

Translocations and fauna reconstruction sites: *Western Shield* review—February 2003

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SUMMARY

Objectives

The objectives of *Western Shield* with regard to fauna translocations were to re-introduce a range of native fauna species to a number of sites located primarily in the southwest of Western Australia. At some sites whole suites of fauna needed to be re-introduced, while at others only one or a few species were targeted for re-introduction.

Integration of *Western Shield* activities with recovery actions and co-operative arrangements with community groups, wildlife carers, wildlife sanctuaries, Perth Zoo and educational outcomes were other key objectives.

Achievements

The fauna translocation objectives defined in the founding documents (Burbidge *et al.* 1995) and draft 'Western Shield Strategic Plan' have been largely met, and in some cases exceeded within the first six years of the program in terms of the number of species translocated, the number of translocations attempted and the number of successful translocations. The target sites for the re-introductions were different for some species from those originally proposed, but the variation was made on the basis of better information about species requirements and changes to the baiting strategy (usually a discontinuation of baiting) for some sites neither of which were expected to be immutable.

There has been reasonable integration of *Western Shield* activities with species recovery actions, but there is scope to improve internal communication between Recovery Teams and Western Shield staff.

Cooperative arrangements with community groups, wildlife carers, wildlife sanctuaries and the Perth Zoo have been one of the great successes of the program to date, with a high level of exposure for the program.

Difficulties

Limited human resources in some Department of Conservation and Land Management (CALM) regions and slow production of animals from captive breeding programs have hampered translocation opportunities for some species. More realistic production time lines will

address this problem, but will result in slower progress towards future milestones for some species.

The captive-breeding of western barred bandicoots has also been hampered by disease issues, but this problem is dealt with in more detail elsewhere in this edition (see Morris *et al.* this issue).

There is a clear need to better define criteria that will be used to determine the success or failure of translocation programs, and for those same criteria to be included in Recovery Plans and Interim Recovery Plans.

A small number of the species that are currently the subject of captive-breeding programs and or translocations do not have Recovery Plans or Interim Recovery Plans, contrary to CALM Policy Statement No. 50. In other cases the priorities by which plans are written does not reflect the IUCN rank assigned those species by the Western Australian Threatened Species Scientific Committee.

There is a clear disparity in the effort devoted to *Western Shield* activities between the various regions in the southwest of the State. The reasons for this are not immediately apparent, but this problem could be addressed with a clear directive from the CALM Executive reconfirming the high priority that this program should have in regional activities.

Potential economies

Increased use of student research involvement could help elucidate specific issues relating to fauna translocations for threatened and non-threatened species covered under Western Shield. To maximize this potential it will require a broader commitment from CALM staff to develop project outlines, to co-supervise the students and where possible to assist in identifying and sourcing funds to support student research projects.

Potential improvements

Staff trained to participate in *Western Shield* activities such as fauna monitoring and translocations must be given the opportunity to undertake those duties, and that these activities not be seen as secondary to other activities within CALM (e.g. fire management, tree planting etc.) at critical periods of the year when fauna monitoring or translocations are best carried out.

INTRODUCTION

In the original *Western Shield* proposal (Burbidge *et al.* 1995) the conservation of those elements of the Western Australian native fauna that were declining because of fox predation were to be protected by means of strategic fox baiting. It was expected that a number of extant populations of several species would be able to recover once the impact of foxes was reduced. However, at many sites it was also expected that it would be necessary to re-introduce particular species or entire suites of fauna (predominantly mammals) into some sites in order to reverse the impact of exotic predators. It was proposed that the translocation of up to 13 species to 17 fauna reconstruction sites and 25 species recovery sites would be desirable by the year 2000.

Fauna Reconstruction Sites are defined in the CALM Policy Statement No. 29 (CALM 1995) as 'areas where the Department is proposing to reconstruct, or is reconstructing, the vertebrate fauna as far as possible through predator control, habitat management or translocations'.

Species Recovery Sites are defined in the same Policy Statement as 'areas where management priority is given to the recovery and conservation of one or more nominated threatened species'.

The aims and objectives of the original *Western Shield* proposal were reinforced in the draft '*Western Shield* Strategic Plan 1999-2004' (CALM 1999) mission statement [Note: the draft strategic plan was never ratified by the CALM Corporate Executive.] One of the mission statements relating to fauna translocations was 'To reconstruct the fauna that has become locally extinct because of predation by reducing the density of foxes and feral cats on conservation lands, and encourage their reduction on private lands.' Translocations of native fauna were only to be undertaken in situations where the native fauna species were not present and/or could not colonize areas subject to introduced predator control by natural spread. Species listed as 'threatened' [i.e. listed on Schedule 1 of a Specially Protected Fauna Notice, under the provisions of Section 14(2)(ba) of the *Wildlife Conservation Act 1950*] were to have higher priority for translocation than non-threatened species. Monitoring of translocated threatened species was to continue until the population was established but no definition was provided for 'establishment'.

TRANSLOCATIONS CONDUCTED UNDER WESTERN SHIELD SINCE 1996

The term 'translocation' is defined in Policy Statement 29 (CALM 1995) and in this paper as 'the movement of living organisms from one area with free release in another'. Translocation includes introductions, re-introductions and re-stocking. This definition was based on the IUCN Position Statement on Translocation of Living Organisms (IUCN 1987).

It should be noted that some of the translocations referred to in this review involve the release of animals at more than one location within a baited area at one time or the release of several groups of animals at the one site in successive years. In such cases these releases are incorporated under a single translocation proposal and are presented in this review as single translocations.

Since April 1996 when the *Western Shield* program was officially launched through until 30 September 2002, 88 separate fauna translocations have been carried out. Eighty-three (83) of those translocations were conducted in Western Australia—involving 25 species of native animals (19 mammal taxa, 3 species of bird, 2 species of reptile and one species of amphibian). In addition to the translocations conducted in Western Australia there have been three (3) translocations, involving two (2) species of mammal carried out to South Australia using animals sourced from wild or captive populations in Western Australia. Two (2) translocations, involving one (1) species of mammal, have also been carried out to New South Wales using animals sourced from wild or captive populations in Western Australia.

The specific details of the eighty-eight translocations are set out in Table 1, along with the total number of animals used to found each population and an assessment of the status of each translocation (i.e. success, failure or outcome pending).

CHANGES IN IUCN THREAT STATUS FOR SPECIES TRANSLOCATED SINCE 1996

The Draft Strategic Plan (CALM 1999) stipulated that species listed as threatened were to have a higher priority for translocation than other non-threatened species. Table 2 sets out the conservation status of the various species that have been the subject of translocations and that are referred to in Table 1, at the time of each translocation and as of September 2002.

The conservation status of the majority of the species listed in Table 2 has not changed during the period 1996-2002. The main reason for this lack of change in conservation status is that only a small number of translocations have been conducted for most species and that the outcome of many of the translocations has not yet been confirmed. Even if all of the translocations had been successful the reduction in known previous range of many species has been so great that many more successful translocations would be required before the various species would satisfy the IUCN criteria for down-grading of their threat category.

There are five species listed in Table 2 that now have a lower IUCN threat category than they had in 1996, or at the time translocations first commenced post-1996. Translocations of woylies began in Western Australia as early as 1977, but did not achieve success until after broad-scale fox baiting was introduced in 1992 in programs that were the precursor to *Western Shield*. Woylie translocations became so successful that the species had recovered in

TABLE 1

Translocations of native fauna conducted in Western Australia under the umbrella of *Western Shield* during the period 1996-2002. [RI=re-introduction, RS=re-stocking, IN=introduction. CALM=Department of Conservation and Land Management, AWC=Australian Wildlife Conservancy, CSIRO=Commonwealth Scientific and Industrial Research Organization, SADEH=South Australian Department for Environment and Heritage, NSW NPWS= New South Wales National Parks and Wildlife Service. TNR= Total Number Released. % figures in last column indicate most recent trap success rates reported for the respective translocations. Outcome: P=Pending, N=Failed, Y= Succeeded.

