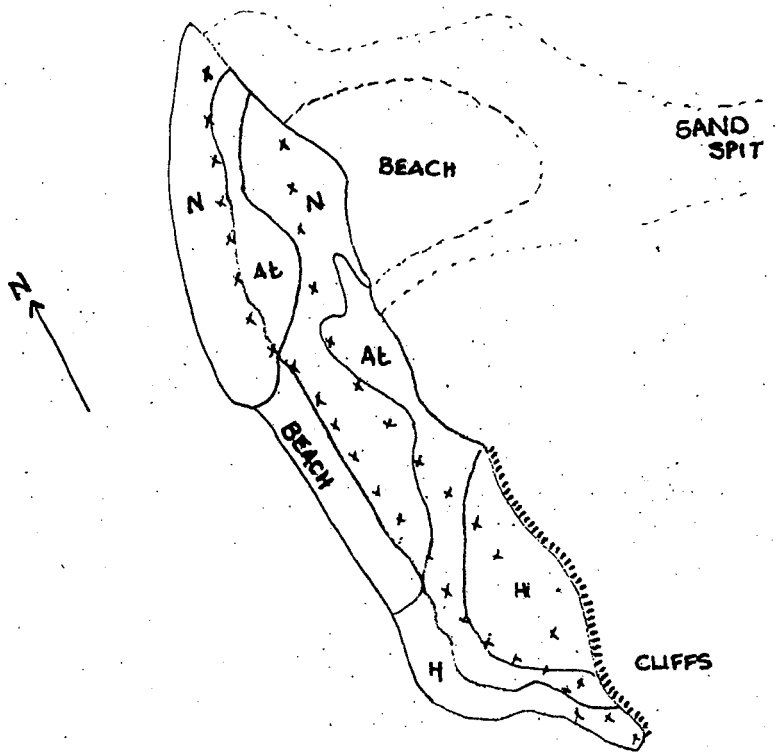
3.2.1. Island populations

Dibbler occurrence in relation to vegetation
Most of Whitlock Island consists of a low limestone plateau covered with low heath growing on shallow soils. The densest and tallest vegetation association is dominated by *Nitraria billardieri.* It grows on a small "dune" system near the centre of the island (Alford and Keighery, unpublished data). Trap results suggest dibblers prefer it to the low heath. Figure 4 shows the vegetation types.

In contrast Boullanger Island is composed entirely of sand apart from a limestone headland. This headland is often separated from the island by winter storms. No dibblers were captured on the headland in December 1994 and it was not trapped in 1995-96.

Boullanger Island is covered by low heath with 50-100 % cover. Burrowing by seabirds seems to have decreased and the vegetation is apparently more dense than it used to be. Alford and Keighery surveyed vegetation in 1985. They reported a canopy cover of 40-90 % (Alford personal communication). The southern end of the island seems to have changed from a low open heath of *Olearia axillaris, Myoporum insulare* and *Scaevola crassifolia* to a shrubland dominated by *Acacia cyclops* over heath. Figure 5 shows the vegetation cover.

Figure 4. Vegetation map and capture sites: Whitlock Island.



* = *P. apicalis* capture locations. **N** = *Nitraria* shrubland, **At** = *Atriplex* heath, **H** = succulent heath.
(Vegetation map adapted from Alford and Keighery, unpublished.)

There are no recorded introduced plant pathogens on the islands and the risk of infection by *Phytophthora* spp. is low because of the alkaline soils and floristic composition of the flora. The islands have not burnt in recorded history. Nevertheless CALM has a fire strategy written specifically to conserve dibblers (Hockey 1996; Appendix 3).

Island Population Density 1995-96

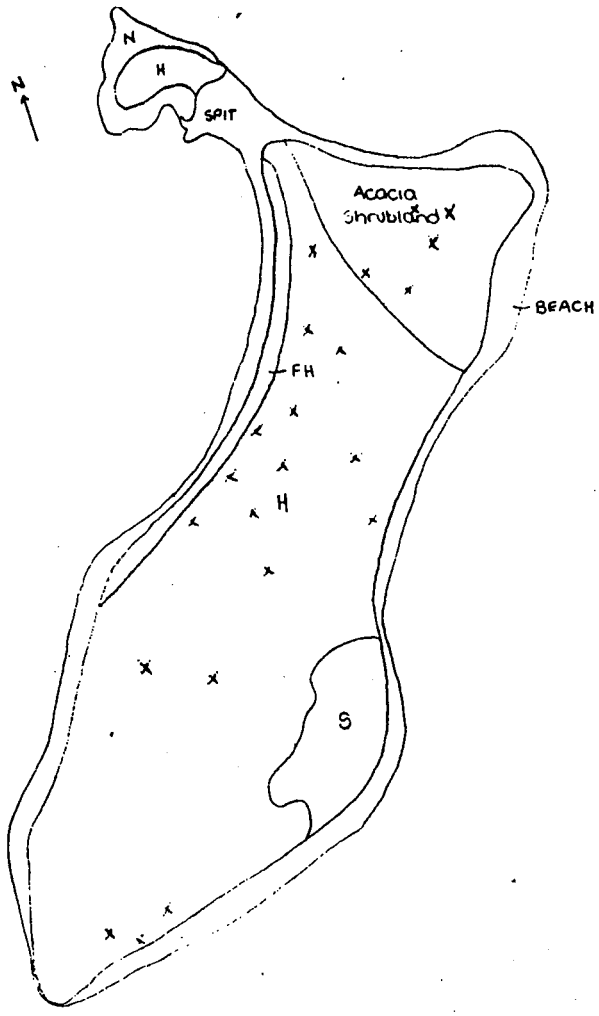
Appendices 4 and 5 show results of trapping between December 1994 and March 1996. There are enough data to indicate some population trends. In comparison to Dickman's 1986-88 results the number of animals on Boullanger Island has decreased. There are insufficient data to reliably calculate the population size now but it is probably about 50% of that recorded by Dickman. However the population on Whitlock is about the same as it was when Dickman worked there.

Future study will compare various factors with data collected by Dickman (for example invertebrate and *Mus musculus* numbers). Our trapping results did not indicate that the mouse numbers had increased and we did not record invertebrate abundance. Another factor that could be important is the apparent decrease in seabird burrows on the island. This may be linked to the increased vegetation cover over the past 10 years.

Male Die-off

Dickman recorded a synchronised male die-off. In 1995 this did not happen. We don't know what occurred in 1996. The male die-off may be related to dibbler population density, possibly through stress-related hormonal change. Male die-off is a well-known strategy of small dasyurid species (Dickman and Braithwaite 1992, Lee and Cockburn 1985). Baczocha and Dickman will publish the data.

Figure 5. Vegetation map and capture sites: Boullanger Island.



* = *P. apicalis* capture locations. **N** = *Nitraria* shrubland, **H** = succulent heath, **FH** = fore dune heath, **S** = succulent shrubland (Vegetation map adapted from Alford and Keighery, unpublished).

Other investigations

Several bait trials were conducted on the islands. Universal bait (rolled oats and peanut butter) was used as a base to which one of the following ingredients was added. Washed traps were also set without any bait. No preference was detected amongst mice or dibblers.

- vanilla essence
- liver digest
- food dye (red and greed colours)
- pilchards in aspic
- honey
- live cockroaches (from the island)
- no additives

Three male dibblers were radio-collared in December 1994. When released they immediately sought shelter in the nearest sea bird burrow. The next day signals from each were detected near their capture sites, apparently underground beneath very dense shrubs. We found no evidence of a tunnel entrance. It is possible that entrances were well concealed or further away from our search area (approximately 2 metres around the point of best reception). None were excavated because that would have damaged the habitat too much.

The Evolutionary Biology Unit in the South Australian Museum, funded by a grant from the BankWest *Landscope* Visa Card, examined the genetic relationship of island and mainland populations. The results were inconclusive because of technical problems (Appendix 1).

