Protected Areas Programme

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Protected Areas in Western Australia

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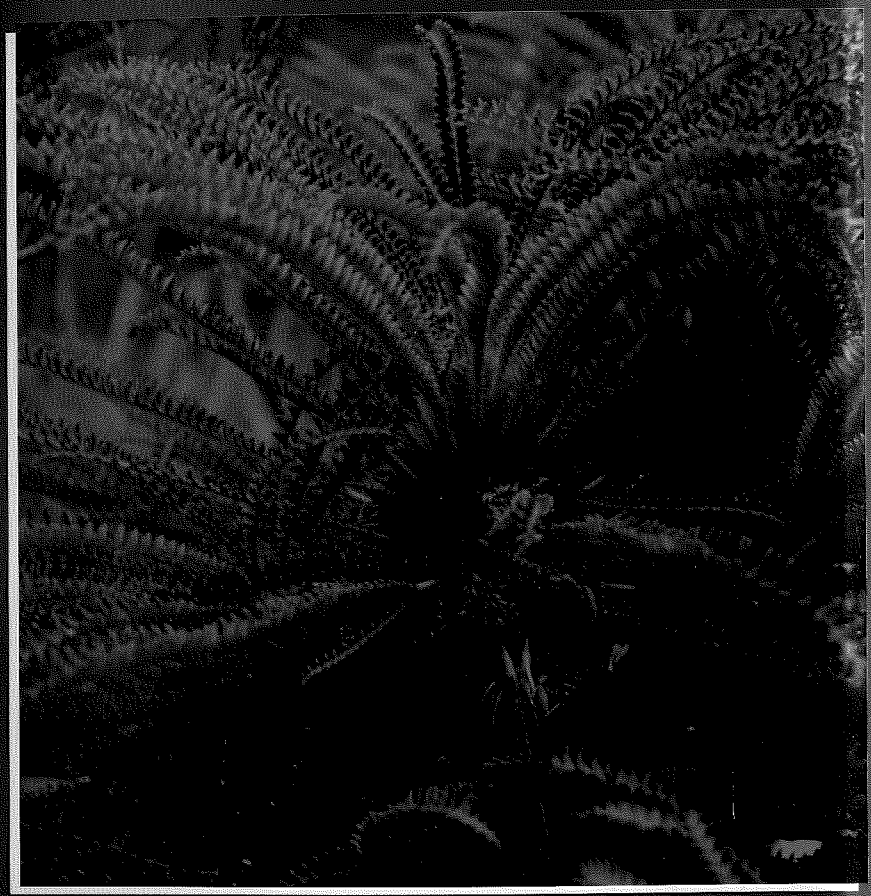

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PARKS is published to strengthen international collaboration among protected area professionals and to enhance their role, status and activities by:

- maintaining and improving an effective network of protected area managers throughout the world, building on the established network of WCPA
- serving as a leading global forum for the exchange of information on issues relating to protected area establishment and management
- ensuring that protected areas are placed at the forefront of contemporary environmental issues such as biodiversity conservation and ecologically sustainable development

Cover photo: Dryandra montana, *a Critically Endangered endemic plant found in Stirling Range National Park, Western Australia.* Photo: Ellen Hickman.

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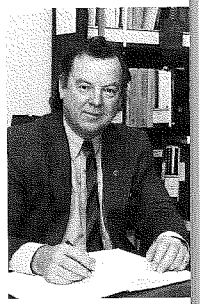
Editorial

LEE THOMAS



THIS EDITION OF PARKS features papers relating to Western Australia and in particular the South East Region of that State. This region is featured since it will be the venue for the Commission's "From Islands to Networks" Symposium, to be held in the township of Albany and its environs between 23 and 29 November 1997.

The papers provide a snapshot view of conservation management in Western Australia involving both the governmental sector, private interests and the community. The integrated management approach which has been developed embraces the philosophy of policies determined by the Western Australian Government in response to the views of the community. The integrated approach to the management of public lands and wildlife, which has commercialisation as one of its core elements, remains controversial in some quarters. However, as these papers show, there can be no doubt that it represents a workable solution, harnessing resources, commitment and effort from a range of sources for the betterment of nature conservation.