YEAR	TP	SPECIES	LOCATION	SOURCE	PROPONENT	TNR	OUTCOME
1996-8	RI	Quokka	Karakamia Sanctuary (AWC)	Dwellingup	CALM	5	P
2001	RI	Banded H-wallaby	Francois Peron NP	Captive bred (Bernier Is. stock)	CALM	18	N
2001-2	RI	Black-flanked rock-wallaby	Paruna Sanctuary (AWC)	Mt Caroline NR/ Querekin Rock	AWC	22	P
2001-2	RI	Black-flanked rock-wallaby	Avon Valley NP	Mt Caroline NR/ Querekin Rock	CALM	46	P
2002	RI	Black-flanked rock-wallaby	Walyunga NP	Mt Caroline NR/ Querekin Rock	CALM	29	P
1998-9	RI	Tammar wallaby	Warrup Forest	Perup Forest	CALM	63	Y
1998	RI	Tammar wallaby	Karakamia Sanctuary (AWC)	Tutanning NR	CALM / AWC	13	Y
1998-2002	RI	Tammar wallaby	Julimar Forest	Tutanning NR	CALM	57	P
1999-2000	RI	Tammar wallaby	Bennelaking Forest	Tutanning NR	CALM	46	P
2000	RI	Tammar wallaby	Alcoa Huntly Mine	Tutanning NR	CALM / Alcoa Ltd	20	P
2001-2	RI	Tammar wallaby	Paruna Sanctuary (AWC)	Tutanning NR	AWC	44	P
2001-2	RI	Tammar wallaby	Avon Valley NP	Tutanning NR	CALM	100	P
2002	RI	Tammar wallaby	Thames Forest	Perup Forest	CALM	41	P
2002	RI	Tammar wallaby	Boyndaminup Forest	Perup Forest	CALM	40	P
1996	RI	Woylie	Hills Forest	Dryandra Forest	CALM	37	N
1997-8	RI	Woylie	Lake Magenta NR	Dryandra Forest	CALM	35	N
1997-8	RI	Woylie	Francois Peron NP	Dryandra Forest, Battalling Forest	CALM	147	N
1998	RS	Woylie	Pooginup & Chitelup Forest	Perup Forest	CALM	40	P, 0.7%
1998	RI	Woylie	Easter & Barlee SF	Perup Forest	CALM	40	Y
1998-9	RI	Woylie	Genaren Hills, NSW	Dryandra Forest, Karakamia Sanctuary	GHLCG	24	N
1998	RI	Woylie	St Johns Forest	Perup Forest	CALM	40	N
1998	RI	Woylie	Denmark Forest	Perup Forest	CALM	38	N
1998	RI	Woylie	Centaur Forest	Battalling Forest	CALM	39	P, 5.4%
1999	IN	Woylie	Giants Forest	Perup Forest	CALM	40	P, 1.0%
2000	RI	Woylie	Wellington NP	Battalling Forest	CALM	30	P, 6.6%
2000	RI	Woylie	Davis Forest	Battalling Forest	CALM	37	P, 8.1%
2000	RI	Woylie	Kalbarri NP	Dryandra Forest	CALM	32	P
2000-1	RI	Woylie	Paruna Sanctuary (AWC)	Karakamia Sanctuary	AWC	128	P, 5.3%
2000	RI	Woylie	Shannon NP	Perup Forest	CALM	40	P
2000	RI	Woylie	Strickland Forest	Perup Forest	CALM	40	P, 3.0%
2000	RI	Woylie	Watts PP	Battalling Forest	CALM	19	Y, 51.6%
2000	RI	Woylie	Tucker PP	Battalling Forest	CALM	19	P
2000	RI	Woylie	Hadfield Forest	Battalling Forest	CALM	29	P, 8.3%
2001	RI	Woylie	Yathong NR, NSW	Dryandra Forest	NSW NPWS	25	N
2002	RI	Woylie	Thames Forest	Perup Forest	CALM	37	P
2002	RI	Woylie	Flybrook	Perup Forest	CALM	21	P
2002	RI	Woylie	Boyndaminup	Perup Forest	CALM	21	P
1999	RI	Boodie	Roxby Downs, SA	Heirisson Prong, Bernier Is	CSIRO / SA DEH	10	P
2000	RI	Boodie	Roxby Downs, SA	Bernier Island	SADEH	20	P
2002	RI	Boodie	Faure Island (AWC)	Heirisson Prong	AWC	17	P
1998	IN	Mala	Trimouille Is, Montebello Is.	Captive colony, Tanami Desert, NT	PWCNT / CALM	30	Y
2001	RI	Mala	Francois Peron NP	Captive Colony, Peron	CALM	16	N
1998	RS	Euro	Useless Loop	Carrarang Station	CALM	29	Y
1987-96	RI	Numbat	Tutanning NR	Dryandra Forest	CALM	35	Y
1994-9	RI	Numbat	Karakamia Sanctuary (AWC)	Dryandra Forest	CALM	6	P

TABLE 1 (continued)

YEAR	TP	SPECIES	LOCATION	SOURCE	PROPONENT	TNR	OUTCOME
1995-6	RI	Numbat	Dragon Rocks NR	Dryandra Forest	CALM	37	P
1996-8	RI	Numbat	Hills Forest	Dryandra Forest	CALM	62	P
1998-2000	RI	Numbat	Stirling Range NP	Dryandra Forest, Boyagin NR, Perth Zoo	CALM	48	P
1995-6	RI	Quenda	Boyagin NR	Swan Coastal Plain	CALM	26	P, 1.0%
1996	RI	Quenda	Leschenault CP	Big Swamp Wildlife Park	CALM	15-20	P
1994-7	RI	Quenda	Karakamia Sanctuary (AWC)	Various metro sites	CALM	34	Y
1997-8	RI	Quenda	Hills Forest	Jandakot	CALM	18	Y, 1.8%
1997	RS	Quenda	Mt Barker, Albany Hwy	Dongolocking NR	CALM	37	P
2000	RI	Quenda	Paruna Sanctuary (AWC)	Rockingham, Karakamia	AWC	56	P, 1.2%
2000	RI	Quenda	Creery Wetlands	Mandurah transfer station	CALM	22	Y, 27.9%
2000	RI	Quenda	Yalgorup NP	Mandurah transfer station	CALM	9	P
2002	RI	Quenda	Avon Valley NP	Beeliar, Casuarina	CALM	15	P
1995-6	RI	WB bandicoot	Heirisson Prong	Dorre Island	CSIRO / CALM	14	N
2000	RI	WB bandicoot	Roxby Downs, SA	Bernier Island	SA DEH	12	P
2000	RI	Bilby	Dryandra	Captive bred	CALM	36	P
2000-2	RI	Bilby	Francois Peron NP	Captive bred	CALM	55	P
1996-7	RS	Chuditch	Lake Magenta NR	Perth Zoo	CALM	81	Y, 1%
1997-8	RI	Chuditch	Cape Arid NP	Perth Zoo	CALM	46	P
1999	RS	Chuditch	Mt Lindsay NP	Perth Zoo	CALM	48	P, 0.7%
2000	RI	Chuditch	Kalbarri NP	Perth Zoo	CALM	33	P
1998-2000	IN	Dibbler	Escape Island, Jurien	Perth Zoo (Whitlock & Boullanger Islands)	CALM	94	Y, 31.2% F3
2001	RI	Dibbler	Peniup 'NR'	Perth Zoo (FRNP stock)	CALM	41	P
1995-2001	RI	WRt possum	Yalgorup NP	Port Geographe, E Buss PS	CALM	188	P
1991-7	RI	WRt possum	Leschenault CP	Derelicts & Busselton	CALM	106	P
1995-2002	RI	WRt possum	Karakamia Sanctuary (AWC)	Port Geographe	CALM	43	P
1997-9	RI	WRt possum	Lane Poole Reserve	Derelicts, Busselton	CALM	118	N
1999-2001	RI	G stick-nest rat	Heirisson Prong	Salutation Island	CSIRO / CALM	48	P
1993-8	IN	SB mouse	Doole Island NR	Bernier Island, Perth Zoo	CALM	149	P
1999	IN	SB mouse	North West Is. Montebello Is.	Perth Zoo	CALM	26	P
2002	RI	SB mouse	Faure Island (AWC)	Perth Zoo	AWC	88	P
1996	RS	P-mound mouse	Adjacent area, Site 2	Jimblebar Mine	BHP	27	?
1997	RS	P-mound mouse	Adjacent area, Site 3	Jimblebar Mine	BHP	4	?
1997	RS	P-mound mouse	Orebody 25, Newman	Orebody 18, Newman	BHP		?
1997	RS	P-mound mouse	north of HIY	HI Yandi project	Hammersely Iron	101	Y
1996	IN	Thev. Is. mouse	Serrurier Island NR	Thevenard Is. NR	CALM / UWA	65	Y, 205%
1997-8	RS	Malleefowl	Francois Peron NP	Eggs from N wheatbelt	CALM	66	Y, 6 nests
1997-2002	RI	Noisy scrub-bird	Darling Range	Two Peoples Bay NR	CALM	72	P
1999-2000	RI	Western bristlebird	Walpole-Nornalup NP	Two Peoples Bay NR	CALM	15	P
1994-9	RI	Western swamp tortoise	Twin Swamps NR	Perth Zoo	CALM	130	Y
2000-1	IN	Western swamp tortoise	Mogumber	Perth Zoo	UWA / CALM	26	P
2001	RS	Western swamp tortoise	Ellen Brook NR	Perth Zoo		12	Y
2002	IN	Lancelin Island skink	Favourite Island	Perth Zoo	CALM	41	P
2001	IN	Orange-bellied frog	Adelaide Creek	Spearwood Creek	CALM	8-20 Egg masses	P