3.2.2. Fitzgerald River National Park

Reported dibbler sightings

Many people have reported Dibblers from many areas of the park. All the capture records we are aware of are listed in Appendix 2. People have reported seeing dibblers during the day and at night. It is difficult to verify sightings, but one detail may prove useful. Whether the dibber stopped to watch its observer or darted across a track, most people have commented on the upright carriage of the tail. This posture may signal agitation or a warning. As far as we know, no other similar small mammal carries its tail upright. This characteristic may help verify or even identify dibbler sightings.

Habitat Preferences

Although our knowledge of dibbler habitat requirements is incomplete some broad statements can be made.

Dibblers have been caught in a variety of vegetation types. Chapman and Newbey (1995) give detailed descriptions of vegetation at most of their dibbler locations; new locations are described in less detail in Appendix 6. They seem to prefer vegetation with a dense canopy >1 metre high which has been unburnt for at least 10 years. Other vertebrate species are often relatively numerous at sites where dibblers are caught in FRNP (Sanders and Baczocha in prep.)

Long-term changes to habitat caused by fires or die-back diseases are likely to have long term effects on the local persistence of dibblers. All of the known sites have a high dieback hazard rating but the risk of disease introduction is reasonably low because of proactive management, including access restrictions.

Table 8 suggests that males outnumber females in trapped samples of dibbler populations but the data are not adequate to determine if the difference is significant. In previously reported samples the ratio of males to females has approximated 1:1 (Woolley 1977, Fuller and Burbidge 1987; Smith 1990; Chapman and Newbey 1995).

Table 8. Dibbler sex ratios at various capture locations (excluding recaptures)

Location	% Male	% Female	Total captured
Boullanger Island 1994-96	57.1	42.8	49
Whitlock Island 1994-96	54.6	45.3	75
FRNP 1986-87	50.0	50.0	18
FRNP 1995-96	66.7	33.3	29

This may be important for the management and conservation of dibblers and it emphasises the need to learn more about the reproductive biology, recruitment and mortality of dibblers.

Behavioural Observations

Other observers (Woolley[17] personal communication; Dickman personal communication) have noted that dibbler activity peaks at dawn and dusk. However they may be active during the day and at night. When startled they seek shelter in thick cover. After some time they dart between

[17] Dr. P. Woolley - La Trobe University.

thick vegetation clumps, away from the disturbance. They use their powerful neck and shoulders to "swim" through thick vegetation and strong claws to provide a good grip on branches. They are capable of climbing and may spend a lot of time in trees, particularly flowering banksias. They can travel long distances in little time. One previously-tagged animal was re-trapped and released about 600 meters from its original point of capture. Within half an hour it had returned to first site and re-entered a trap.

Radio tracking is useful in the confined area of a small island and Dickman successfully studied radio-collared dibblers on Boullanger Island. An attempt was made to radio-track four individuals (one female, three males) in FRNP. The results were disappointing because, at night, the animals travelled long distances, soon moving beyond the range of the equipment. (In this terrain the range was sometimes as little as 70 metres.) During the day, even resting animals would move when approached to within 100 metres, but they did not travel far so long as the observer moved quietly. No nesting or shelter sites were found but the animals were apparently resting above ground by day.

Other methods of following dibblers were tried. Fluorescent pigment (Leman and Freeman 1985) was dusted onto animals prior to releasing them. The dust is traceable for up to two days under ideal conditions (Halfpenny 1992). This type of tracking causes less stress to animals and, thus, less change in behaviour (Mikesik and Drickmer 1992). It can show an animal's movements in more detail than radio-tracking (Goodyear 1989, McShea and Gilles 1992). Time limitations and bad weather hampered the work but the potential value of the technique was evident.

Spooling with cotton thread was not useful. The animals are very dexterous, extremely strong and their fur pulls out very easily. Most spools were dumped within five metres of the release point regardless of the attachment position, spool-type or the adhesive used.

Breeding Cycles

Signs of breeding activity (pouch staining, nipple size and activity) were seen in FRNP from February to April 1996. This corresponds with breeding seasons on the islands. A female with eight pouch young (crown-rump = 11 mm) was caught in late May. Adult males have been caught at all times of the year and do not necessarily die-off.

3.3. Scope 3: POTENTIAL THREATS TO DIBBLER POPULATIONS

Mainland populations

Plant diseases

The impact of plant diseases on mainland dibbler populations is unknown. However plant diseases such as die-back caused by *Phytophthora* spp. can have dramatic effects on the floristics and structure of vegetation in areas where dibblers are known to have occurred. These can affect small mammals (Wilson *et al.* 1994). Since dibblers seem to use most strata in their habitat, simplifying the structure and reducing or altering floristic diversity will probably adversely affect dibblers. The effects of these changes need to be investigated and they should be a high priority for future studies.

Predation

Dibblers are taken by owls. A substantial proportion of the sub-fossil bone collections containing dibbler material has accumulated from barn owl pellets deposited in rock shelters (Baynes personal communication). However there is no evidence of the extent to which such native predators affected dibbler populations.

Predation by exotic predators (foxes and cats) is rarely recorded but this may not reflect its importance. Fox and cat densities in the FRNP have probably been fairly high although recent baiting programs should have reduced fox numbers in some areas. A new aerial and ground baiting program, Western Shield, should control foxes throughout FRNP. Cats do not take fox baits but CALM is researching broad scale cat control. Whether these predators are effective hunters of dibblers in FRNP is also questionable. Algar[18] and Kinnear think that neither foxes nor cats would find dibblers easy prey in the dense undergrowth (personal communications). However dibblers may be easy prey after fire or dieback diseases reduce the density and complexity of the vegetation.

Fire

In FRNP Dibblers have been found in areas as young as seven years post fire, albeit near long unburnt vegetation. This contrasts with reports that dibblers only live in vegetation older than 25 years (eg. Chapman and Newbey 1995). Total exclusion of fire from the whole Park is impractical. The FRNP Management Plan recognises the need to be able to restrict wildfires to relatively small blocks and the value of a mosaic of fire ages, including long unburnt areas. Large wildfires have been exacerbated by continuous tracts of old vegetation.

Monitoring dibbler populations in relation to fire histories is an important issue that should be included in future research on the south coast. More information will allow improvements to fire management strategies.

Island populations

Mice

House mice, *Mus musculus*, have colonised Boullanger and Whitlock Islands. Dibblers eat house mice but they obviously did not depend on mice for food before the latter were introduced. We do not know

- if changes to the island ecology have altered the availability of natural dibbler food, transferring dependence by dibblers to mice. (Mice may not be an important diet item)
- if mice compete for resources. Competition with mice for items such as invertebrates may be crucial to dibbler survival or recruitment.
- if mice alter important components of the dibblers' habitat Eg. vegetation structure/floristics or seabird occupation.

The interaction between dibblers and mice will be a priority for future investigations.

Fire

CALM has prepared a Fire Contingency Plan for Boullanger and Whitlock Islands (Hockey 1996; Appendix 3). There will be no prescribed fires on the islands. Any wildfires will be suppressed if possible. The vegetation is not normally very flammable and lightening strikes are probably infrequent. The greatest risk of ignition is with visitors to the islands. The Recovery Plan will prescribe salvage actions if fires seriously threaten either population and interim provisions have been decided.

3.4. Scope 4: INTERIM RECOVERY PLAN

At the beginning of 1996 a draft Interim Recovery Plan was prepared and a Recovery Team appointed. Tony Start is chair of the Recovery Team. Table 9 shows the membership at the end of 1996. An innovative component is the appointment of two interstate people as "Corresponding Members". Drs. Chris Dickman and Pat Woolley have extensive experience of dibblers and other dasyurids.

[18] Dr. D. Algar - CALM - Science and Information Division.

Table 9
Membership of the Dibbler Recovery Team.