These papers show that Western Australia is quite unique in nature conservation terms. The isolation of this ancient land, its reworked landscapes and infertile soils, together with its diverse and variable climates, have combined to facilitate the evolution of a complex and diverse biota. There are more than 12,000 flowering plant species in Western Australia, which is half of the total Australian flora. The majority of plant species are endemic. Among the 147 indigenous species of terrestrial mammals 29 are endemic. The coastline extends over 13,000 kilometres and is divided almost equally by the Tropic of Capricorn. Coral reefs extend further south than anywhere else in the world and include the Ningaloo Reef – the largest coral fringing reef in Australia.

The paper on wildlife corridors by Dr Andrew Bennett is included because of its general interest and because a number of the philosophies and guidelines developed in his forthcoming publication have either application for or have been drawn from work undertaken in Western Australia.

I trust that the papers presented here are of interest. For those fortunate to be able to travel to Albany and south-east Western Australia I hope that the reading will provide a valuable insight into what you can expect to see and experience in this beautiful and largely unspoiled part of the world.

Lee Thomas, WCPA Vice Chair, Australia and New Zealand, Environment Australia Biodiversity Group, GPO Box 636, Canberra ACT 2601, Australia.

Regional planning and protected areas in south Western Australia

JOHN WATSON

Regional planning is a valuable tool for setting a broad framework for more detailed planning levels. In particular it can provide for a protected area system a logical set of priorities for individual area management plans, and can identify a 'spectrum' of protected area types within a single IUCN category - similar to the Recreation Opportunity Spectrum (ROS) concept. Regional planning also provides a sound basis for strategic operational plans and for setting and evaluating individual works programmes.

ALMOST ALL protected areas in Western Australia are managed by the Western Australian Department of Conservation and Land Management (CALM). There are a very small number of protected areas under private ownership or management and some areas controlled by local government authorities which may also meet one or more of the IUCN categories.

Prior to March 1985 the CALM-managed protected areas were controlled by three different government agencies: national parks by the National Parks Authority; nature reserves by the Department of Fisheries and Wildlife; state forest/timber reserves by the Forests Department. Each agency operated under a separate act.

The functions of these three agencies with respect to protected area management were then combined through the establishment of CALM. The enabling legislation (CALM Act 1984) addressed new procedures for management planning, in particular:

- every national park and nature reserve should have a management plan
- management plans should be prepared in draft form, placed open to public comment for a minimum period of 2 months, and presented as a final form along with an analysis of public submissions
- management plans once approved by the Minister for the Environment could be valid for up to 10 years with provision for extension
- public involvement over and above the minimum requirements was allowed for, e.g. public workshops or establishment of planning advisory committees to help with plan preparation and provide for more detailed or formal public input.

The legislation also established quite restrictive procedures for the management of those national parks and nature reserves without completed management plans. In the absence of a management plan only 'necessary operations' could be undertaken, namely operations "necessary for the preservation or protection of persons, property, land, flora and fauna, or for the preparation of a management plan". Although these restrictions have now been relaxed for national parks through changes to legislation so as to allow for "compatible operations", any such proposals are also subject to public advertisement and are open to public comment.

In the absence of an approved management plan a framework was needed to undertake essential works such as fire management, disease control and recreation site maintenance on an interim basis. CALM has therefore developed "Interim

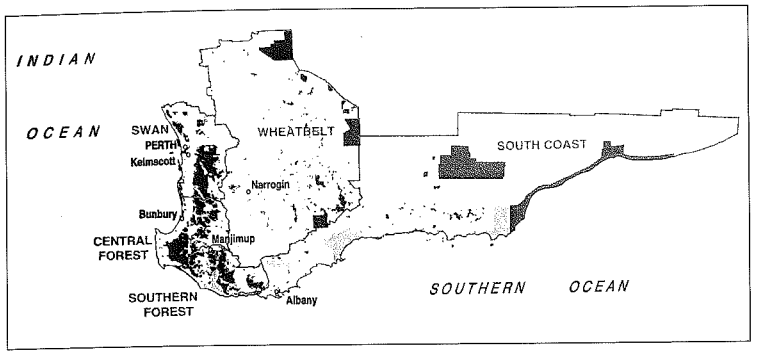


Figure 1. CALM managed lands and waters in south Western Australia. Light shading indicates National Parks, dark shading indicates other protected areas.

