

Independent review of *Western Shield*—February 2003

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THE WESTERN SHIELD FAUNA RECOVERY PROGRAM FOR WESTERN AUSTRALIA

Australia's native fauna have not fared well in the past 200 years due to environmental changes, including clearing of native vegetation, altered fire regimes and the introduction of predators such as the fox. This is particularly true of its medium-sized mammals. Twelve species of mammal that once occurred in Western Australia are now extinct and many more that were once widely distributed across much of the nation, or large parts of Western Australia, are now confined to a few isolated populations or a small number of offshore islands.

Research conducted in Western Australia over the past 30 years has shown that the most important current threatening process affecting these species is predation by foxes and feral cats. Similarly, research has shown that if these introduced predators can be controlled then many native species can recover in suitable habitats. In 1996 the Department of Conservation and Land Management (CALM) commenced a major fox control program called *Western Shield*. The program is now applied to nearly 3.5 million hectares of land (primarily in national parks, nature reserves and State forest), mostly in the southwest of the State. The fox control program is designed to reduce fox numbers enough to allow the affected native fauna to survive and recover. Fox numbers are controlled by laying dried meat baits containing the poison 1080 (sodium monofluoroacetate) at least four times per year.

Western Shield has five objectives. The first has been to maximise the recovery of sustainable populations of vulnerable native fauna by reducing the impact of fox and cat predation. In those areas where populations of native fauna have become locally extinct but suitable habitat remains, fauna are translocated to establish new populations. Preference is given to species that are currently considered threatened with extinction, but at specific sites the aim is to reconstruct entire suites of native fauna and associated ecological processes. The animals used in translocations are obtained from extant wild populations wherever possible. In those cases where extant populations can not presently sustain the removal of even small numbers of animals for translocation or where the costs and logistics of collecting them from the wild are

prohibitive, then animals are bred in captivity specifically for the purpose of release into the wild at sites protected from introduced predators. Indicator species are monitored at selected locations across the geographic extent of the *Western Shield* program to measure the recovery of extant populations of native fauna and the establishment of translocated populations. The successes of the program to date have enabled four species to be supplied to other States for re-establishment.

While foxes are the main threat in many areas of the State, in particular the higher rainfall areas of the southwest, it is also recognised that feral cats are a major threat to some species in more arid environments. The second objective of the *Western Shield* program has been to develop cost efficient and effective control techniques for foxes and feral cats. The success of this element of the program will largely determine the technical capacity of CALM to expand predator control efforts and fauna re-introductions into arid environments. The extent of the implementation of these techniques will depend on the availability of financial resources necessary for such an expansion.

The third objective relates to CALM's ability to conduct the program. The community's acceptance of the program is largely dependent on the development and conduct of an education and public relations program to increase awareness of the effect of fox and feral cat predation on native fauna and what can be done to mitigate this effect. The Department also has a responsibility to ensure that adjacent landholders are aware of the risk to domestic dogs and that any people visiting baited areas understand the implications of taking dogs into those areas.

The fourth objective has required that the *Western Shield* program makes the best use of new and existing research to enhance its recovery programs. It is important that vital and effective links be maintained between research and management to maximise the returns gained from available funds and staff resources.

The final objective has been to provide opportunities to develop and maintain partnerships with groups and organizations (e.g. universities, non-government conservation organizations, commercial businesses) to maximize the efficiency and effectiveness of fauna recovery across Western Australia, and where possible Australia.

The *Western Shield* program has been running for seven years and it is appropriate that the program be reviewed to determine how successful it has been, what aspects of the existing program should be changed, and in which direction those changes might take the program. It also provides an opportunity to examine resource allocation to the program, whether there is scope for savings, or an opportunity to build on the successes and invest additional resources to maintain or enhance the program.

The direct annual cost of *Western Shield* as of 2002 is about \$1.25 million with indirect costs that increase that amount at least two-fold. Only one staff member is directly employed under *Western Shield*, most of the costs are for on-ground work (see Wyre, this issue).