Natasha Baczocha	Consultant Scientist	Dibbler Project Researcher
Mark Bradley	Perth Zoo	Director of Research
Andrew Burbidge	CALM WATSCU	Director of WATSCU
Chris Dickman	Uni. Sydney (Corresponding Member)	Scientist with dibbler experience
Kelly Gillen	CALM South Coast Region	Leader, Nature Conservation Program
Keith Hockey	CALM Midwest Region	Senior Ranger, Cervantes
Nathan McQuoid	CALM South Coast Region	Ranger in Charge, Fitzgerald River NP
Vic Smith	Community member	Experience with Dibblers, retired vet
Tony Start	CALM, SID	Supervising Scientist, Dibbler Project
Sally Stephens	Environment Australia, (TS&CS)	Project Officer for Dibbler project
Pat Woolley	La Trobe Uni (Corresponding Member)	Scientist with dibbler experience

4 PUBLICITY

Public interest has been generated by articles in local papers and the involvement of local volunteers. Copies of the articles are held in the Albany CALM office and on CALM files. A poster has been displayed in appropriate CALM offices and at Jurien Expo and a pamphlet is widely available through CALM Offices. Promotion of public awareness of the project has been aimed at local interest groups living near the known dibbler sites. The similar appearance of dibblers to other common species, their elusive nature and small size as well as their rarity are probably reasons why there has been little public response to requests for sightings.

Three papers are in preparation by N. Baczocha.

- One, to be co-authored with C.R. Dickman and G. Friend, will discuss male die-off
- One will present findings of the work carried out under this project on the south coast.
- One, to be co-authored with A. Sanders, will document the occurrence of dibblers within the FRNP

5 FUTURE DIRECTIONS

The management Team has recommended to Environment Australia that work in 1997 should concentrate on the island populations and the setting up of a captive breeding program. The reasons are

On the mainland it is very difficult to study dibbler populations and there is probably little that can be done (that is not already being done) to manage recovery of dibblers because

- populations seem to pop up and vanish within a year or two of discovery
- dibblers are probably widespread, if patchily distributed, in FRNP
- Recovery Plan actions within FRNP would include feral predator control. Foxes are now baited from the air throughout FRNP. CALM is researching broad scale control methods for cats and will apply them when available. Until then, nothing can be done to significantly reduce cat populations. (This applies to most other dibbler sites on the south coast.) The effects of the baiting programs will be monitored
- Recovery Plan actions within FRNP would include fire management. The FRNP Management Plan already provides for fire protection to preserve habitat of several

vulnerable species requiring long-unburnt vegetation. Dibblers were amongst the species of concern when the plan was written

- access constraints in FRNP, and resource limitations, limit studying dibblers by recapture techniques. It is unlikely that substantially more information of use to population management can be acquired in the short-term (and the project has only one year to run).
- Recovery Plan actions would probably prescribe translocations. However we would have difficulty identifying suitable sites because the patchy and, often, transient distribution of dibblers makes it hard to locate sites where they are known to have become extinct
- we do not have the capability to follow radio-collared dibblers and other means of following them are short-term (hours, not days). Thus we would not be able to monitor translocated animals

In conclusion, it is difficult to envisage work for another year on the south coast significantly improving our ability to manage dibbler populations.

On the islands. It is relatively easy to study dibbler populations because they are geographically restricted. However, there are causes for concern and management decisions could address these if we have the appropriate knowledge. These include

- the vulnerability of two small populations marooned on small islands close inshore, adjacent to a popular holiday town
- the significance of the populations to the genetic diversity of the species (and possible taxonomic implications). They are the only representatives of the species known to have survived on the west coast
- the decline of the Boullanger island population in the last ten years
- the effects of introduced house mice, declining seabird colonies and weeds
- the need for more basic biological knowledge, (particularly the breeding system) of dibblers.

We can achieve significant increases in our knowledge of vulnerable populations and basic dibbler biology from the proposed program.

6. REFERENCES

Archer, M. and Baynes, A., 1973. Prehistoric mammal faunas from two small caves in the extreme south west of Western Australia. *Journal of the Royal Society of Western Australia* **55:** 80-89

Baynes, A., 1987. The original mammal fauna of the Nullarbor and southern peripheral regions: Evidence from skeletal remains in superficial cave deposits. In: McKenzie, N.L. and Robinson, A. C. (eds) *A biological survey of the Nullarbor region South and Western Australia in 1984.* SA Department of Environment and Planning, Adelaide and WA Department of Conservation and Land Management, Perth: 401-402.

Burbidge A.A., 1993. Conservation biology in Australia: Where should it be heading, will it be applied? In: Moritz, C. and Kikkawa, J. (eds.). *Conservation Biology in Australia and Oceania.* Surrey Beatty and Sons, Chipping Norton: 27-37.

Butler, W.H. and Merrilees, D., 1971. Remains of *Potorous platyops* (Marsupialia, Macropodidae) and other mammals from Bremer Bay, Western Australia. *Journal of the Royal Society of Western Australia*, **54(2)**: 53-58.

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 study of Parantechinus apicalis using DNA sequence markers.* Unpublished report to Western Australian Threatened Species and Communities Unit, Western Australian Department of Conservation and Land Management.

Dickman, C.R. and Braithwaite, R.W., 1992. Postmating mortality of males in the Dasyurid marsupials, *Dasyurus* and *Parantechinus*. *Journal of Mammalogy* **73**: 143-147.

Fuller, P.J. and Burbidge, A.A. 1987. Discovery of the Dibbler *Parantechinus apicalis* on islands at Jurien Bay. *Western Australian Naturalist* **16**: 177-181.

Goodyear N.C., 1989. Studying fine-scale habitat use in small mammals. *Journal of Wildlife Management.* **53(4)**: 941-946.

Halfpenny J.C., 1992. Environmental impacts of powder-tracking using fluorescent pigments. *Journal of Mammalogy* **73(3)**: 680-682.

Hockey K., 1996. *Fire Occurrence Contingency Plan, Boullanger and Whitlock Islands, Jurien Bay.* Unpublished Operational Plan, Western Australian Department of Conservation and Land Management. Geraldton.

Hopkins A.J.M. and Smith G.T.S. (eds), in prep. *The Natural History of Two Peoples Bay Nature Reserve.* Western Australian Department of Conservation and Land Management.

Lee, A.K., Bradley, A.J. and Braithwaite, R.W., 1977. Corticosteriod levels and male mortality in *Antechinus stuartii*. In: Stonehouse and Gilmore (eds.). *The biology of marsupials.* MacMillan, London: 209-220.

Lee, A.K. and Cockburn, A., 1985. *Evolutionary ecology of marsupials.* Cambridge University Press, Cambridge, UK.

Lynam, A.J., 1987. *Inbreeding and juvenile dispersal in insular populations of two dasyurid marsupials; the dibbler,* Parantechinus apicalis, *and the Grey-bellied Dunnart* Sminthopsis griseoventer. Honours Thesis, University of Western Australia.

McShea W.J. and Gilles A.B., 1992. A comparison of traps and fluorescent powder to describe foraging for mast by *Peromyscus leucopus*. *Journal of Mammalogy* **73(1)**: 218-222.

Mikesic D.G. and Drickmer L.C., 1992. Effects of radio-transmitters and fluorescent powders on activity of wild house mice (*Mus musculus*). *Journal of Mammalogy* **73(1)**: 663-667.

Morcombe, M.K., 1967. Rediscovery after 83 years of the Dibbler, *Antechinus apicalis*. *Western Australian Naturalist* **8**: 135-142.

Muir, B.J., 1985. The Dibbler (*Parantechinus apicalis*: Dasyuridae) found in the Fitzgerald River National Park, Western Australia. *Western Australian Naturalist* **16**: 48-51.

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

Sanders A. and Baczocha N., in prep. The fauna of the Yilgarn Block, Fitzgerald River National Park, WA.