TABLE 2

Conservation status of translocated species (IUCN rank) at the time that each translocation was conducted and at 30 September 2002. [EW=Extinct in the Wild, CR=Critically Endangered, EN=Endangered, VU=Vulnerable, LR(nt)=Lower Risk (near threatened)].

SPECIES	IUCN CONSERVATION STATUS AT TIME OF TRANSLOCATION	IUCN CONSERVATION STATUS AT 30 SEPTEMBER 2002
Quokka	Nil	VU
Banded hare-wallaby	VU	VU
Black-flanked rock-wallaby	VU	VU
Tammar wallaby	VU, LR(nt)	LR(nt)
Woylie	VU, LR(nt)	LR(nt)
Boodie	VU	VU
Mala	EW	EW
Euro	Nil	Nil
Numbat	VU	VU
Quenda	VU, LR(nt)	LR(nt)
Western-barred bandicoot	EN	EN
Bilby	VU	VU
Chuditch	VU	VU
Dibbler	EN	EN
Western ringtail possum	VU	VU
Greater stick-nest rat	VU	VU
Pebble-mound mouse	VU	LR(nt)
Shark Bay mouse	VU	VU
Thevenard Island mouse	EN	LR(nt)
Mallefowl	VU	VU
Noisy scrub-bird	VU	VU
Western bristle-bird	VU	VU
Western swamp tortoise	CR	CR
Lancelin Island skink	VU	VU
Orange-bellied frog	VU	VU

numbers and range to such an extent that it was de-listed from the IUCN threat categories and down-graded to LR(nt) in 1996. The term 'Conservation Dependent' was previously applied to this species, however in the 2000 review of the IUCN red book the use of this term was discontinued. Conservation dependent provides an apt description of the status of the woylie, since its continued survival in the wild is totally dependent on broad-scale predator baiting programs.

The threat status of the quenda and the tammar wallaby was down-graded in 1998 following an assessment of their conservation status by the Western Australian Threatened Species Scientific Committee using the IUCN criteria of the day. Both species were found not to satisfy the criteria for even the lowest category of threat (Vulnerable), and accordingly were de-listed from Schedule 1 of the Specially Protected Fauna Notice (Government Gazette, 14 July 1998). One of the factors contributing to the decision to de-list the quenda was that it still had a fairly wide distribution and that on the mainland there was evidence of increasing populations in areas baited to control introduced predators. The case for de-listing the tammar wallaby was also bolstered by the fact that there are secure populations in the Abrolhos Islands and on Garden Island.

The Thevenard Island mouse (*Leggadina lakedownensis*) was de-listed on the basis that it was not genetically distinct from the adjacent mainland populations, despite clear morphological differences

(larger size) (Morris 1993). Since populations occur in both the Pilbara and Kimberley regions, there was no justification for maintaining the insular population as endangered. The pebble-mound mouse (*Pseudomys chapmani*) was de-listed following a thorough review (Start *et al.* 2000) that showed this species was still widespread and common in areas with suitable habitat over more than half of its former range. On this basis it did not meet the criteria for the lowest threat category (Vulnerable).

TABLE 3

Criteria used to assess outcome of translocations and the relevant source reference. (IWMG=Interim Wildlife Management Guideline, RP=Recovery Plan, IRP=Interim Recovery Plan)

SPECIES	CRITERIA FOR SUCCESS	SOURCE REFERENCE
Quokka	Not stated	No IRP or RP exists for this species
Banded hare-wallaby	Not stated	Draft Interim Recovery Plan (CALM 2000)
Black-flanked rock-wallaby	F2 breeding, or 50% increase in pop'n within 3 years	Orell, P & Dans, P. (2002)
Tammar wallaby	Breeding of F1 generation	Translocation Proposals
Woylie	Avg. daily trap success of 7.5%	Start <i>et al.</i> (1995)
Boodie	N=265 or more, <u>and</u> population persists for at least 5 yrs	Short & Turner (2000)
Mala	Not stated	Translocation Proposals
Euro	Not stated	No IWMG, Sims (1997)
Banded hare-wallaby	Not stated	IRP, Sims (2001)
Numbat	Sighting rate of 1-5/100km at various sites + at least 9 self-sustaining pop'ns	Friend (1994)
Quenda	Not stated	No IWMG, IRP or RP
Western barred bandicoot	Six criteria defined in translocation proposal	Short (1995), Short and Friend (1995)
Bilby	Not stated	Friend & Orell (2000)
Chuditch	Avg. daily trap success rate of 1%	Orell & Morris (1994)
Dibbler	F1 generation trapped with pouch young	Friend (2001)
Western ringtail possum	Not stated	IRP, Translocation Proposal
Greater stick-nest rat	Establish a mainland pop'n	Morris & Short (1999)
Pebble-mound mouse	Not stated	Translocation Proposals
Shark Bay mouse	'Establish self-sustaining pop'	Morris <i>et al.</i> (2000)
Thevenard Island mouse	Not stated	IWMG, Morris 1993
Mallefowl	Not stated	Morris & Barton (1996), Sims and Barton (1997)
Noisy scrub-bird	Not stated	Danks <i>et al.</i> (1996)
Western bristle-bird	Not stated	Burbidge (1999)
Western swamp tortoise	Not stated	Burbidge <i>et al.</i> (1990)
Lancelin Island skink	Not stated	Pearson & Jones (2000)
Orange-bellied frog	Not stated	Wardell-Johnson <i>et al.</i> (1995)

OUTCOME OF TRANSLOCATIONS CONDUCTED UNDER WESTERN SHIELD

A total of 83 translocations have been conducted in Western Australia under the *Western Shield* banner since April 1996. Based on the available criteria for assessing the outcomes of those translocations that have been provided in either the recovery plans and or the translocation proposals, 9 (10.8%) translocations are considered to have failed, 17 (20.5%) to have succeeded, 54 (65.1%) are pending and three (3.6%) can not be determined due to lack of follow-up monitoring.