REVIEW METHOD

The terms of reference of the review panel are detailed in appendix 1. The formal part of the review took place over seven days, from 24 February to 2 March 2003. The schedule for the seven days was:

DATE	ACTIVITY
24 Feb	Review Panel arrived in Perth, visited captive breeding operations at Perth Zoo (Dr Terry Fletcher host), met the Minister for the Environment and Heritage and the Acting Executive Director, and met senior CALM staff involved in the review of <i>Western Shield</i> .
25 Feb	The panel attended a full day workshop at which twelve papers describing aspects of the program were presented. The workshop concluded with a general discussion. The invited audience included a wide array of people representing interstate and Commonwealth sister agencies, tertiary institutions, public interest groups, collaborating organisations, agencies and individuals, and CALM staff involved in <i>Western Shield</i> .
26 Feb	The panel met members of the Conservation Council of Western Australia before attending a full day, in-depth discussion of the subjects covered in the workshop. Other participants included review paper authors, senior CALM officers, including the Acting Executive Director and representatives from interstate and Commonwealth sister agencies.
27 Feb	The panel and senior CALM staff travelled to Harvey where they inspected the CALM bait factory and discussed practical issues associated with bait production with the local staff before travelling to Dryandra Forest. At Dryandra Forest, the panel was shown captive breeding facilities and the Barna Mia educational and public night-viewing facility. Local officers and Science Division staff involved in fauna recovery work at Dryandra hosted the visit.
28 Feb	The panel returned to Perth and met with the Acting Executive Director. Hugh Possingham returned to Brisbane late that night.

DATE	ACTIVITY
1 Mar	Peter Jarman and Allen Kearns, together with the Acting Director Nature Conservation and Director Science Division and other senior CALM officers flew to Denham (Shark Bay) via Geraldton, including a low level over-pass of Dirk Hartog, Bernier and Dorre Islands. Local staff hosted a visit to the Project Eden captive breeding pens and release sites in Francois Peron National Park.
2 Mar	The party returned to Perth Airport where Peter Jarman and Allen Kearns caught flights.

The Review panel used information gathered during the formal part of the review, other information, and their own experience in Australia and overseas, to formulate this report. The Review Panel provided a draft report to the Acting Executive Director on 16 March 2003, and following discussions with the Department finalised its report in August 2003.

Review

We believe that *Western Shield* is a world-class predator threat abatement program that is strategically targeted at the recovery of a wide range of threatened fauna. The success of the program has been a consequence of:

- south-west Western Australia's natural advantage in having 1080-tolerant native fauna, while introduced mammals remain susceptible
- implementing a scientific research and management framework that exploits that natural advantage
- a clear vision of the scale of the predation control challenge and the potential rewards in terms of reintroductions and *in situ* recovery of native fauna
- dedicated and competent staff
- operational efficiency, particularly with respect to baiting operations.

More specifically, the program has achieved:

- formal improvement in the listed conservation status of the woylie, tammar wallaby and quenda, and improvements in the abundance and distribution of many other critical weight range mammals. This has been achieved within a remarkably short timeframe. Few Australian fauna have improved their conservation status through direct action—most improvements in threatened species status have been through discoveries of new populations or changes in taxonomy.
- increases in the number of 'viable' populations of several critical weight range mammals.
- broad-scale, although not always quantified, improvement in the status of a broad spectrum of other species—e.g. reptiles and ground nesting and/or foraging birds.

- a recovery of certain, but poorly defined, ecosystem services associated with fauna recovery. For example soil turnover of 6 tonnes/yr/woylie, has improved soil water penetration and enhanced seed dispersal (see references in Mawson, this issue).
- development of skills and knowledge relating to the intensive and extensive captive-breeding of several threatened mammal species, and their translocation and release to the wild
- advances in baiting methods including the prospect of successfully baiting cats
- growing public awareness about Western Australia's threatened native fauna, and the role of feral predators as threats to native fauna.

The Department is to be commended for initiating an external and transparent review that will include the publication of 12 background papers. Independent and external reviews are all too rare in Australian conservation. The terms of reference given to authors included instructions to document successes, problems, threats and opportunities, as well as technical aspects of the program (Appendix 2).

During the course of the review, and as part of the review terms of reference, many issues were discussed. The purpose of this review is not to rehash those discussions in detail, but to provide clear recommendations with succinct justification. These recommendations are listed below.