Smith, V.W., 1990. The terrestrial vertebrate fauna of the Torndirrup National Park. *Western Australian Naturalist* **10**: 103-111.

Whittell, H.M., 1954. John Gilbert's notebook on marsupials. *Western Australian Naturalist* **4**: 104-114.

Wilson B.A., Newell G., Laidlaw W.S. and Friend G., 1994. Impact of plant diseases on faunal communities. *Journal of the Royal Society of Western Australia* 77: 139-143.

Woolley, P.A., 1971. Observations on the reproductive biology of the Dibbler, *Antechinus apicalis* (Marsupialia: Dasyuridae). *Journal of the Royal Society of Western Australia* **54**: 99-102.

Woolley, P.A., 1977. In search of the Dibbler, *Antechinus apicalis* (Marsupialia: Dasyuridae). *Journal of the Royal Society of Western Australia* **59**: 111-117.

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., 1991. Reproductive pattern of captive Boullanger Island Dibblers, *Parantechinus apicalis* (Marsupialia: Dasyuridae). *Wildlife Research* **18**: 157-163.

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**: 241-245.

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Appendix 1

A population genetics study of *Parantechinus apicalis* using DNA sequence markers

By Steven Cooper & Jan Birrell
Evolutionary Biology Unit, South Australian Museum

Aim

Investigate the species status of mainland forms of *Parantechinus apiclais* using a mitochondrial DNA (mtDNA) sequence marker and test the hypothesis that *P. apicalis* compromises a single species.

Introduction

A previous allozyme survey of *P. apicalis* found no genetic differences between island and mainland forms of *P. apicalis* at 46 loci (Mark Adams, unpublished data). In addition, it was found that there were was no allozyme variation within the Boullanger island population. These results imply that a hypothesis that *P. apicalis* comprises a single species can not be rejected. However, low levels of variation at allozyme loci have been commonly reported for dasyurid marsupials (Baverstock *et al*, 1984), and hence allozyme electrophoresis may not reveal speciation events that have occurred more recently during the evolution of dasyurids. The d-loop region of the mitochondrial genome is known to evolve rapidly in eutherian mammals relative to single copy nuclear DNA and allozymes. It was therefore chosen as a suitable genetic marker to investigate the species status of island and mainland forms of *P. apicalis.*

Prior to the commencement of this project we used the polymerase chain reaction (PCR) procedure to amplify and sequence the d-loop region from four other dasyurid genera, *Smithopsis, Planigale, Antechinomys* and *Dasycercus.* These were used as reference sequences for an analysis of the d-loop region in *P. apicalis.*

Results

Initially, DNA was extracted from 9 ear punch samples, including 3 each from Fitzgerald River National Park, Boullanger Island and Whitlock Island using phenol-chloroform based extraction procedure. Additional ear punch tissue was available from each of these populations and was stored in alcohol.

PCR primers and conditions used to amplify the d-loop region in *Smithopsis* were initially tested with *P. apicalis* DNA but failed to amplify a specific d-loop product. A combination of primers, previously designed from other mammalian mitochondrial DNA sequences, were therefore tested and PCR amplification of an approximately 500 bp DNA fragment was obtained for one set of primers (designated m3 and m7). This fragment was amplified and sequenced from the 9 DNA samples referred to above. Three allelic sequences were detected, each differing by between 1 and 2 nucleotides. Within each population individuals were found to have identical alleles.

Comparison of this sequence, using pairwise DNA alignment program, with d-loop sequences from *Sminthopsis* and *Planigale* showed no significant regions of homology. These comparisons suggest that this *P. apicalis* sequence was not the d-loop region and is most likely to be nuclear in origin. To test this possibility DNA was extracted from frozen *P. apicalis* liver tissue (donated by the SA Museum) using a procedure that preferentially enriches for mitochondrial DNA (mtDNA) over nuclear DNA. The m3/m7 primers were found to amplify 2 fragments from this DNA sample, one of which was the same size as the fragment previously sequenced. A second combination of d-loop primers (m20/m7) were found to amplify a single 650 bp fragment from the enriched mtDNA and this fragment was purified and DNA sequenced. The sequence obtained showed significant regions of homology with d-loop sequence from *Sminthopsis crassicaudata* and *Planigale gilesi* and no regions of homology with the sequence previously derived from *P. apicalis* (Fig 1.).

The same m20/m7 primer combination, however, failed to amplify a specific PCR product from DNA extracted from ear punch tissue. To obtain d-loop sequence data from these samples, two P. apicalis-specific d-loop primers were designed and synthesised. Recent experiments carried out to optimise PCR amplifications using these primers, resulted in sequence being obtained from on either specimen. The 8 other DNA samples obtained from skin tissue failed to show PCR amplification of the predicted d-loop product. To date, d-loop sequence data has been obtained from two *P. apicalis* individuals, both of which were collected from Boullanger Island.

Discussion

Due to a number of major difficulties we have been unable to obtain mtDNA sequence data from mainland WA and Whitlock Island populations of *P. apicalis* and, therefore, can not address the hypothesis that island and mainland forms of *P. apicalis* comprise a single species. A possible reason for these technical problems is that mtDNA is not present in high copy number in the skin cells of ear punch tissue. In contrast, liver tissue provides a rich source of mtDNA and was used successfully to PCR amplify the d-loop region from *P. apicalis*. DNA samples are currently being extracted, using mtDNA enrichment procedure, from frozen liver tissues stored at the SA Museum and will be used to obtain d-loop sequence data from a mainland specimen of *P. apicalis* and *P. bilarni*. Liver tissue from a Whitlock Island specimen of *P. apicalis* is currently unavailable. These data, although limited, will enable us to assess the level of variation in the d-loop region between the island and mainland forms of *P. apicalis* and determine whether further sample would be necessary to complete the study.

Using the primer combination m7/m3 sequence data was also obtained from a DNA fragment that is likely to be nuclear in origin. Three allelic sequence variants were detected each of which were geographically localised. Although preliminary in nature these results suggest possible nuclear DNA differences between each of thee populations. However, further data is required to estimate the frequency of each allele in the 3 populations and test this possibility. Techniques can be developed t identify the variable nucleotide sites in each allele without the use of DNA sequencing and would greatly facilitate the use of DNA marker in future population studies of *P. apicalis.*

References

Baverstock, P.R., Adams, M. & Archer, M. (1984) Electrophoretic resolution of species boundaries in the *Sminthopsis murina* complex (Dasyuridae). *Aust. J. Zool.* **32** : 823-832.

Fig. 1. DNA sequence alignment of a portion of the d-loop from *P. apicalis* (dibblerm7/) with d-loop sequences from *Planagale gilesi* (6/12Pgil-w) and *Sminthopsis crassicaudata* (4/17psmb9).

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dibblerm7/      CACTTTTATTTCTTCAGAATTCACTAACATATGTATTAATATATATTTAT
6/12Pgil-w      CA-----A-GT------AAATTACATATA-ATGAATTAATAAATATTTAT
4/17psmb9       CA-----ATGT------AAATTACATATC-ATGTTACAATAAATATTTAT
                **     *  *      ** * **  *   ***    **** ********

dibblerm7/      GTATATAGAGCATACATTTATATACCTCTAGCATATATTAATATACATAT
6/12Pgil-w      GTATATAGAGCATACATTTATATACCTCTAGCATATAATAATATACATAT
4/17psmb9       GTATATAGAGCATACATTTATTTACCACTAGCATATAATAATATACATAA
                ********************* **** ********** **********

dibblerm7/      TAACTAAGTATTACTAAATACATTAATATATTATATTGCTATAAATTAAT
6/12Pgil-w      TTATCATACATTACTAAATACATTAATTTAA-GTATTATTAATAATGA-T
4/17psmb9       TAATCATATATTACTAAATACATTAATATAA-GTATTACTAATAATTA-T
                * *  *   ******************** **   ****  **  *** * *

dibblerm7/      ATAAATACATTCATATCATAAATTAATATAATCTCATAATAGTACATAAT
6/12Pgil-w      TTAA-TACATGCATATCTTAACCTAATATA-TATCATA-TAGTACATACT
4/17psmb9       ATAA-GACATGCAGATCATTACCTAATAAA-TCTCATA-TAGTACATAAT
                 ***  **** ** *** * *  ***** * * ***** ********* *

dibblerm7/      ACATAATATGTATATATTACATAAGACATATAATGTTGGCGTACATAGAC
6/12Pgil-w      ACATATTATGTATATATTACATAAGACATTACATGTTGGCGTACATAGAC
4/17psmb9       ACATAATATGTATATATTACATAAGACATTATATGTTGGCGTACATAGAC
                ***** ************************   ******************
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Appendix 2