Of the five translocations made post-1996 from Western Australia the two to New South Wales failed and the three to South Australia are still pending.

Of those translocations that are considered to have failed seven were translocations involving woylies. The two translocations of woylies to New South Wales both failed because of inadequate control of exotic predators. In the case of the Genaren Hills translocation, foxes and possibly cats were the problem, while at Yathong Nature Reserve the failure was solely due to predation by feral cats as foxes had been eliminated from the reserve. Of the five translocations that failed in Western Australia only the translocation to Francois Peron National Park appears to have failed due to feral cat predation. Low founder numbers appear to have contributed to the failure of the translocations to Hills Forest, Lake Magenta Nature Reserve, St. Johns Forest and Denmark Forest. The presence of chuditch as potential predators at Lake Magenta Nature Reserve and Denmark Forest along with the recent severe drought may also have compounded the effect of small founder numbers.

The translocations of banded hare-wallaby and mala (both to Francois Peron National Park) and western barred bandicoots (to Heirisson Prong) have all failed because of feral cat predation of animals released into fox-free environments. The failure of the translocation of western ringtail possums to Lane-Poole Reserve has been attributed to heavy predation by chuditch and health problems of some of the rehabilitated animals sourced from volunteer wildlife carers used in the release.

The remaining 54 translocations for which an outcome is still pending are mostly recent releases (<3 years old, e.g. black-flanked rock-wallaby, quenda, Shark Bay mouse) or involve species that are slow to mature (e.g. western swamp tortoise) or produce only one or a few young each year (e.g. tammar wallaby, chuditch, dibbler). Further monitoring of these translocations in coming years will provide a clearer indication of the fate of these translocations.

LEVEL OF MONITORING OF TRANSLOCATED SPECIES

It is now standard practice within CALM to indicate in the translocation proposal how and when monitoring of translocated populations will be achieved. In many cases

this has been achieved by releasing animals into sites that are already monitored as part of standard *Western Shield* fauna monitoring sites (see Orell this issue). In those cases where the translocations have been to sites that are not part of the current fauna monitoring program, specific provision has been made by the CALM District supporting the translocation to undertake monitoring in accordance with the prescription set out in the proposal.

All of the translocated populations described in Table 1 are, or have been, monitored in some fashion. The intensity of monitoring and the methods used vary across species and for different locations for the same species, according to the availability of resources and the suitability of available techniques in different landscapes. Many populations have been intensively monitored during the first 6-12 months following release. This level of monitoring has been vital in determining the causes of failed translocations (e.g. banded hare-wallaby, mala, western ringtail possum).

Given the available resources (people and funds), the standard and quantity of monitoring has been adequate for most translocations. For those few translocations that are currently monitored at a low level, the human resources and funds required to achieve greater monitoring would be disproportionate to the value of the data that would be forthcoming relative to the goals set out in the draft '*Western Shield* Strategic Plan 1999-2004'. Monitoring of translocated populations in more remote locations is, or will be, limited. This deficiency is primarily a function of available funds.

Are the most appropriate monitoring and analysis techniques employed?

Analytical techniques used to assess the progress of translocated and recovering populations include percentage trap success (i.e. the number of animals trapped per 100 traps set), KTBA ('known to be alive') and, in some cases, population estimates based on mark and recapture data (all translocated animals are individually marked and in most cases unmarked animals captured during monitoring programs are subsequently marked and released) (see Orell this issue). While these techniques may not be the most sophisticated available, they provide sufficient information to address the strategic goals within the available finance and resource structure of the *Western Shield* program. For more specific examples of the analytical techniques used refer to the review paper on fauna monitoring (Orell, this issue).

Have translocations helped achieve *Western Shield* strategic objectives?

The original *Western Shield* proposal and the draft '*Western Shield* Strategic Plan 1999-2004' contained a number of objectives specifically relating to fauna recovery. In determining whether translocations have helped achieve the strategic objectives of the *Western Shield* program it is necessary to assess the performance of the program against the objectives of both documents.

Fauna reconstruction and fauna recovery sites

In the original *Western Shield* proposal (Burbidge *et al.* 1995) one of the stated objectives was to translocate 13 species to 17 fauna reconstruction sites and 25 species recovery sites by 2000. However, in Table 3 of that document only 13 fauna reconstruction sites were listed along with 27 species recovery sites (c.f. 17 fauna reconstruction sites and 25 species recovery sites referred to in the text). Fauna translocations involving 10 species of fauna have now been conducted to 10 of those 13 reconstruction sites, and four species have been translocated to seven (7) of the 27 species recovery sites. A further 12 species of fauna have been translocated to sites other than those identified in the original *Western Shield* proposal, primarily because of the site and habitat specific needs of those species, that were identified after the writing of the *Western Shield* proposal. Two of these species recovery sites have either never been baited or are no longer baited to control foxes and as such have not received any translocations to date.

Only three fauna reconstruction sites listed by Burbidge *et al.* (1995) have not received any fauna translocations during the period 1996-2002 (Batalling Forest, Fitzgerald River National Park and Perup-Denbarker forests), while 20 fauna recovery sites have not received any translocations. Batalling Forest has received woylies on two occasions prior to the establishment of *Western Shield* (i.e. pre 1996) and is now an important source site for woylie translocations. Similarly, Perup-Denbarker forests are significant source areas for woylie and tammar wallaby translocations, and the area is still considered suitable for future translocations of other species (e.g. bilbies). Fitzgerald River National Park is the only anomaly, in that it lacks several of the species that previously inhabited the region, is baited and monitored, but has not been the subject of any translocation proposals. Possible reasons for this will be addressed later in this review.

In the draft '*Western Shield* Strategic Plan 1999-2004' the list of fauna recovery sites and species recovery sites were combined in one table but not discretely identified. The list of sites differed from that in the original *Western Shield* proposal and contained 39 sites in total. Fauna translocations involving 12 species have been conducted to 18 of those 39 sites, and fauna have been sourced from five sites to facilitate translocations. A further 13 species have been translocated to sites other than those identified in the draft '*Western Shield* Strategic Plan', primarily because of the site and habitat specific needs of those species. Five of the sites identified are currently not baited to control foxes and a further two sites have only been baited for 12 months, and are not considered secure enough to commence translocations yet.

In light of the knowledge CALM now has on the requirements of each species and the apparent suitability of each fauna reconstruction site and species recovery site identified by Burbidge *et al.* (1995) it is recommended

that all of the 13 fauna reconstruction sites listed be retained as such, while the species recovery sites: Karroun Hill Nature Reserve, Noggerup State Forest, Ravensthorpe Range, Saddleback-Quindanning State Forest and Yabberup Forest be deleted or replaced with more suitable sites. With regard to sites listed in the draft '*Western Shield* Strategic Plan' it is recommended that Gervase State Forest, Scott River National Park, Karroun Hill Nature Reserve be deleted or replaced with more suitable sites. Wheatley State Forest should be replaced with Easter and Barlee State Forests as these two sites are further to the west and have already received woylies in formal translocations (see Table 1). The decision to delete or replace sites should be based on CALM's ability to bait and monitor those sites effectively, and the range of habitats that these sites can provide for species that are the subject of translocation programs. It is probably also appropriate at this point in time to reassess the list of fauna reconstruction sites and give consideration to adding new sites or replacing some currently listed sites with better alternatives in light of the results of fauna monitoring at those sites and the current and proposed baiting regimes.