Recommendations

1. **Future of *Western Shield*.** We believe that *Western Shield* should continue. It is a world-class and iconic threat-abatement program that has delivered real conservation outcomes with high efficiency at a time when most of Australia's fauna and flora is still in rapid decline. In addition, we believe that *Western Shield* should be expanded to focus more effort into feral cat research and management. Particular attention needs to be focussed on cat-fox-dog-native fauna interactions at the whole-landscape level of ecosystem management.
2. **Scope of *Western Shield*.** Exactly what activities are, or are not, classified as part of *Western Shield* has evolved through a sequence of historical events. At one extreme *Western Shield* could be expanded to encompass all threats and recovery activities to do with rare and threatened fauna, or it could be contracted to deal with issues of fox control in the State's southwest forests. There is merit in retaining focus from both a strategic science and targeted marketing perspective. We believe that an appropriate and well-contained scope for *Western Shield* is:

Feral predator control (where predators include foxes, cats and in particular cases rats and maybe even pigs) for the purpose of recovering remnant, and re-establishing new, populations of critical weight range mammals and associated terrestrial vertebrates (e.g. reptiles, ground-nesting birds).

Where re-establishment requires various forms of captive breeding then these operations should be included in *Western Shield* in an integrated and effective manner, using a network of captive breeding facilities and operators. We recommend CALM clarifies the focus and develops a concise form of words that leaves the public and CALM in no doubt about what is, or is not, in *Western Shield*. It would be simplest if there were no anomalies (e.g. *Project Eden*) that some people currently consider to be in, and others out, of *Western Shield*. Based on the definition of *Western Shield* above, *Project Eden* would be part of *Western Shield*.

3. Management structure and strategic direction.

Western Shield has now reached a point of complexity in its organisation and operations where it needs one clear leader, whose task will be defined as the scope identified above. Ideally, that leader will be both the strategic science and business director and the public 'face' of *Western Shield*. CALM should consider whether *Western Shield* is of sufficient scale and complexity to warrant the appointment of a Director level position similar to the Director, Nature Conservation. If not, then a *Western Shield* Manager reporting to the Director, Nature Conservation, should have the resources and authority to commission management-oriented research, and review actions and advice from within and outside CALM. It is important that the *Western Shield* leadership and management structure recognises the need for, and empowers, both strategic leadership and managerial (operational) leadership. The *Western Shield* Manager will need to have a clear line of effective management and strategic direction. The person should also have access to independent science, economic and social advice from the Conservation Council of Western Australia or other appropriate bodies. The current management structure (1999–2003) places too much emphasis on the *Western Shield* Strategic Committee to co-ordinate activity between the Director, Nature Conservation, and the management committees for the South West, Project Eden and the future Arid Zone. It would be preferable to have clearly assigned Project Managers in each of these geographic zones taking advice from local advisory committees, made up of CALM staff and representatives from community and other science and Natural Resource Management based organisations in WA. The central co-ordinating role of the *Western Shield* Manager needs to be adequately resourced and organised to integrate cross-geographic synergies and learning for staff involved in baiting operations, communication, field research, monitoring, scientific advice and review, captive breeding and community involvement. At present

communication between some groups, especially those more geographically isolated, is not adequate. An annual meeting of CALM staff and stakeholders, similar to that initiated for the *Western Shield* Review would provide a great opportunity to build social capital for future challenges, develop program cohesion and enhance shared learning.

4. **Community involvement** in *Western Shield* could be enhanced by building on the goodwill already generated by *Western Shield* and by moving from efficient consultation and publicity to genuine dialogue and real partnerships. Mechanisms for effective community involvement are needed at different scales of operation of *Western Shield*. For example, high-level community representation, reporting and partnering could be developed through the Conservation Commission of Western Australia, or a similar body. More focussed local level participation could be developed by further fostering local community groups in project areas, along the lines of the Mallee Fowl Protection Group model. Some technology transfer should be part of that process. The *Western Shield* manager would interact frequently with these groups, and report those interactions annually to CALM. The Conservation Commission, or similar body high level reference group, should provide broad strategic and stakeholder advice and not be involved or concerned with day-to-day issues on local projects where local community groups are operating with CALM.
5. **Full-cost accounting.** Choosing between different management options requires an understanding of the full costs and risks of those options. For example whether or not to embark on a new baiting application, a captive breeding program, a breeding facility such as the one at Dryandra, or use an island to develop a new population means the full costs of these activities need to be determined. This information, along with the careful application of risk assessment, will enable the program to maximise its expected benefits (Appendix 3). Full cost accounting must include direct costs, salary costs, infrastructure costs and discounting, and organisational infrastructure costs. For example, normal multipliers for full cost recovery are between 2 and 3 times salary costs.
6. **Bait Development, Procurement and Delivery.** Both CALM and the Agricultural Protection Board of WA have made impressive advances in the development and delivery of baits as well as the wise use of 1080 for predator control in WA. The Review Panel also consider that there is an interdependence between the two organisations and their different approaches to 1080 bait development using Dry Meat Baits (APB) and Probait sausages (CALM). There was some discussion during the review about the need for full-cost accounting to be used to make sure that decisions that could affect the Agricultural Protection Board of WA are made on an equitable basis. Importantly, the loss of one department's future capacity to prepare baits could lead to the unintended