P. apicalis data collected from FRNP 1985 - 1996

SITE	DATE	ID #	N/R/RT	SEX	WT (g)	HL (mm)	COMMENTS
12A	8/16/85		N	M	23		# DIED IN CAPTIVITY, sent to WA Museum
18A	8/20/85		N	F	?		# 8 DISTENDED TEATS
18A	8/22/85		N	M	28.5		# PHOTOGRAPHED AND RELEASED
18A	8/24/85		RT	M	28.5		#
32B	9/29/85		N	M	60		#
32B	12/8/85		RT	M	119		#
18A	2/8/86		N	F	39		# KEPT FOR PHOTO, RELEASED 11/2/86
14A	2/10/86		N	F	49.5		# PIT TRAPPED
18A	2/11/86		N	M	77		# PIT TRAPPED, KEPT FOR PHOTO, RELEASED 13/2/86
17B	2/12/86		N	F	76.5		# PIT TRAPPED, 8 SMALL TEATS
51A	2/15/86		N	M	93		# PIT TRAPPED
51A	2/15/86		RT	M	106		# PIT TRAPPED
8B	2/19/86		N	M	115		# PIT TRAPPED
19B	3/7/86		N	F	67		# PIT TRAPPED
51A	11/28/86		N	F	76.5		# PIT TRAPPED
51A	11/29/86		N	F	48.5		#
51A	12/2/86		N	M	71.5		# PIT TRAPPED, ORANGE MITES AROUND ANUS
18A	12/16/90		N	M	82	43.0	CAUGHT BY L. WHISSON
12A	11/10/94		N	?	?		PIT TRAPPED BY J. KINNEAR
TWIN FIRE BREAK	11/8/95	1	N	M	58	39.1	COLLARED
FR9	11/9/95	3	N	F	40	39.8	COLLARED
TWIN FIRE BREAK	11/10/95	4	N	M	61.5	40.4	COLLARED
FR9	11/10/95	5	N	M	63	39.3	COLLARED
TWIN FIRE BREAK	11/11/95	6	N	M	75	41.1	
TWIN FIRE BREAK	11/11/95	7	N	F	44	39.1	NO POUCH DEV
FR9	11/12/95	10	N	M	77		
TWIN FIRE BREAK	11/12/95	8	N	F	43	37.8	
TWIN FIRE BREAK	11/12/95	0	N	0	0		ESCAPED
FR9	11/12/95	9	N	M	94	39.3	
FR9	11/13/95	3	RT	F	42		COLLAR TIGHTENED
TWIN FIRE BREAK	11/13/95	11	N	M	80	41.6	
TWIN FIRE BREAK	11/14/95	4	RT	M	58		OLD INJURY ON BACK OF SKULL
THUMB PEAK	11/15/95	12	N	M	70	41.5	CAUGHT IN CAGE BY S. BARRETT ON TWIN BAYS TRACK
TWIN FIRE BREAK	11/15/95	1	RT	M	60		
FR9	11/15/95	13	N	F	62	41.7	ELONGATED NIPPLES (8)
FR9	11/15/95	5	RT	M	75		COLLAR REMOVED
TWIN FIRE BREAK	11/17/95	8	RT	F	45		
THUMB PEAK	1/22/96	1	N	M	104	46.1	
THUMB PEAK	1/25/96	2	N	M	105	45.1	CAUGHT NEAR LOCATION OF NO. 11

SITE	DATE	ID #	N/R/RT	SEX	WT (g)	HL (mm)	COMMENTS
FR9	2/5/96	3	R	F	66	42.7	COLLAR RETRIVED. NO POUCH DEV
TWIN FIRE BREAK	2/5/96	16	N	M	118	44.8	
TWIN FIRE BREAK	2/22/96	17	N	F	68	43.2	CLOACA SWOLLEN, NIPPLES RECESSED, FAINT POUCH STAINING
TWIN FIRE BREAK	2/22/96	8	R	F	65	42.0	NIPPLES RECESSED, NO POUCH STAINING, CLOACA SWOLLEN
TWIN FIRE BREAK	2/22/96	16	R	M	125	46.0	
TWIN FIRE BREAK	2/23/96	16	RT	M	120		MOVED 600m IN 20 MIN
TWIN FIRE BREAK	2/23/96	16	RT	M	115		
TWIN FIRE BREAK	2/23/96	18	N	M	91	45.0	RIGHT CANINE WORN
TWIN FIRE BREAK	2/23/96	19	N	M	117	47.2	
TWIN FIRE BREAK	2/23/96	20	N	M	121	47.6	CLOACA SWOLLEN, R FLANK WOUNDED, COVERED IN SMALL TICKS
TWIN FIRE BREAK	4/17/96	19	RT	M	94	44.7	IN EXCELLENT CONDITION
TWIN FIRE BREAK	4/18/96	21	N	F	71	41.1	POUCH DEV NIPPLES RECESSED
TWIN FIRE BREAK	/96	6	R	M	84	42.4	
TWIN FIRE BREAK	5/28/96	16	R	M	105	34.5	ORANGE EAR MITES AT BASE OF EAR
TWIN FIRE BREAK	5/29/96	16	RT	M	108		
TWIN FIRE BREAK	5/30/96	16	RT	M	108		
TWIN FIRE BREAK	5/30/96	16	RT	M	113		MAY HAVE BEEN No. 6
TWIN FIRE BREAK	5/30/96	25	N	F	85	43.3	8 PY CR 11.5 CAUGHT LATE PM (1700HRS)
TWIN FIRE BREAK	9/13/96	8	R	F	62	38.9	LACTATING, 8 ACTIVE NIPPLES
TWIN FIRE BREAK	9/13/96	6	R	M	90	42.4	SPOOLED PM
TWIN FIRE BREAK	9/13/96	22	N	F	32	36.1	JUVENILE, SPOOLED PM
TWIN FIRE BREAK	9/14/96	24	N	F	32	35.6	JUVENILE
TWIN FIRE BREAK	9/14/96	23	N	M	37	34.8	JUVENILE, BROKEN TAIL 1/2 WAY DOWN
TWIN FIRE BREAK	10/23/96	26	N	M	71	43.2	NOT THIS YEAR'S YOUNG
TWIN FIRE BREAK	10/23/96	6	R	M	100	43.3	
TWIN FIRE BREAK	10/24/96	26	RT	M	82		
TWIN FIRE BREAK	10/25/96	27	N	M	70	43.1	
TWIN FIRE BREAK	10/25/96	26	RT	M	70	42.0	

SITE	DATE	ID #	N/R/RT	SEX	WT (g)	HL (mm)	COMMENTS
12A	10/29/96	28	N	M	68.5	40.0	*
12A	10/30/96	29	N	F	48.0	37.0	*ORANGE MITES AROUND ANUS
7km E Quiss Rd	11/1/96	30	N	M	60.0	40.8	*ORANGE MITES AROUND ANUS
3km E 14A	11/1/96		N				*ESCAPED
51A	11/8/96	31	N	M	55.5	39.0	*ORANGE MITES AROUND ANUS

Caught by A. Chapman
* Caught by A. Sanders
~ the date is written month/day/year to show seasonal differences

N = not previously caught, **R** = recapture from a previous trip, **RT** = recapture from same trip
HL = Head length

Appendix 3

FIRE OCCURRENCE CONTINGENCY PLAN

BOULANGER and WHITLOCK ISLANDS

JURIEN BAY

1.0 FORWARD

This fire control contingency plan has been prepared to meet a requirement identified by the Interim Recovery Team at their inaugural meeting on 2 April 1996.