Influence of changing climate

The suitability of the current fauna reconstruction sites and species recovery sites in light of recent and predicted climate change requires a considerable amount of subjective assessment. The recent climate changes (over the last 30 years) have been taken into consideration in choosing reconstruction and recovery sites, and for the most part those choices have proven valid. The drought that is affecting most of the southwest of the State (2000-2002) is providing a useful reminder of the natural variation in rainfall and is also providing CALM with a unique opportunity to monitor the natural response of a range of mammal species to drought in the areas where fox predation is controlled or absent. The information available from the Indian Ocean Climate Initiative and modeled by the CSIRO suggests that in the next 30 years rainfall will continue to decrease in the southwest and the number of days above 30°C will increase in summer and the winter minima will also increase. Plant groups such as *Dryandra* will be significantly affected and many species will be lost, and some of the *Acacia* species growing in the high rainfall parts of the southwest will be lost. The flow-on effects of these types of changes, many of which will be even more extreme by 2070 suggest that many of the sites we have identified for fauna translocations in the northern and eastern wheatbelt, particularly those located away from coastal influences will probably become unsuitable for some species of mammal. The native frog species will also be adversely affected, making translocations for this group of fauna difficult if not impossible.

For a number of species that are currently captive-bred and then translocated (e.g. bilby, mala, banded hare-wallaby) we do not know enough of their ecological tolerances to know whether translocations into arid areas

will continue to be possible. Species that are currently limited to mesic areas (e.g. numbat and woylie) but had a much wider distribution including arid areas may not survive in those arid areas in the future. It is also likely that the amount of effort required to successfully establish viable populations will increase (i.e. multiple releases will be required in more than one year). This will place additional calls on financial, staff and captive-breeding resources. For species that currently have fragmented distributions in mesic environments (e.g. quokka on the mainland, tamar wallaby, black-flanked rock-wallaby) it is possible that these species will become extinct in those parts of their current distribution that will be most affected by climate change.

Aside from the actual loss of those populations, the predicted climatic change will also probably result in elevated threat categories for those species placing an increased obligation on CALM to take remedial action (i.e. species currently ranked VU will change to EN or CR in accordance with CALM Policy Statement 50). Added to this is the likelihood that a number of species currently not considered threatened (i.e. Lower Risk (nt)) will actually become threatened (e.g. western mouse, brush-tailed phascogale and water rat) increasing the number of species that will require action to be taken to conserve them. Several species currently restricted to the Kimberley and Pilbara (e.g. long-tailed dunnart, rock ringtail, scaly-tailed possum, monjon, spectacled hare-wallaby, black-footed tree rat and golden-backed tree rat) may also fall into this category meaning we will have to deal with this issue on more than one front. The cost and staff resource implications of such a scenario could not be managed under the current *Western Shield* structure and budget.

There is no evidence to suggest that any of the species that are the subject of translocations or captive breeding programs will benefit from the likely climate changes in the southwest, although there may be some species that are not directly affected.

Integration with species recovery plans

The second objective in the draft '*Western Shield* Strategic Plan' incorporated a need to integrate *Western Shield* predator control and fauna monitoring with species recovery plans. Recovery plans have not been written for all of the threatened species (e.g. banded hare-wallaby, western barred-bandicoot and red-tailed phascogale) and some of these species have already been the subject of fauna translocations (e.g. banded hare-wallaby and western barred-bandicoot). Some species do have recovery plans written for them, but the recovery plans are national ones (e.g. mala and bilby) and the meetings are held outside of Western Australia on most occasions making attendance by CALM staff difficult at times. The Western Shield Zoologist attends species recovery team meetings for the numbat, Shark Bay mouse, western ringtail possum and dibbler. The Western Shield Zoologist currently does not attend recovery team meetings for Gilbert's potoroo,

noisy scrub-bird, western bristlebird, western ground parrot or malleefowl although not all of these species currently have translocations as a recovery action. There is scope to improve this situation and to ensure that any decisions made with regard to translocations are done so with access to all relevant information and experience.

Cooperative arrangements

The third objective included a requirement to establish cooperative arrangements with community groups, wildlife carers, wildlife sanctuaries and Perth Zoo to achieve fauna recovery and educational outcomes. The Department has a lengthy history of arrangements with the Perth Zoo for the captive breeding of chuditch, Shark Bay mouse, numbat, dibbler, Lancelin Island skink and western swamp tortoise. The chuditch and Shark Bay mouse programs have now been completed. The Department also has a financial arrangement with the Kanyana Rehabilitation Centre to house, feed and breed bilbies and western barred-bandicoots with the progeny made available to CALM for release at designated sites of its choosing. The details of the productivity of these various programs are covered elsewhere (see Mawson this issue).

Since 1995 CALM has had a formal relationship with what is now the Australian Wildlife Conservancy (AWC), which owns and operates Karakamia and Paruna Sanctuaries and Faure Island, Mount Gibson and Mornington Stations (all pastoral leases). CALM has provided six species of animal for translocation into Karakamia Sanctuary and four species of animal (directly or indirectly) for translocation into Paruna Sanctuary. A further two species of animal have been provided from captive-bred sources external to CALM for translocation to Faure Island, but CALM has had a direct involvement in the development and approval of the translocation proposals for all of these activities in accordance with the department's policy statement (No. 29). In late October 2002 the AWC was able to supply woylies to the CALM to facilitate a translocation of this species into Avon Valley National Park.

Until recently (2000) there had been only limited opportunity for the community to become involved in fauna aspects of *Western Shield*, primarily by accompanying CALM staff on fauna monitoring field trips. Depending on the age and experience of the individuals their participation in the fieldwork varies from observation, to carrying bait buckets, to recording data obtained by CALM staff (e.g. morphometrics, tag identification) to actively assisting in trap clearance. Specific educational opportunities have been developed for school groups and school teachers and are described in detail by Kawalilak *et al.* this issue).

Community groups and school groups have also been invited to participate at the release events for a number of fauna translocations, and several of these events have been reported in local media (print, radio and television), along with delayed accounts in internal CALM communication

media (CALM's Intranet, *Western Shield Newsletter*, *WATSNU* and *Conservation News*). In 2001–2002 a small number of translocations were conducted that benefited from the direct involvement of a small number of community members (registered wildlife carers, Land for Wildlife registrants and volunteers from groups such as the Chittering Landcare Centre, Swan River Trust, Muchea Tree Farm and Bullsbrook Scouts) physically assisting in the transport and release of black-flanked rock-wallabies from access tracks to more remote release sites. These interactions received wide media coverage and were well received by those involved.

WHY TRANSLOCATE SPECIES THAT ARE NOT THREATENED?

During the period 1996–2002 five (5) species of mammal that are currently not listed as threatened species have been translocated to fauna reconstruction sites and fauna recovery sites. Four of those species (woylie, tammar wallaby, quenda and Thevenard Island mouse) were listed as threatened species at the time they were first translocated, but were subsequently de-listed (see section text and Table 2, above). Additional translocations of these species will further secure their conservation status and contribute to the reconstruction of fauna assemblages found at the time of European settlement of Western Australia.

The Thevenard Island mouse was translocated only once (to Serrurier Island) before the taxonomic status of the population was resolved. Since the translocation was successful there was no further requirement to conduct additional translocations for this insular population.