consequence of poorer predator control in WA because both departments serve different land jurisdictions and stakeholders. The concern is that the loss of either DMB or Probait could lead to a 'brittle monopoly' for the sole supplier of baits not having the capacity to adequately deliver enough baits to both production and protection interests in WA. It is recommended that the departments consider a co-operative approach to meeting bait development needs and community involvement in bait delivery in the future. A more open process of scientific, community and technological review of bait development and delivery techniques would greatly enhance co-operation in this area that is of vital importance for the future of *Western Shield*. The bait factory developments at Harvey, and the development of long-life baits and alternative toxins to 1080, are strongly supported by the panel. In addition, because baiting operations are such a costly part of *Western Shield* it was felt that consideration should be given to modifying the actual baiting operations themselves in order to reduce costs. For example, as part of an active adaptive management approach consideration could be given to reducing the number of annual baiting cycles from four to three by dropping the winter operation or by reducing the number of baited areas after evaluating the monitoring information.

7. **Monitoring.** Monitoring in wildlife management can have one of four purposes:
 - a. Provide information for public relations. Much of the monitoring for *Western Shield* and associated programs provides important material for public relations. The recovery of local populations and increases in the number of local populations of key fauna are important and compelling information that engages community support and justifies continued public and private investment. We recommend that some of the indirect benefits of *Western Shield* (e.g. recovery of non-target fauna and complete communities) and the recovery of ecosystem processes (soil litter turnover and seed dispersal) are used more in future publicity.
 - b. Provide information with respect to performance targets – an auditing function. This is not always a very profitable function.
 - c. Trigger pre-specified actions and inform management about opportunities to change the management program to test new ideas and/or reallocate funds to other priorities. For example one might wind-back monitoring once a population has an $x\%$ trap success for five consecutive years, or increase bait frequency if a particular population shows no response after y years.
 - d. Monitoring needs to be seen, and enabled, as the critical feedback loop for information flow in an active adaptive management framework, see recommendation 8.

Monitoring has also engaged CALM District operational staff in *Western Shield* and has provided valued and valuable skills training.

We recommend that management review the purposes of monitoring and the extent to which the present techniques, distribution, and staff input effectively and efficiently fulfils these purposes. Issues of data management and analysis are in the next recommendation on research needs.

8. Research needs.

- a. *Basic questions.* *Western Shield* research purchased by the proposed business manager (recommendation 3) should be targeted at solving critical problems. Certain critical problems are already under active investigation—including the problem of cat control and appropriate baiting, and the question of pre-release predator training for captive-bred stock. These specific management-based research questions appear to be well thought out and carefully targeted. In all management there is a trade-off between actions that enhance learning and actions that are most likely to achieve management goals. There are a few questions where existing management actions could be reformulated in an experimental framework to deliver knowledge that will improve future management— for example, alterations in the frequency and intensity of fox baiting, including pulse baiting or even no baiting in a few sites where species like woylie, quenda and brush-tailed possum populations appear to have recovered.
- b. *Research partners.* Expand interaction with universities (inside and outside WA), CSIRO and others to deliver research outcomes in peer-reviewed and broadly accessible literature (cf New Zealand Department of Conservation model).
- c. *Quantitative ecology in CALM.* Build critical in-house capacity for modelling population and community dynamics and ecological statistical expertise in CALM, or acquire the expertise in a strategic manner from research partners. More specifically, one of the largest data sets presented to the Review Panel is that presented by Peter Orell (this issue). Whilst the lack of control site data is a problem, the capture data could be analysed with advanced time series methods to disentangle information about the effects of baiting, rainfall, density-dependence and interaction between species. Such analysis is a first step towards designing experimental management regimes.
- d. *Data storage.* Where the community is involved in data collection, very basic data storage using common packages (e.g. ACCESS) and delivery through the Web may be the best option. One person must be nominated as data custodian to ensure quality and consistency before web-based delivery. Attractively presented web-based deliver

can be a good community communication device and may attract research partners.