Management Guidelines" (IMGs) for these areas to address such issues. These documents are prepared by operations staff usually in liaison with key local interests, e.g. bushfire control organisations, but they are required to be formally approved by the Director of National Parks or the Director of Native Conservation and must be reviewed at least every 3 years.

This precautionary approach to management planning has resulted in a somewhat laborious procedure but it has certainly minimised the risk of rash decisions and actions which may have pre-empted more thorough and publicly transparent decision making.

Need for regional planning

Whereas at the time of establishment of CALM the three land and wildlife management agencies had in place various management plans or wildlife programmes under their respective acts, with the creation of the amalgamated agency there was an immediate requirement to assess priorities on a coordinated Statewide basis.

In the South Coast Region we were faced with a new network of a dozen or so national parks, over 100 nature reserves (mainly IUCN category I and II) and a small number of timber reserves and State Forest (category V), totalling over 2.4 million hectares and extending along some 1,500 km across the region (Figure 1).

There were compelling reasons for commencement of a management plan for the Fitzgerald River National Park based on its unquestionable biological value and the risks to that value from *Phytophthora* dieback, feral animals and inappropriate fire regimes.

For the remainder of the Region's protected area network it was decided to use a broad regional approach first through preparation of a Regional Management Plan. The regional planning process duly began in 1987, a draft plan was released in 1989 (CALM 1989) and the final document two years later (CALM 1991).

Hierarchical planning model

It is also useful to use a triangular hierarchy of plans (Figure 2A). This aids the recognition of priorities, acts as a dynamic indicator of quantitative progress, and assists the management agency in its own planning. The basic principle is that it is easier to prepare meaningful plans at any level of the hierarchy if the levels of planning above are completed. As a general rule plans are more detailed down the triangle and also public involvement and site detail are increased.

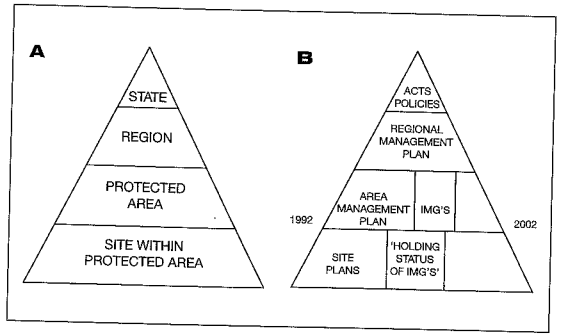


Figure 2.
A: hierarchical planning model; B: protected area planning progress.

By using the horizontal axis of the triangle for our 10 year time frame we are able to pictorially represent progress towards our legislative goal, namely to have in place gazetted management plans for all protected areas and, once in place, have the plans maintained or updated on a minimum 10-year rotation. In summary, our challenge is to progressively reduce the blank portion of the Figure 2B and to increase the proportion of area management plans against interim management guidelines.

We use the same approach to strategically plan within specific programmes such as wildlife recovery plans, where for example we have broad district plans for some suites of species (e.g. threatened flora), and species specific plans addressing distinct populations. As with protected area management, plans can be 'interim' or 'final', i.e. formally approved by the Minister or legally gazetted.

Particular values of regional planning

The main body of our Regional Management Plan addresses broad management issues such as conservation of flora and fauna, protective management from threatening processes (e.g. plant diseases, weeds, feral animals), public recreation and activities, community participation and liaison, commercial activities and research.

It thereby provides a framework along with IMGs for day to day management activity. However, the regional approach also enables three key aspects of protected area planning to be addressed:

- overall review of the system, i.e. bio-regional planning
- indicative priorities for more detailed area management plans
- application of the Recreation Opportunity Spectrum (ROS) for national parks.

The CALM South Coast Regional Management Plan (CALM 1991) adopted these approaches as follows.

Bio-regional planning

As for a single protected area management plan, it is necessary to review the physical and biological attributes of a region as a key basis for assessment of the existing and proposed protected area network. Hence climate, geology, landform and soils, vegetation and fauna are considered.

In our case, due to the amalgamation of three separate protected area networks in 1985, it was important to review the values of each protected area unit and to re-assess its IUCN category in the new regional context. Furthermore, the existing protected area network was not exhaustive in that substantial areas of public land remained outside the reserve system, in particular coastal reserves, several wide foreshore reserves and vacant Crown land along major river systems, and large areas of unalienated Crown land (Figure 3) inland beyond the limits of viable agriculture and on the vast Nullarbor Plain. We therefore decided to review all available public land within the region for possible inclusion in the protected area system.