The woylie was de-listed in 1996 on the basis of the success of translocations conducted prior to *Western Shield* commencing, but it was considered appropriate to continue to translocate this species for two reasons. First, the woylie's former distribution was far more extensive than that occupied in 1996 and it was a recorded part of the mammal fauna in nearly all parts of the southwest, hence there was still justification for continuing to translocate this species to baited areas after the species was de-listed. Second, the woylie breeds rapidly and if the habitat is suitable and predators are adequately controlled it is a very useful indicator species. If woylies are unable to survive in fauna reconstruction and species recovery sites with inadequate protection from fox predation then it is almost guaranteed that more susceptible species will also fail. In this respect woylies are used as pioneer species to evaluate the adequacy of fox control. Woylies also provide an ideal species to further develop the animal handling skills acquired during the CALM training course that can then be applied to other species at a later date. Woylies also provide good media and community involvement opportunities during translocations and standard monitoring programs.

Quenda were de-listed in 1998 and are one species where remnant natural populations have shown some

capacity to recover where fox baiting is applied, but the species has little or no dispersal capabilities especially where the suitable habitat is fragmented. Development of remnant vegetation sites in the Perth metropolitan area continues subject to the requirements of the human population. Research has shown that quenda do not respond well to being progressively pushed out of their home ranges into adjacent bush areas, and invariably die of starvation, predation or are killed on roads. Populations that inhabit lands subject to development can be salvaged and translocated to secure conservation estate with costs met by the land developers. All of the quenda translocations listed in Table 1 were the result of animals being salvaged from development / roadwork sites and the costs associated with the capture, relocation and for the most part the monitoring were met by the developers. This type of translocation will continue to arise in the future, and given that quenda were formerly distributed from Kalbarri south and east to Cape Arid there is no reason why this species should not continue to be translocated.

The tammar wallaby was also de-listed in 1998, primarily due to the number of island populations that still exist. However, this species has suffered significant reductions in its range on the mainland, and like the quenda, does not have the capacity to re-colonize suitable habitat without human assistance. All of the tammar wallaby translocations reported in Table 1 have been based on animals sourced from either the Perup Forest or Tutanning Nature Reserve. The tammar wallaby populations at both of these sites have increased dramatically following the establishment of fox control programs and at both sites the tammar wallabies now cause damage to cereal crops grown on private property adjacent to lands managed by CALM. Given that the tammar wallaby is not listed as threatened it is possible to consider issuing damage licences authorizing the destruction of wallabies damaging crops, but it is just as effective and of greater conservation value to capture and translocate animals to new sites where they will not have the opportunity to damage crops. The costs of translocation are borne by CALM, while the costs of destruction would be borne by the landholders, but the political and conservation benefits of translocation mean that the current approach is preferable.

The single translocation of Euros resulted from a need to relocate 29 captive-bred animals from a licensed wildlife park that closed down. Translocation was considered more acceptable than euthanasia of the animals. There is no intention to repeat this process for Euros in the future.

The issue of when a species would no longer be considered for translocation was not specifically addressed by either Burbidge *et al.* (1995) or in the Draft Strategic Plan. However, there is a clear intent in both documents for fauna reconstruction and species recovery sites to receive as many of those species that originally occurred there as possible. The fact that a species' conservation status has improved sufficiently for it to be de-listed from any of the threat categories should not preclude it from

being used in subsequent translocations. If such a narrow view of translocation acceptability had been taken then the total number of translocations that would have taken place would be only 51, which is 32 less than the total of 83 that have actually occurred in Western Australia 1996–2002.

The difficulties involved in breeding and establishing some species that are currently bred as part of the *Western Shield* program means that only a few translocations of threatened species will be possible in some years. While the reasons for this are understandable from a scientific viewpoint there may be less appreciation of this amongst the general public. It would be inadvisable to cease translocations of non-threatened species such as woylies, quenda and tamar wallabies purely because an arbitrary decision had been made to translocate only those species that were listed as threatened at the time of the translocation. To take such a position would be difficult to justify given the lack of certainty that any particular translocation would be successful, and the fact that the very success of those translocations would be a factor contributing to the CALM's ability to de-list a species. Adopting this stance would also place CALM at risk of losing some of the current public support that has been built up largely through the participation of the public in translocations of non-threatened species.

Probably the most important reason for continuing to translocate non-threatened species such as the woylie and quenda are that species such as these have an important role to play in re-invigorating ecosystem function. Work on the woylie (Garkaklis *et al.* 1998; Garkaklis 2001; Garkalis *et al.* 2000) and the quenda (Watson 2002) has shown that the digging carried out by these two species has a significant impact on soil turnover, water penetration, redistribution of surface and subsurface nutrients, dispersal of fungal spores and seeds (e.g. *Santalum* sp.; Murphy 2002; Murphy *et al.* 2002). Our understanding of these processes is currently limited but it would seem intuitive that many of the ills that native vegetation communities are experiencing might be overcome if some of these key ecosystem processes were restored.

TRANSLOCATION OF SPECIES IN RELATION TO CALM POLICY STATEMENT 50

Policy Statement 50 sets out the process by which priorities are established for the conservation of Western Australia's threatened flora and fauna. The policy stipulates that;

- at least every two years threatened taxa are ranked according to the procedures laid down in the Policy Statement
- that all taxa identified as Critical are conserved, through the preparation and implementation of recovery plans or interim wildlife management guidelines / interim recovery plans and that taxa

identified as Endangered and Vulnerable are allocated research and management resources in priority order

- conservation action for taxa identified as Critical commences as soon as possible and always within one year of endorsement of that rank by the Minister.

An examination of the current listing of fauna species that have been translocated, or could be considered for translocation, as part of *Western Shield* activities (see Table 2) indicates that recovery plans have been written and implemented for the two most endangered species [western swamp tortoise (CR) and mala (EW)]. No recovery plans or interim recovery plans have been written for two of the three species ranked as Endangered (western barred-bandicoot and red-tailed phascogale), while an interim recovery plan has been written for the dibbler. Recovery plans have been written for a number of Vulnerable taxa (numbat, chuditch, bilby, greater stick-nest rat, Shark Bay mouse, malleefowl, noisy scrub-bird, Lancelin Island skink and orange-bellied frog) and Interim Recovery Plans have been written for others [banded hare-wallaby (draft only) and western ringtail possum]. A draft recovery plan has also been written for Gilbert's potoroo.

While the current IUCN threat status of some of the species mentioned above has been downgraded since the recovery plans and interim recovery plans were first written, there are still some examples of Endangered species that do not seem to have been dealt with according to the priority setting process outlined in Policy Statement 50. This is despite active research on these species by CALM staff at some time in the recent past (e.g. red-tailed phascogale), and that one species (western barred bandicoot) is currently maintained in captive breeding facilities and has been the subject of translocations to Heirisson Prong in Western Australia and to Roxby Downs in South Australia.

COMPARATIVE EFFORT TOWARDS WESTERN SHIELD AMONGST CALM REGIONS

A range of factors is likely to influence the amount of effort that each CALM region might be able to contribute towards the *Western Shield* program. These factors include the number of trained staff present in each region at any one time, the number of suitable release sites for fauna that have been baited for a sufficient period to achieve an adequate reduction in fox numbers, the number of extant populations of fauna that could be used to provide animals for translocation within and beyond each region, the funding available within each region's nature conservation allocation, and the ability and willingness of regional staff to get involved in the program and to initiate translocations (e.g. author translocation proposals).

Translocations under the *Western Shield* program have been largely restricted to the southwest of the State, Francois Peron National Park, Heirisson Prong and three islands off the Pilbara coast and two islands off the

Midwest coast. A summary of fauna translocations conducted under the *Western Shield* banner 1996–2002 in relation to the CALM regional structure is set out in Table 4.