Overall we recommend enhancing the experimental aspects of *Western Shield* management within an active adaptive management framework.

9. **Dingoes.** There is healthy debate within CALM, and more broadly, on the role of dingoes in Australian ecosystems. From a broader perspective, it is probably true that dingoes deliver cat and fox control benefits, a form of ecosystem service, in areas where they retain their numbers and social organisation. The Department could take a leadership role in Australia by reviewing the role of dingoes in the restoration of ecosystems and drawing together national and international expertise in multi-species predator systems. This would be the step towards determining a long-term management position for dingoes in different ecosystems. As CALM scientists know, there is a considerable international literature on the management of predator systems and the problems of meso-predator release from removal of top predators.
10. **Cats.** The control of cats, and the likely competitive release of cats following the loss of other predators in the arid zone (see recommendation 8 above), is a significant issue that *Western Shield* is actively addressing. We strongly support and expanded effort on cat research and management which could be the focus for reinvigorating the original vision of *Western Shield* and the next phase of its implementation. Such a program would have implications across Australia and partnerships with other state agencies and research groups should be developed further to address this nationally significant problem.
11. **Moving outside the southwest forests and *Project Eden*.** CALM could consider developing action research and active adaptive management projects along the interior edge of the wheatbelt, working from the outset in negotiated projects in partnerships with private conservation organisations and community groups in farming areas. This might address some of the current disparities between CALM Regions in their involvement in translocation and faunal reconstruction programs. The interior edge of the wheatbelt may be a logistically simpler place than more central WA deserts to reconstruct unfenced, semi-arid, critical weight range fauna. However, the bold and visionary strategy implemented by CALM in the southwest forests and *Project Eden* would need to be fully revitalised and scaled up to tackle the world-class conservation challenge faced in overcoming cat predation effects and small mammal reintroductions in the arid zones and rangelands of WA. In order to meet this visionary challenge, there needs to be research into how large areas of the arid zone of Australia could sustain viable populations of native fauna in largely unfenced ‘mainland islands’.