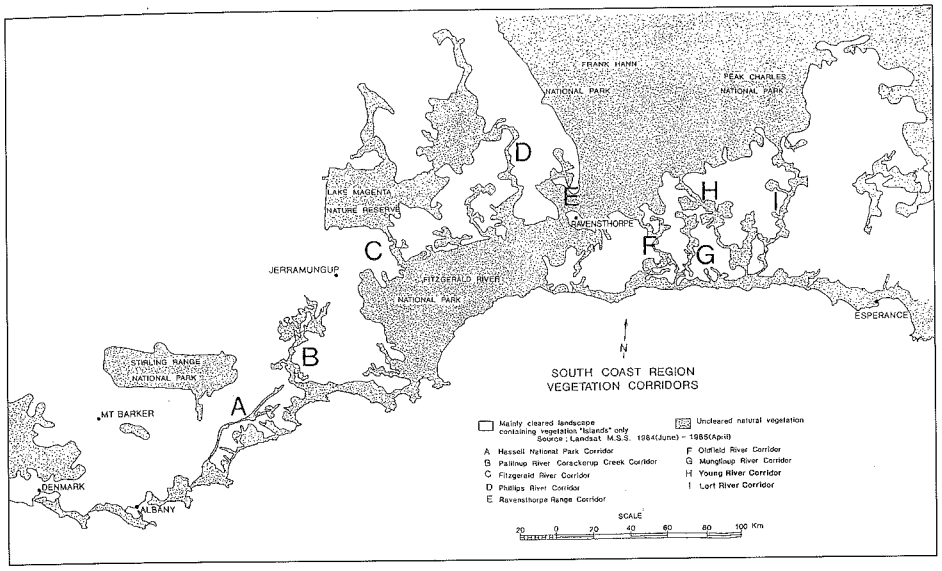


Figure 3. South Coast Region vegetation corridors.

In the case of coastal and often isolated reserves in the agricultural zone, the assessment was relatively straight forward and was based on the use of a checklist of biological and geological features plus location in relation to other reserves. For the large areas of the interior the recommendations of previous biological surveys were generally adopted (McKenzie and Robinson 1987, WA Museum 1988).

The eventual outcomes were recommendations for an improved regional network of protected areas based on biological and physical attributes, juxtaposition with respect to other parts of the network and the potential for major corridor linkages, particularly along uncleared river systems through the eastern agricultural zone (Watson 1991). There were around 150 changes of land tenure or purpose proposed with some quite large areas being proposed to change from category I to category II or vice versa.

In recent years the concept of geodiversity has been increasingly articulated (Kiernan 1996). Whereas geology, land forms and soils did form a part of the basis of our regional overview, and indeed assessment of individual areas, at the first 10 year review of the South Coast Regional Management Plan we anticipate greater attention to this concept ensuring that a geologically representative system of protected areas is also achieved. Although the vegetation is overall an excellent indicator of geology, land form and soils, and hence may have ensured a reasonable degree of geodiversity in our protected area system by default, a conscious review is nevertheless required to check for completeness.

Area management plan priorities

A regional management plan can also be used to foreshadow the approximate priority order for individual area management plans. As indicated above, one area, the Fitzgerald River National Park, presented an obvious and compelling case and

Table 1. Priority for preparation of area management plans (as appearing in Regional Management Plan, CALM 1991, but with chronology updated to 1997).

ALBANY DISTRICT

1. Fitzgerald River National Park (completed 1991)
2. West Cape Howe National Park (completed 1995)
3. Two Peoples Bay Nature Reserve (completed 1995)
4. Stirling Range and Porongurup National Parks (draft 1997)
5. Waychinicup and Gull Rock National Parks
6. William Bay National Park and Quarram Nature Reserve
7. Torndirrup National Park
8. Other Reserves

ESPERANCE DISTRICT

1. Esperance Lakes Nature Reserves (including "RAMSAR" Wetlands) (draft 1997)
2. Stokes National Park and other Reserves of Esperance District West Coast
3. Cape Arid National Park and Nuytsland Nature Reserve
4. Peak Charles National Park
5. Cape Le Grand National Park
6. Recherche Archipelago Islands and Rocky Islets
7. Eucla National Park
8. Other Reserves
9. Helms Arboretum

management planning for this area occurred in tandem with the regional management plan during the period 1987–1991.