Some of the fauna recovery sites listed in Burbidge *et al.* (1995) and the Draft Strategic Plan were included primarily, or solely because they were locations supporting significant extant populations of threatened species that were likely to be used as source populations for fauna translocations (e.g Perup Forest for woylies and tammar wallabies; Mount Caroline Nature Reserve for black-flanked rock-wallaby; Tutanning Nature Reserve for tammar wallabies). A comparison between the number of translocations conducted in each CALM region with the number of translocations involving animals sourced from those same regions produces some interesting results (Table 5).

The Pilbara region has received eight translocations; four (3 species) to islands (Trimouille, Doole, Northwest and Serrurier Islands) and four (1 species) to mainland sites (all sites in the Hamersley Ranges). The island translocations all involved captive-bred stock while the mainland translocations involved wild-caught stock. The Midwest region has received translocations to Francois Peron National Park (5 species), Faure Island (AWC operated, 2 species), Heirisson Prong (3 species), Kalbarri National Park (2 species) and two islands off Jurien (2 species). All of these animals with the exception of woylies to Francois Peron and Kalbarri national parks were derived from captive-bred stocks. No translocations were

conducted using animals sourced directly from the wild in this region.

The Wheatbelt region has received only nine (9) translocations of six species to five sites (Lake Magenta, Tutanning, Dragon Rocks and Boyagin Nature Reserves and Dryandra Forest) while providing founder populations for 25 translocations to other regions, but none to sites within Wheatbelt region. The Swan region has received 44 translocations to 12 sites involving nine species. Two of these sites are managed by the AWC and have received six species between them. The other ten sites are managed by CALM and have received eight species between them. Three species from a number of sites have been sourced from the wild for translocations within the region, and the remaining species have come from captive-bred stocks.

The Southwest region has received only eight translocations (six species) to eight sites. Batalling Forest has provided woylies for eight translocations within and external to the region and western ringtail possums have been sourced from the wild for translocations on two occasions and orange-bellied frogs from one site on one occasion. The Warren region has received 14 translocations (four species) to 12 sites. Perup Forest has provided woylies and tammar wallabies for 13 translocations within and external to the region. The South Coast region has received only four translocations to four sites (4 species) and has provided source populations for two translocations (1 species).

TABLE 4

Numbers of translocations conducted according to location of the release site within various CALM Regions. (Note: Some translocations of fauna approved as a single translocation are counted in each year that animals were released, hence the totals do not match those in Table 1).

CALM REGION	YEAR							TOTAL
	'96	'97	'98	'99	'00	'01	'02	
Midwest	1	2	4	2	5	4	2	20*
Wheatbelt	3	2	2	0	1	1	0	9
Swan	6	6	7	6	7	9	3	44
Southwest	1	0	2	0	5	0	0	8
Warren	0	0	4	5	3	0	5	17
South Coast	0	1	2	1	2	0	0	6
Pilbara	3	3	1	1	0	0	0	8**

* Includes 8 translocations to islands. ** Includes 3 translocations to islands.

Note: No translocations have been conducted in either the Kimberley or Goldfields regions to date.

TABLE 5

Number of translocations conducted according to the location of the source populations of animals within various CALM Regions for the years 1996–2002. (Note: Some translocations of fauna approved as a single translocation are counted in each year that animals were released, hence the totals do not match those in Table 1 above.)

CALM REGION	YEAR							TOTAL
	'96	'97	'98	'99	'00	'01	'02	
Midwest	1	0	1	1	0	1	1	5
Wheatbelt	3	4	4	3	4	4	3	25
Swan	2	1	1	0	4	1	0	9
Southwest	4	5	5	3	7	2	0	26
Warren	0	0	5	3	2	0	5	15
South Coast	0	1	1	2	1	0	0	5
Captive-bred	2	5	7	5	6	7	1	33

TABLE 6

Translocation history according by CALM Region / Division or external institution for the senior author of the translocation proposals for the years 1996–2002. (Note: Some translocations of fauna approved as a single translocation are counted in each year that animals were released, hence the totals do not match those in Table 1 above).

ORIGIN OF AUTHOR BY CALM REGION	NUMBER OF PROPOSALS	ORIGIN OF AUTHOR BY CALM REGION	NUMBER OF PROPOSALS
Midwest	5	South Coast	1
Swan	3	Science Division	25
Wheatbelt	1	Wildlife Branch	10
Southwest	5	Australian Wildlife Conservancy	10
Warren	13	CSIRO, UWA	5

There are now only three Science Division staff members actively engaged in research work on fauna species covered under *Western Shield* (one each on mammals, birds and reptiles). Three other staff are involved in research on cat control techniques. The small number of Science Division staff working on species covered under *Western Shield* relative to the total Division commitment seems at odds with the corporate priority that the program is meant to have. This issue may need to be reviewed.

When the results shown in Tables 4–7 are considered in concert it is clear that that effort being directed to *Western Shield* varies greatly between CALM regions and that in the Wheatbelt and South Coast regions in particular opportunities to advance conservation efforts through translocations are not being taken up with anywhere near the resolve that is being shown elsewhere. It will be important to clarify why there is such disparity in effort between regions and to ensure that there are clear directives from the CALM Executive that *Western Shield* is a corporate conservation program and that it is amongst the department's higher priorities.

COLLABORATIVE EFFORTS WITH ACADEMIC /TERTIARY AND OTHER RESEARCH INSTITUTES

During the seven years that the *Western Shield* program has been running a respectable list of student research projects have been initiated and completed covering a wide range of research fields and focusing on a considerable array of species (threatened and non-threatened).

Topics that have been covered include; biology, physiology, genetics, bioperturbation, reproductive ecology, conservation biology (via translocations) and the impacts of predators and eco-tourism. The various tertiary institutions that have been involved are detailed below along with the species of animals that have been studied by students from those institutions. With time the nature and focus of the research projects have become more refined and there has been a move towards an increase in the number of outcomes that have direct relevance to fauna conservation and management, two issues that will greatly improve the department's capacity to achieve better outcomes through *Western Shield*. Most of these projects

TABLE 7

Translocation history matrix (species x CALM Region) for the years 1996–2002. (Note: Some translocations of fauna approved as a single translocation are counted in each year that animals were released, hence the totals do not match those in Table 1 above).

	MIDWEST	WHEATBELT	SWAN	SOUTHWEST	WARREN	SOUTH COAST	PILBARA
Quokka			1				
Banded hare-wallaby	1						
Black-flanked rock-wallaby			2				
Tammar wallaby			5	1	4		
Woylie	2	1	2	7	10		
Boodie	2						
Mala	1						
Euro	1						
Numbat		2	2	1		1	
Quenda		1	6			1	
Western barred-bandicoot	1						
Bilby	1	1					
Chuditch	1	1				1	
Dibbler	1					1	
Western ringtail			3	1			
Greater stick-nest rat	1						
Shark Bay mouse	2						2
Malleefowl	1						
Noisy scrub-bird				1			
Western bristle-bird					1		
Western swamp tortoise			3				

have been conducted with only in-kind contributions provided by CALM, although a small number of the more recent projects have had direct financial input from CALM as well as access to data, field support and student supervision.

Universities

University of Western Australia – quokka, woylie, western swamp tortoise, numbat, chuditch, western barred-bandicoot, heath rat, pebble-mound mouse, dibbler, Gilbert's potoroo, brush-tail possum

Edith Cowan University – chuditch, quenda, woylie, banded hare-wallaby, mala

Murdoch University – brush-tail phascogale, woylie, quokka and western barred bandicoot (via Pest Animal Control CRC and Marsupial CRC), feral cat

Curtin University – western ringtail possum

Notre Dame University – chuditch

Charles Sturt University – woylie

University of New South Wales – quokka, western ringtail

University of Western Sydney – western barred bandicoot

Australian National University – western ringtail possum

Other research facilities

CSIRO – greater stick nest-rat, western barred-bandicoot, boodie, Tunney's rat

Pest Animal Control CRC – quokka, woylie, brush-tail possum

Perth Zoo/Marsupial CRC – dibbler, brush-tail possum, quokka

CONCLUSION

While *Western Shield* has provided many successful translocations, some have failed and it is still to soon to judge many others. There have also been significant departures from the original background document (see Burbidge *et al.* 1995) in relation to both the species used and at the areas covered. While this is basic adaptive management in practice, it is also apparent that there is a need for CALM to renew its commitment to the project and to direct some management and resource attention to regions such as the South Coast and Wheatbelt to ensure a consistent level of commitment within the overall *Western Shield* program.