- 12. The role of islands and marooning.** The costs of island-based work are high, but can deliver more secure populations if successful eradication of cats, black rats and rabbits is possible. The rationale for continued work on islands needs to be fitted within a cost-benefit analysis (Appendix 3). Opportunities exist on islands for harbouring and marooning endangered fauna, as well as for experimental trials of novel baiting techniques and other pest animal control techniques with an emphasis on ecosystem management, for example, habitat manipulation and recovery. Recent developments on the eradication of cats on Faure Island, close to Peron Peninsula, and the eco-tourism centre at Monkey Mia, offers new opportunities for the use of islands to encourage fauna recovery in WA.
- 13. Public relations.** The active program of public relations needs to continue to maintain community profile and support. However, a strategy needs to be developed to best communicate and report on failures in order to educate the community more broadly that success in ecological restoration is highly uncertain. Indeed failures are a necessary part of a risk-weighted management system that intends to maximise expected benefits rather than be excessively risk-averse. Openly discussing disappointing news will build community trust and a better understanding of the reality of predator control and the difficulty of implementing native mammal recovery in Australia.
- 14. Captive breeding.** A network of CALM staff, and research and community collaborators, needs to be developed to more effectively capture and transfer the valuable science management knowledge being developed within the different captive breeding programs providing animals for reintroductions. There is an extraordinary level of commitment and ingenuity being practised within the different captive breeding and intentional release projects and the different groups would benefit from a facilitated network, with both virtual exchanges of knowledge and actual exchanges of personnel. A systems analysis of the currently fragmented captive breeding programs is essential input for choosing between management options and maximising the benefits of working with interested partners.
- 15. Co-ordination between projects at Shark Bay.** The current program on the Peron Peninsula involves intensive management of animals in small pens with consequent high husbandry requirements, likely undesirable modifications to animal behaviour, and higher disease risks. The facilities appear to require significant upgrades to overcome some inherent problems with the incursion of large numbers of house mice and occasionally snakes. The current facility is clearly a significant investment in terms of the costs of maintaining even the existing inadequate infrastructure and the amount of staff effort required to maintain the animals and the facilities at Peron. The current program needs to be reviewed in terms of what critical role the facility plays in the reintroduction of animals and the role it could achieve in terms of public education, along the lines of the Barna Mia model at Dryandra. For example, the existing Peron captive breeding facility could be replaced by one of two alternative models: Large semi-free range yards similar to the 17-hectare yards used on Heirisson Prong. This model is likely to work best on Peron if integrated with ecotourism (nocturnal viewing like the Barna Mia facility), or Replacement of captive breeding entirely by establishment of free-range populations at smaller and more secure nearby sites (Faure Island and/or Heirisson Prong). These sites allow extensive breeding of wild populations at the scale of 1200–5000 ha. Faure Island provides a cat-free site, while Heirisson Prong's smaller size makes it easier to guarantee effective cat control. Both of these sites could become sources for reintroductions elsewhere (note that burrowing bettongs from Heirisson Prong have already been used to start new populations at Roxby Downs and Faure Island). Both sites could support secure populations of species known to be highly sensitive to cat predation that are unlikely to be effectively established on Peron in the short to medium-term.
- 16. Publication and communication.** *Western Shield* is an exemplary program, at the forefront of Australia's conservation effort. It already influences conservation opinion and practice in other Australian States, more often than not through word of mouth. *Western Shield* could well be seen as an international exemplar of strategic cost efficient conservation management. To serve Australian and international conservation most effectively, its activities and outcomes need to be transparently and promptly reported. We suggest that CALM designs and implements means for the rapid and accurate dissemination of *Western Shield* data and their interpretation, in addition to timely publication in peer-reviewed journals of science and management. Journals like *Bioscience* or *New Scientist* would be appropriate venues to overview the science-management interaction within the program. Publishing some of the more rigorous papers from the review in the international peer-reviewed literature would be worth the effort. There is an exploding suite of conservation journals to which this applied research could be submitted: *Ecological Applications*, *Conservation Biology*, *Biological Conservation*, *Journal of Applied Ecology*, *Animal Conservation*, *Oryx*, *Pacific Conservation Biology* and *Biodiversity and Conservation*.
- 17. The wise use of 1080.** *Western Shield* builds on 15 years of research by the Agriculture Protection Board in WA (particularly Denis King) and CSIRO Wildlife and Ecology in Canberra (John McIlroy) to establish the respective tolerances of native and pest species to 1080. This research established the generally far higher tolerances of native species in WA when compared with native species in eastern Australia and

non-native pest species such as rabbits, foxes and cats. These differences were linked to the co-evolution of native species in the west with native peas (*Gastrolobium* spp.). These peas contain sodium monofluoroacetate as a secondary compound to deter herbivory. This compound is the same active ingredient as in 1080. *Western Shield* also built on the observations of:

- Faunal decline following the phasing out of extensive use of 1080 'one-shot' oat baiting for rabbit control in wheatbelt areas with the introduction of a new vector for myxomatosis, the rabbit flea.
- The coincidence of surviving remnant populations of mammals in south-west WA and dense forest or woodland understoreys containing thickets of *Gastrolobium*.

- Initial successes by CALM (Jack Kinnear) in the management of remnant populations of threatened mammals in the late 1980s and early 1990s. These include the resurgence of numbats at Dryandra and of populations of black-footed rock wallabies on isolated rock stacks in the WA wheatbelt following the introduction of fox management.

Clearly, the success of *Western Shield* is underpinned in large part by the availability of 1080, its natural occurrence in native vegetation and the tolerance of a wide range of native mammals in WA to 1080. The 1080 toxin plays a fundamentally important role in the conservation of the biodiversity and natural heritage of WA. Based on the WA experience, and while viable alternatives to 1080 are not available, it would be prudent, if not essential for Australian nature conservation, to retain the wise use of 1080 in Australia.

APPENDIX 1

Terms of Reference of Review Panel

The members will:

- Act collaboratively as a Review Panel

The Panel will:

- Prepare and submit a report to the Acting Executive Director. The report will be available for public comment before presentation of the final report to the Minister for the Environment and Heritage.

The report will address strengths and weaknesses in:

- The concept and parameters of the project
- The geographical distribution of operational programs throughout the State
- The operational implementation of feral predator control procedures from bait procurement and deployment to public awareness of baiting operations
- The operational implementation of fauna management procedures from captive breeding and translocation to monitoring (and response to monitoring results)
- The direction and methodology of research programs, particularly in regard to cat control
- Management of the project at all levels, particularly integration of the various components as well as monitoring and reporting
- Allocation of resources
- The cost-effectiveness of the project
- Public awareness and acceptance of the project, including the use of 1080 baits

- Any other issues that the panel deems significant to the improvement or future implementation of the *Western Shield* project.