Although the effects of a major fire occurrence on the fauna populations and in particular dibblers inhabiting Boulanger and Whitlock Islands is relatively unknown, it is generally accepted that such an incident could have drastic effects on the future viability of the populations.

As a result, a policy of fire exclusion has been decided upon and will remain so until such times as further information comes to light to support the contrary.

The purpose of this plan is to detail the response procedure identified as practical in regards to resources and the obvious geographical restrictions imposed by the very nature of the islands themselves, whilst considering the limited resources of the CALM Moora District.

2.0 PREVENTION

Objective: To exclude fire from Boulanger and Whitlock islands.

Strategies:

- Continue to follow Moora District policy regarding the use of wood fireson CALM estate.
- Discourage use of the islands, particularly for activities that are synonymous with the use of fire. e.g. camping, bbqs, etc.
- Remove any evidence of the use of fire during routine visits. eg fire places, ashes, etc.

3.0 PREPAREDNESS

Objective: To ensure that adequate planning and preparation .is given with regard to combating a fire occurrence on the islands.

Strategies:

- Ensure CALM Moora District staff are aware of this plan and the role they play in it.
- Encourage the local community to report any fire occurrences to CALM as soon as possible.
- Ensure the inflatable boat stationed at Cervantes is maintained in an operational state for rapid deployment.
- Prepare a list of equipment required to be taken to the island for the initial reconnaissance and suppression

4.0 RESPONSE

Objective: Were possible attend fires that occur on the islands and minimise the area burnt.

4.1 On report of fire :

- Notify the District Manager or the "Fire Emergency Availability" Officer (FEA)
- In consultation with the District Manager or the FEA Officer Moora arrange for a reconnaissance of the fire. (Consideration will be required in regards to the time of day or night and weather conditions to ensure safe passage to the island.)
- Dispatch 2 officers in the boat stationed at Cervantes to the island equipped with :

a) 2 x Rake Hoes .
b) 2 X Knapsacks.
c) 1 x hand held CALM VHF radio.

4.2 On arrival at the island:

- Assess the situation and report back to the District Manager or FEA Officer.
- Arrange for any assistance that may be required to suppress the fire.
- If practical begin work with hand tools. ie Knapsacks and rake hoes.

4.3 District Manager/FEA Officer Role

- Provide incident control infrastructure.
- Notify Director of WATSCU and the Supervising Scientist, Dibbler Project of the fire occurrence and status of events.
- Notify Regional Duty Officer of situation.

Appendix 4

Trapping results from ***P. apicalis*** captures on Boullanger Island ~ December 1994 - March 1996

Date	Id	N/R/Rt	Sex	WT (g)	HL (mm)	Comments
12/7/94	1	N	M	50	36.9	
12/8/94	7	N	M	35	36.0	
12/8/94	8	N	F	32	37.2	NO TEAT/POUCH DEV
12/8/94	50	N	F	34	39.1	NO TEAT/POUCH DEV
12/8/94	6	N	M	49	37.4	COLLARED
12/8/94	5	N	M	44	37.1	COLLARED
12/8/94	4	N	M	45	36.9	COLLARED
12/8/94	3	N	F	47	36.9	3 DEV TEATS (2 RECESSED)
12/8/94	2	N	F	33	35.6	NO POUCH DEV 3+ NIPPLES
12/9/94	51	N	M	42	36.0	
12/9/94	10	N	M	50	39.1	
12/9/94	52	N	F	34	29.5	NO TEAT/POUCH DEV
12/9/94	9	N	F	40	35.4	
2/8/95	11	N	M	37	38.8	
2/8/95		N	F	42	35.9	DEAD IN TRAP ,NO POUCH/TEAT DEV
2/8/95		N	M	80	40	DEAD IN TRAP
2/8/95		N	M	65	39.3	DEAD IN TRAP
2/9/95	13	N	M	68	41.9	
2/9/95	12	N	F	56	38.3	8 TEATS, DEV POUCH
2/9/95	14	N	F	46	37.9	8 TEATS, NO POUCH DEV
3/8/95	2	R	F	57	38.3	DEV POUCH, 8 DEV NIPPLES
3/9/95	17	N	F	43	26.8	NO POUCH DEV, 8 NIPPLES
3/9/95	16	N	F	43	35.0	NO POUCH DEV, 8 NIPPLES
3/10/95	18	N	M	83	39.3	LARGE ADULT MALE
3/10/95	14	R	F	48	37.2	LITTLE POUCH DEV, ID LOOKS LIKE #24
4/4/95	80	N	M	50.5	39.7	
4/5/95	24	R	F	38.5	37.0	NO POUCH DEV
4/6/95	12	R	F	46	38.3	POUCH STAINING & DEV, GROWTHS ON EAR
4/7/95	4	R	M	46.5	38.7	
4/7/95	20	N	M	53	39.8	
4/7/95	24	RT	F			
4/7/95	19	N	M	50.5	37.7	VERY BONY/SWOLLEN ANUS
4/7/95	21	N	F	44	37.7	POUCH STAINING & DEV/OLD BREAK 2/3 FROM BASE OF TAIL
9/5/95	20	R	M	51	36.9	
9/5/95	25	N	F	36	36.5	1 EXTENDED NIPPLE
9/6/95	10	R	F	48	37.7	MAYBE #20? 8 ACTIVE NIPPLES
9/6/95	26	N	M	24	31.0	JUVENILE
9/8/95	20	RT	F	47	36.9	8 LACTATING NIPPLES

Date	Id	N/R/Rt	Sex	WT (g)	HL (mm)	Comments
12/6/95	63	N	M	68	39.0	
12/6/95	66	N	F	35	34.5	SCAR BETWEEN EYES
12/6/95	64	N	M	48	37.0	
12/6/95	62	N	M	60	38.1	
12/6/95	67	N	F	37	36.0	NO POUCH DEV
12/6/95	60	N	M	46	37.7	
12/6/95	59	N	M	54	38.2	
12/6/95	58	N	F	37	35.3	NO POUCH DEV
12/6/95	57	N	F	34	35.2	NO POUCH DEV
12/6/95	56	N	F	34	35.6	NO POUCH DEV
12/6/95	55	N	M	57	38.4	
12/6/95	54	N	M	49	38.2	
12/6/95	53	N	M	55	40.4	
12/6/95			M	52		ESC
12/6/95	65	N	M	58	37.8	
12/7/95	63	RT	M	65		
12/7/95	21	R	F	50	39.2	TAIL BROKEN 2/3 FROM BASE TAIL, NO POUCH ACTIVITY
12/7/95	23	N	F	39	38.1	NO POUCH DEV, UNBRED
12/7/95	22	N	M	55	39.7	
12/7/95	69	N	M	53	39.2	
12/7/95	68	N	F	50	35.3	REGRESSED POUCH, 7 NIPPLES
12/7/95	67	N	M	52	36.0	LUMP ABOVE LEFT EYE/NOSE
12/7/95	70	N	F	40	36.5	
3/26/96	2	R	F	53	38.3	SWOLLEN NIPPLES, POUCH DEV
3/27/96	20	R	M	75	42.1	
3/27/96	2	RT	F	58		
3/28/96	67	R	M	70	40.9	GOOD CONDITION
3/28/96	2	RT	F	55		

* the date is written month/day/year to show seasonal differences

N = not previously caught, **R** = recapture from a previous trip, **RT** = recapture from same trip