REFERENCES

- Burbidge AH (1999) Translocation proposal for the western bristle-bird. Department of Conservation and Land Management, Western Australia.
- Burbidge A, Kuchling, G, Fuller PJ, Graham G, Miller D (1990) The western swamp tortoise. Wildlife Management Program No. 6. Department of Conservation and Land Management, Western Australia.
- Burbidge AA, Start AN, Morris KD, Armstrong R (1995) '*Western Shield* – Bringing back our wildlife.' Department of Conservation and Land Management, Western Australia.
- CALM see Department of Conservation and Land Management
- Danks A, Burbidge AA, Burbidge AH, Smith GT (1996) Noisy scrub-bird recovery plan. Wildlife Management Program No. 12. Department of Conservation and Land Management, Western Australia.
- Department of Conservation and Land Management (1995) Translocation of Threatened Flora and Fauna. Policy Statement No. 29, July 1995. CALM, Western Australia.
- Department of Conservation and Land Management (1999) 'Draft *Western Shield* Fauna Recovery Program – Strategic Plan (July 1999-June 2004).' CALM, Western Australia.
- Friend JA (1994) Recovery plan for the numbat (*Myrmecobius fasciatus*) 1995-2004. Western Australian Wildlife Management Program No. 18. Department of Conservation and Land Management, Western Australia.
- Friend JA (2001) Translocation proposal for dibbler (*Parantechinus apicalis*) from Perth Zoo to Peniup proposed Nature Reserve. Department of Conservation and Land Management, Western Australia.
- Friend JA, Orell P (2000) Translocation proposal: re-introduction of bilby (*Macrotis lagotis*) to Dryandra woodland from Return To Dryandra breeding colony enclosures and Kanyana Captive breeding colony. Department of Conservation and Land Management, Western Australia.
- Garkaklis MJ (2001) 'Digging by the woylie *Bettongia penicillata* (Marsupialia) and its effects upon soil and landscape characteristics in a Western Australian woodland.' Ph.D. thesis, Murdoch University, Western Australia.
- Garkaklis MJ, Bradley JS, Wooller RD (1998) The effects of woylie foraging on soil water repellency and water infiltration in heavy textured soils in southwestern Australia. *Australian Journal of Ecology* **23**, 492-496.

- Garkaklis MJ, Bradley JS, Wooller RD (2000) Digging by vertebrates as an activity promoting the development of water-repellant patches in sub-surface soil. *Journal of Arid Environments* **45**, 35-42.
- IUCN (1987) The IUCN position statement on translocation of living organisms: introductions, re-introductions and re-stocking. IUCN, Gland, Switzerland.
- Kawalilak R, Higgs N, Moore E (2004) Communications, community awareness and schools education programs: *Western Shield* review—February 2003. *Conservation Science W. Aust.* **5** (2) 96-107. Department of Conservation and Land Management, Western Australia.
- Mawson PR (2004) Captive breeding programs and their contribution to *Western Shield*: *Western Shield* review—February 2003. *Conservation Science W. Aust.* **5** (2) 122-30. Department of Conservation and Land Management, Western Australia.
- Morris KD, (1993) Interim wildlife management guidelines for the Thevenard Island mouse *Leggadina* aff. *lakedownensis*. Department of Conservation and Land Management, Western Australia.
- Morris K, Barton B (1996) Translocation proposal for malleefowl - eggs from nest in the wild to be incubated and subsequent young released into Francois Peron National Park. Department of Conservation and Land Management, Western Australia.
- Morris K, Short J (1999) Translocation proposal for greater stick-nest rat: Salutation Island to Heirisson Prong. Department of Conservation and Land Management, Western Australia.
- Morris K, Sims C, Himbeck K, Christensen P, Sercombe N, Ward B, Noakes N (2004) *Project Eden* - fauna recovery on Peron Peninsula, Shark Bay: *Western Shield* review—February 2003. *Conservation Science W. Aust.* **5** (2), 202-234. Department of Conservation and Land Management, Western Australia.
- Morris K, Speldwinde P, Orell P, (2000) Djoongari (Shark Bay mouse) recovery plan. Wildlife Management Program No. 17. Department of Conservation and Land Management, Western Australia.
- Murphy MT (2002) 'Caching of sandalwood (*Santalum spicatum*) by the woylie (*Bettongia penicillata*) in Dryandra woodland.' B.Sc. (Hons) thesis, Murdoch University, Western Australia.
- Murphy M, Garkaklis MJ, Pronk G, Dell G, Hardy G (2002) The role of caching by woylies (*Bettongia penicillata*) in the development of a sustainable sandalwood industry. Ecological Society of Australia Symposium, Cairns.
- Orell. P (2004) *Western Shield* : Fauna monitoring and staff training 1996-2002: *Western Shield* review—February 2003. *Conservation Science W. Aust.* **5** (2) 51-95. Department of Conservation and Land Management, Western Australia..
- Orell P, Dans P (2002) Translocation proposal for black-flanked rock-wallaby (*Petrogale lateralis lateralis*) from Mount Caroline Nature Reserve and Querekin Rock to Walyunga National Park. Department of Conservation and Land Management, Western Australia.
- Orell P, Morris K (1994) Chuditch recovery plan. Wildlife Management Program No. 13. Department of Conservation and Land Management, Western Australia.
- Pearson D, Jones B (2000) Lancelin Island skink recovery plan. Wildlife Management Program No. 20. Department of Conservation and Land Management, Western Australia.
- Short J (1995) Interim recovery plan for the western barred bandicoot (*Perameles bougainville*). CSIRO Division of Wildlife and Ecology, Perth.
- Short J, Friend AJ (1995) Translocation proposal for the western barred bandicoot. CSIRO and Department of Conservation and Land Management, Western Australia.
- Short J, Turner B (2000) Reintroduction of the burrowing bettong *Bettongia lesueur* (Marsupialia: Potoroidea) to mainland Australia. *Biological Conservation* **96**, 185-196.
- Sims C (1997) Methodology for relocation of Euros from Useless Loop to Carrarang Station. Department of Conservation and Land Management, Western Australia.
- Sims C, Barton B (1997) Translocation proposal for malleefowl - eggs from nest in the wild to be incubated and subsequent young released into Francois Peron National Park. Department of Conservation and Land Management, Western Australia.
- Start T, Burbidge A, Armstrong D (1995) Woylie recovery plan. Wildlife Management Program No. 16. Department of Conservation and Land Management, Western Australia.
- Start AN, Anstee SD, Endersby M (2000) A review of the biology and conservation status of the ngadji, *Pseudomys chapmani* Kitchener, 1980 (Rodentia: Muridae). *CALMScience* **3**(2), 125-147.
- Wardell-Johnson G, Roberts JD, Driscoll D, Williams K (1995) Orange-bellied and white-bellied frogs recovery plan. Wildlife Management Program No. 19. Department of Conservation and Land Management, Western Australia.
- Watson KE (2002). An experimental comparison of digging activity and soil displacement by the southern brown bandicoot (*Isodon obesulus*) and the woylie (*Bettongia penicillata*) in southwestern Australia. B. Sc. (Hons) thesis, Murdoch University, Western Australia.