The report will comment on proposals for future directions and make recommendations for:

- Improvement to existing components
- Varying (increase or decrease) the current funding allocations
- New initiatives.

Responsibilities of the Department of Conservation and Land Management

The Department will make available to Panel members pertinent information through:

- Presentation of papers at a workshop
- Opportunity for in-depth discussion with key people in all areas
- Opportunity to visit a range of sites where components of the project are carried out
- Facilitating access to further information that the panel deems desirable or necessary to its task.

Duration

The Panel's function will cease after it has reported to the Department to the satisfaction of the Acting Executive Director.

APPENDIX 2

Terms of Reference for CALM authors assigned the task of writing background papers for the *Western Shield* review process

Authors were asked (where relevant) to:

- consider their topic in relation to the 1996 *Western Shield* proposal and the *Western Shield* Strategic Plan (July 1999 to June 2004)
- provide sufficient background, detail and budget information to allow independent assessment and review
- address specific terms of reference (detailed below)
- provide a summary that addressed objectives, achievements (against targets), difficulties, potential economies and potential improvements.

They were also advised that the papers would be published in *Conservation Science Western Australia* as a useful landmark against which future work can be judged.

Financial analysis—*Gordon Wyre*

- Provide an overview of total costs of *Western Shield* (including staff time) and discuss cost-effectiveness in relation to the objectives set in 1996.

Baiting—*Roger Armstrong*

- List all areas being baited with dates of commencement and costs of each operation, overall and per hectare.
- Consider the results of the ‘Foxglove’ research conducted by Paul de Tores into baiting intervals and protocols, and any other relevant research, and discuss what the results mean for future baiting plans.
- Discuss issues relating to bait production and past and future costs.
- Discuss the development of Pro bait and the steps needed to obtain registration.
- Discuss whether all programmed baitings have been conducted, and if some have not occurred, state the reasons.
- List any changes made to baiting protocols at any site, state why the decision to make changes were made and by whom, and any evidence suggesting that changed baiting regimes may be more or less effective.

Monitoring and staff training—*Peter Orell*

- Present all monitoring data for all sites in a summarised and analysed format that allows easy comparison between sites.
- Discuss where monitoring data suggests that baiting has not produced any, or produced only limited, species recovery.

- Discuss locations where species numbers have declined after an initial increase.
- Discuss any problems in monitoring, including failures to meet monitoring targets and problems with data being received or data being inadequate.
- Describe past and current staff training programs, list all staff who have graduated from the mammal conservation course and whether they have used the skills they developed. Provide any feedback from staff who have attended the courses.
- Discuss options for future training programs.

Community support and education—*Ron Kawalilak, Liz Moore and Nigel Higgs*

- Provide an overview of work done to present *Western Shield* and its progress to the general public.
- Provide an overview of programs aimed at school pupils and describe how successful they have been.
- Discuss what changes in public perception and attitude have resulted from the community support and education programs carried out.

Translocations and fauna reconstruction sites—*Peter Mawson*

- Provide a list of all fauna translocations that have taken place under *Western Shield* since 1996 together with information on the success or failure of each translocation. Provide an overview of the reasons for each translocation and what monitoring has been undertaken.
- For each species translocated, present information on its conservation status at the time of the translocation and its conservation status now.
- Discuss how the translocations have helped achieve *Western Shield* targets.
- Discuss how translocations have been integrated to achieve targets for Fauna Reconstruction Sites.
- Where translocations have occurred of species that are not critically endangered or endangered, state why the translocation occurred.

Captive breeding and coordination—*Peter Mawson*

- Provide an integrated overview of breeding programs being run at Shark Bay, Dryandra, Two Peoples Bay, Kanyana, and Perth Zoo, including founder numbers, breeding success and death rates within the colonies, costs per animal produced.

- Present information on costs of captive breeding at departmentally-operated sites and elsewhere.
- Discuss why captive breeding was chosen as a strategy for each species and what alternative strategies were considered.
- Discuss whether the Department should be involved in captive breeding at each or any of these sites or whether captive breeding would be more effectively and efficiently carried out at Perth Zoo or other specialist captive-breeding facilities.