HL = Head length

Appendix 5

Trapping results from *P. apicalis* on Whitlock Island ~ February 1995 - March 1996

Date	Id #	N/R/Rt	Sex	WT (g)	HL (mm)	Comments
2/7/95	53	N	F	36.5	34.1	
2/7/95	50	N	M	58	36.9	
2/7/95	51	N	F	35.5	32.4	NO POUCH/TEAT DEV
2/7/95	52	N	M	47.5	34.5	
2/8/95	51	RT	F			
2/8/95		N	F	43		ESCAPED
2/8/95	55	N	M	52	37.5	
2/8/95	64	R	M	63	37.4	EARS HAD OLD NOTCHES, NOT OURS !!
2/8/95	54	N	M	65.5	37.5	
2/8/95	58	N	M	47	35.8	
2/8/95	57	N	F	46	34.1	DEV POUCH WITH MITES (left ear tear bw 2 &4)
2/8/95	56	N	M	48	36.5	
2/8/95		N	F	36	35.3	NO TEAT/POUCH DEV, DEAD IN TRAP
2/8/95	59	N	F	40	37.4	NO TEAT/POUCH DEV
2/8/95	60	N	M	36	34.3	SEMI SCROTAL
2/9/95	62	N	M	36	35	SEMI SCROTAL
2/9/95	64	N	M	51	35.6	
2/9/95	65	N	F	44	35.3	DEV POUCH
2/9/95	66	N	F	35	34.2	NO TEAT/POUCH DEV
2/9/95	63	N	F	47	33.3	black specks (ticks ?) in pouch ~ <1mm diam
2/9/95	61	N	M	37	34.1	SEMI SCROTAL
3/8/95						ESCAPED
3/8/95	67	N	F	41	35.8	NO POUCH DEV
3/8/95	66	R	F	39	35.4	NO POUCH DEV
3/8/95	51	R	F	38	34.6	NO POUCH DEV
3/8/95	70	N	M	64	37.3	
3/8/95	68	N	F	45	35.3	VERY SLIGHT POUCH DEV
3/8/95	56	R	M	53	36.7	
3/8/95	69	N	F	43	36.1	DEV POUCH (2ND YEAR ?)
3/8/95		R	F	36.5	34.3	NO POUCH DEV
3/9/95	71	N	M	66	37.8	
3/9/95	72	N	M	56	36.6	
3/10/95	71	RT	M	61		
3/10/95	73	N	M	48	36.4	
3/10/95	59	R	F	34	35.1	NO POUCH DEV
3/10/95	66	RT	F	37		
3/10/95	76	N	M	52	39.2	FLEAS?
3/10/95	75	N	F	45	36.7	SOME POUCH DEV
3/10/95			M			ESCAPED
3/10/95	74	N	M	57	37.5	

Date	Id #	N/R/Rt	Sex	WT (g)	HL (mm)	Comments
4/4/95		ESC				ESCAPED
4/4/95	2	N	F	34	34.2	POUCH DEV
4/4/95	1	N	F	33	34.9	POUCH DEV
4/4/95	4	N	F	52	35.9	POUCH DEV & STAINING
4/4/95	3	N	F	35	36.4	SOME POUCH DEV
4/4/95	6	N	M	44	36.7	pushed trap door down during the day, after 11am
4/4/95	69	R	F	37	36.7	SOME POUCH DEV & STAINING
4/4/95	66	R	F	38	35.1	POUCH DEV & STAINING
4/4/95	75	R	F	37	35.3	SOME POUCH DEV & STAINING
4/4/95	5	N	F	37	36.4	POUCH DEV & STAINING
4/4/95	60	R	F	33	34.5	SOME POUCH DEV
4/5/95	65	R	F			
4/5/95	7	N	F	34	36.2	SOME POUCH DEV
4/5/95	69	R	M	47	38.2	EAR NOTCH UNCLEAR
4/5/95	60	R	M	52	36	LIGHTER COLORING
4/5/95	67	R	F	43	36	pouch dev & staining/lighter sandy coloring
4/5/95	12	N	F	41	37	POUCH DEV & STAINING
4/5/95	60	R	F	38	35.7	" "/EAR NOTCH UNCLEAR
4/5/95	11	N	F	35	33.6	" "
4/5/95	63	R	F	46	33.2	POUCH DEV & STAINING
4/5/95	6	RT	M			
4/5/95	64	R	M	45	37.8	
4/5/95	10	N	M	46	35.7	CALLOSED BREAK ON TAIL TIP
4/5/95	66	RT	F			large scab b/w shoulder blades (bird attack?)
4/5/95	9	N	M	44	36.7	VENTRAL HAIR LOSS ON TAIL
4/5/95	8	N	M	44	36.5	tip of tail broken/ventral hair loss on tail
4/5/95	72	R	M	47	37.3	
4/5/95	70	R	M	42	35.9	
4/5/95	69	RT	F			
4/5/95	74	R	M	47	38.9	
4/6/95	13	N	F	40	37	some pouch dev/old tail break midway along tail
4/6/95	67	RT?	F	39	32	NO POUCH DEV
4/6/95	52	R	M	31	35.6	
4/6/95	76	RT	M			
4/6/95	72	RT	M			PENDULUS TESTES
4/6/95	2	RT	F			
4/6/95	64	RT	M			
4/6/95	71	R	M	46	37.9	
4/6/95	7	RT	F	31		
4/6/95	14	N	M	42	34.8	
4/6/95	76	R	M		35.6	PENDULUS TESTES
4/6/95	66	RT	F			
4/7/95	59	R	F	37	32.7	
4/7/95	78	N	M	43	37	3MM TEAR ON LEFT EAR
4/7/95	66	RT	F	35		
4/7/95	68	R	F	41	35.2	NO POUCH DEV
4/7/95	77	N	M	48	37.4	
4/7/95	8	RT	M			
4/7/95	14	RT	M			NOTCH #4 IS CLOSE TO THE #7 AREA
4/7/95	70	RT	M			

Date	Id #	N/R/Rt	Sex	WT (g)	HL (mm)	Comments
4/7/95	1	RT	F			
4/7/95	11	RT	F			
4/7/95	63	RT	F			
4/7/95	1	N	M	49	36.9	NATURAL EAR MARK
4/7/95	64	RT	M			
4/7/95	15	N	F	35	34.7	POUCH DEV & STAINING
4/7/95	73	R	M	43	36.6	
4/7/95	75	RT	F			
4/7/95	74	RT	M			
4/7/95	60	RT	F			
9/5/95	72	R	M	45	35.5	
9/5/95	79	N	F	38	35	6 ACTIVE NIPPLES
9/5/95	14	R	M	37	35.8	
9/5/95	15	R	F	36	36	2 ACTIVE NIPPLES
9/5/95	4	R	F	43	35.8	6 ACTIVE NIPPLES
9/5/95	72	R	M	46	37.4	
9/6/95	51	R	M	49	37	?51
9/6/95	86	N	M	50	37	
9/6/95	56	R	F	48	35	7 NIPPLES LACTATING
9/6/95	28	R	F	45	35.1	4 NIPPLES LACTATING, ?28 OR ?21
9/6/95	27	R	M	41	35.7	6 NIPPLES LACTATING
9/6/95		N	F			VERY WET IN TRAP, NOT MARKED
9/6/95		N	M	42	37.3	LRG "V" TOP LEFT EAR, LOST TAIL TIP
9/6/95	54	R	F	47	35.3	UNBRED 2ND YR, REGRESSED POUCH SOME STAINING
9/7/95	11	R	F	34	32.8	4 ACTIVE NIPPLES
9/7/95	69	R	M	44	38.4	?69
9/7/95	51	R	M	43	38.7	?51
9/7/95	66	R	F	39	32.9	5 ACTIVE NIPPLES
9/7/95	81	N	M	17	29.8	JUVENILE
9/7/95	82	N	F	15	29.8	JUVENILE
9/7/95	61	R	F	40	32.4	4 ACTIVE NIPPLES, NOT LACTATING ?61
9/8/95	10	RT	F	37	36.2	R. EAR TORN, 8 ACTIVE NIPPLES
9/8/95	24	N	M	25	30.2	NATURAL "V" AT #4
9/8/95	16	N	F	24	31.6	
9/8/95	15	RT	F	34	34.1	
9/8/95	17	N	F	17	28.9	
9/8/95	27	RT	M	42	36.2	
12/6/95	18	N	M	42	34.2	SCROTAL
12/6/95	72	R	M	60	37.3	SCROTAL
12/6/95	19	N	F	34	33.9	UNBRED
12/6/95	20	N	M	48	35.6	
12/6/95	21	N	M	55	38.9	
12/6/95	22	N	M	49	35.6	
12/6/95	23	N	M	41	35.2	
12/6/95	31	R	F	57	34.8	POUCH DEV, BUT NO MAMMARY DEV
12/6/95	25	N	F	38	35.3	UNBRED
12/6/95	26	N	F	46	35.6	DEV POUCH BUT NIPPLES RECESSED
12/6/95	27	N	M	44	35.2	
12/7/95	28	N	M	49	34.8	
12/7/95	29	N	M	41	36.8	