Feral cat control—*David Algar and Neil Burrows*

- Provide an overview of all research aimed at developing broadscale control technology for feral cats.
- Present results of cat control experiments across various climatic/habitat types.
- Discuss any current obstacles to broadscale implementation and timelines for overcoming them.
- Discuss how and when bait registration can be achieved and the likely cost of feral cat baits.

Threatened fauna issues not covered under *Western Shield*—*John Blyth and Andrew Burbidge*

- Provide an overview of threatened fauna recovery projects not included in the *Western Shield* umbrella.
- List critically endangered and endangered fauna species for which there are no or limited recovery programs and state whether these species have an approved or draft recovery plan. List what recovery actions are underway or needed for each of them.
- Discuss the pros and cons of including additional or all fauna recovery projects under *Western Shield*.

Return to Dryandra—*Tony Friend and Brett Beecham*

- Provide an overview of the project against original targets.
- Present results from breeding and a critical analysis of viability of the Dryandra site for the project.
- Discuss management of the project in relation to the involvement of staff from different departmental divisions.
- Present an overview of future plans.

Project Eden—*Keith Morris, Nigel Sercombe and Colleen Sims*

- Provide an overview of *Project Eden* against original targets.
- Discuss breeding plans, translocation results and timelines and future resource requirements.
- For each species translocated, discuss whether it is likely to establish without any additional translocations.
- Present an overview of future plans.

Montebello Renewal—*Andrew Burbidge*

- Provide an overview of the project against original targets.
- Discuss feral animal eradication methods and results, with justification for any new methods introduced.
- Discuss translocations, why they took place before eradication of introduced animals had been achieved within the whole archipelago.
- Present an overview of future plans.

Western Shield as a fauna management tool. Case studies using the western ringtail possum and the quokka—*Paul de Tores*

- Outline the distribution, changes in status over time and probable causes of change for each species
- Identify the components of *Western Shield* being used in the management of each species (e.g. predator control, translocation) and the populations being managed.
- Identify all the people (and their roles) involved in the management of each species
- Describe or tabulate the implementation of *Western Shield* actions with respect to each managed population and the process for modifying prescriptions
- In consultation with key people from each involved Region, assess the efficacy of the implementation of *Western Shield* actions and decision making procedures

APPENDIX 3

Adopting a decision-theoretic approach to choosing between management options for *Western Shield*

While developing a decision-theoretic approach to threatened species management is a research program in itself - we present a crude model of the application of decision theory to choosing between different management options largely as a tool to introduce this way of thinking.

At any point in time a program like *Western Shield* must decide how to allocate resources across a range of possible management options. For example we may be considering a captive breeding program for Gilbert's potoroo, expanding fox baiting to a new area or marooning a population of Bilbies on an island from which they are currently absent. Here is an example of how a structured decision-making tool might help us to make, *not make*, that decision.

Assume the value of a new population of species i is

$$V_i = \sqrt{(1/N_i)},$$

where N_i is the current number of extant relatively viable populations of that species. Hence establishing the second population of a species gets us 1 point, the third population about 0.7 points and the 10th population about 0.3 points. This (or a similar formula) places more weight on establishing populations of species that have fewer extant relatively viable populations.

The benefit of any management action can now be evaluated as a combination of its cost, 'value' as defined above, and probability of success. For example if V_j is the 'value' of action j (which is the sum of the V_i values because any action could help more than one species), P_j is the probability of success and C_j is the cost (in \$ - add recurrent annual expenses to capital cost divided by ten) then the net expected value of action j is

$$\text{Net expected value per million \$ to conservation} = 1000000V_jP_j/C_j$$

Three management actions are evaluated in the table below and their 'value' per million dollars is assessed. Actions with a significantly higher value per million dollars are probably better choices all else being equal.

On which basis we would conclude that option 2 seems significantly better than options 1 and 3, and that options 1 and 3 are indistinguishable. NB these numbers are hypothetical.

MANAGEMENT ACTION (HYPOTHETICAL)	VALUE	PROBABILITY OF SUCCESS	COST PER ANNUM FOR 10 YEARS	NET BENEFIT
Captive breeding Gilbert's potoroo	1	20%	\$125,000	1.60
Maroon bilbies and western-barred bandicoots on island	1/2+1/3	30%	\$ 62,500	4.00
Fox bait a new site for woylies and chuditch	1/5+1/6	90%	\$ 25,000	1.56

Note: these numbers are hypothetical.