Date	Id #	N/R/Rt	Sex	WT (g)	HL (mm)	Comments
12/7/95	30	N	F	33	31.9	HAIR LOSS ON MUZZLE, NO POUCH DEV
12/7/95	31	N	M	40	34.1	
12/7/95	53	R	F	44	36.5	DEV POUCH, RECESSED NIPPLES
12/7/95	4	R	F	55	36	DEV POUCH, RECESSED NIPPLES
12/7/95	32	N	F	37	34	
12/7/95	83	N	M	40	36.1	
12/7/95	84	N	F	55	33.8	REGRESSED POUCH
12/7/95	71	R	M	60	37.1	
12/7/95	21	RT	M	53		
12/7/95		R	M	56	34.7	LRG "V" TOP LEFT EAR
12/7/95	22	RT	M	51		
12/7/95	85	N	M	46	34.5	SCAR ON TOP NOSE
3/27/96	61	R	F	40	36.1	POUCH DEV
3/27/96	17	R	F	38	35	NO POUCH DEV
3/27/96	23	R	M	42	36.4	
3/27/96	67	R	F	42	37.2	POUCH DEV, NIPPLES SWOLLEN
3/28/96	83	R	M	48	37.8	NOT IN GOOD CONDITION
3/28/96	30	R	F		34.1	MARGINAL POUCH DEV
3/28/96	71	R	M	51	37.5	1/2 EATEN MOUSE IN TRAP
3/28/96	25	R	F		34.1	MARGINAL POUCH DEV
3/28/96	25	R	F	37	35.5	LOWER CANINES WORN, MINOR POUCH DEV
3/28/96	33	N	M	43	37	
3/29/96	83	R	M	40	35.2	
3/29/96	26	R	F	34	34.2	MIN POUCH DEV, LOTS FLEAS (samples taken)
3/29/96	27	R	M	42	35.8	
3/29/96	40	N	M	42	35.3	LARGE "V" IN #40 POSITION
3/29/96	4	R	M	42	34.3	ESC

* the date is written month/day/year to show seasonal differences
N = not previously caught, **R** = recapture from a previous trip, **RT** = recapture from same trip
HL = Head length

Appendix 6

P. apicalis Capture location habitat data : areas not included in K.R. Newbey's Descriptions (Chapman & Newbey 1995)

ET/B Location : approx 7km E Quiss road on northern firebreak

Stratum 1, 3-4m, 5-10 % canopy cover
E. tetragona, E. leptophylla, E. phaenophylla

Stratum 2, 1-1.5m, 5-10 % canopy cover
Hakea corymbosa, H. Trifurcata, H. lissocarpa, Gastrolobium parviflorum, Melaleuca uncinata, Davesia pachyphylla

Stratum 3, 0-1m, 80-90 % canopy cover
Leucopogon sp., Hibbertia sp., Andersonia sp., Calytrix leschenaultii, Gastrolobium parviflorum, Hakea nitida

Sedges 5-10 % cover

Midslope on top of breakaway on loamy sand with spongolite.

ET/C Location : 3km E 14a2 on the northern firebreak , habitat as per 12A2 K.R. Newbey description

Wilderness Area Location : 33° 75', 119° 25'

Stratum 1. 2-3 m, 5-10 % canopy cover
Eucalyptus tetragona, E. spp., Lambertia , Nuytsia floribunda

Stratum 2. 1-2 m, 10-20 % canopy cover
Banksia baxteri, B. coccinea, Lambertia

Stratum 3 0-1m, 80-90 % canopy cover
Banskia calyei, Davesia pachyphylla, Hakea lissocarpa, Hakea trifurcata

Area last burnt 10-15 years ago , mid slope with deep sandy soils.

A. Sanders unpublished data

PCR primers and conditions used to amplify the d-loop region in *Smithopsis* were initially tested with *P. apicalis* DNA but failed to amplify a specific d-loop product. A combination of primers, previously designed from other mammalian mitochondrial DNA sequences, were therefore tested and PCR amplification of an approximately 500 bp DNA fragment was obtained for one set of primers (designated m3 and m7). This fragment was amplified and sequenced from the 9 DNA samples referred to above. Three allelic sequences were detected, each differing by between 1 and 2 nucleotides. Within each population individuals were found to have identical alleles.

Comparison of this sequence, using pairwise DNA alignment program, with d-loop sequences from *Sminthopsis* and *Planigale* showed no significant regions of homology. These comparisons suggest that this *P. apicalis* sequence was not the d-loop region and is most likely to be nuclear in origin. To test this possibility DNA was extracted from frozen *P. apicalis* liver tissue (donated by the SA Museum) using a procedure that preferentially enriches for mitochondrial DNA (mtDNA) over nuclear DNA. The m3/m7 primers were found to amplify 2 fragments from this DNA sample, one of which was the same size as the fragment previously sequenced. A second combination of d-loop primers (m20/m7) were found to amplify a single 650 bp fragment from the enriched mtDNA and this fragment was purified and DNA sequenced. The sequence obtained showed significant regions of homology with d-loop sequence from *Sminthopsis crassicaudata* and *Planigale gilesi* and no regions of homology with the sequence previously derived from *P. apicalis* (Fig 1.).

The same m20/m7 primer combination, however, failed to amplify a specific PCR product from DNA extracted from ear punch tissue. To obtain d-loop sequence data from these samples, two P. apicalis-specific d-loop primers were designed and synthesised. Recent experiments carried out to optimise PCR amplifications using these primers, resulted in sequence being obtained from on either specimen. The 8 other DNA samples obtained from skin tissue failed to show PCR amplification of the predicted d-loop product. To date, d-loop sequence data has been obtained from two *P. apicalis* individuals, both of which were collected from Boullanger Island.

Discussion

Due to a number of major difficulties we have been unable to obtain mtDNA sequence data from mainland WA and Whitlock Island populations of *P. apicalis* and, therefore, can not address the hypothesis that island and mainland forms of *P. apicalis* comprise a single species. A possible reason for these technical problems is that mtDNA is not present in high copy number in the skin cells of ear punch tissue. In contrast, liver tissue provides a rich source of mtDNA and was used successfully to PCR amplify the d-loop region from *P. apicalis*. DNA samples are currently being extracted, using mtDNA enrichment procedure, from frozen liver tissues stored at the SA Museum and will be used to obtain d-loop sequence data from a mainland specimen of *P. apicalis* and *P. bilarni*. Liver tissue from a Whitlock Island specimen of *P. apicalis* is currently unavailable. These data, although limited, will enable us to assess the level of variation in the d-loop region between the island and mainland forms of *P. apicalis* and determine whether further sample would be necessary to complete the study.