The proposed priorities for all other areas were listed in the implementation section of our regional plan (Table 1). The large bulk of nature reserves were to be included in the categories "other reserves". This is because many are small, by their very nature they have low public visitation and the management issues can in most cases be addressed on a 'package' basis.

Although this list of proposed priorities was developed in 1991, it remains remarkably accurate in 1997. However, as the management planning process for protected areas has matured in Western Australia, and in response to financial and staffing stringencies, it is now likely that several of the outstanding areas awaiting plans will be grouped into local batches. For example priorities 5 and 7 in Albany District (Waychinicup, Gull Rock, Torndirrup) and various priorities in the Esperance District (e.g. all coastal national parks) will probably now both be addressed in one management plan.

The priority list in Table 1 was developed largely through a staff workshop, hence there is a strong degree of support and 'ownership' for the strategy from the agency personnel. Interestingly, there was very little public comment on the proposed priorities for planning in response to the draft Regional Plan.

Regional classification of parks

Our national park network in the South Coast Region comprises about a dozen major areas spread across some 700 km from east to west. Furthermore, some four parks are located within a 1–2 hour drive from Esperance and eight within a similar distance from Albany. As Esperance and Albany are the two major regional centres of population, and both are key tourist towns, we proposed through the mechanism of

Table 2. A conceptual opportunity spectrum for major South Coast Region National Parks (from CALM 1991).

park 'type'	*Albany District*	*Esperance District*
parks with major wilderness potential	Fitzgerald River National Park Stirling Range National Park	Cape Arid National Park Peak Charles National Park
'low key' or intermediate parks	Waychinicup National Park West Cape Howe National Park William Bay National Park Porongurup National Park Gull Rock National Park	Stokes National Park
parks with existing or potential major site/ facility developments	Torndirrup National Park	Cape Le Grand National Park

the regional plan a conceptual 'recreation opportunity spectrum' of parks at the 'macro' level. Thus parks with major wilderness potential or conversely parks with existing or potential major site developments were identified (Table 2).

This approach has provided a powerful tool when individual area plans are subsequently prepared. Typically, during the management planning process there is community pressure for a 'bit of everything' in each separate area. However, by viewing each park in its regional context we have been able to set it roughly in a position on the conceptual spectrum. For example, where some members of the community have sought a wilderness zone in each park, planners have been able to argue that wilderness doesn't really fit in all areas and is far better catered for in another national park within the local network (Herford *et al.* 1995).

Plan implementation and work programmes

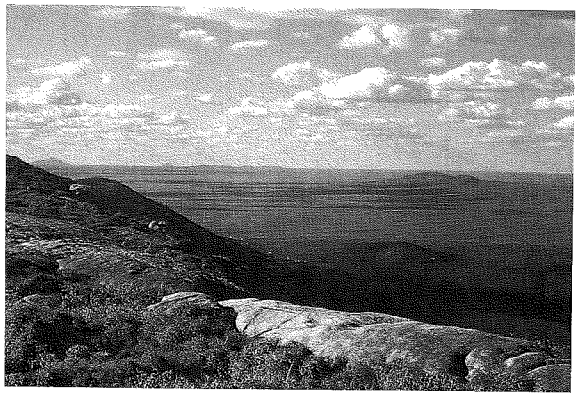
For all our management plans we develop implementation programmes. The regional management plan is no exception in this regard. The implementation programme lists all recommendations or actions from the management plan and identifies those which are 'completed', those which are 'ongoing', those which will be initiated in the next 3 years ('new') and those which will be 'deferred' beyond 3 years. For the 'ongoing' and 'new' prescription we indicate who is responsible for the action, how it may be resourced (e.g. local staff, volunteers, external funding, sponsorship etc.) and for 'new' prescriptions whether proposed for year 1, 2 or 3. This documentation is then used:

- to develop our regional strategic plan and issue specific action plans for staff, which in turn form a basis for budget preparation
- to identify potential sources of funding and resourcing
- as a basis for individual staff works programmes
- as a method of continuous evaluation of plan implementation.

The implementation programmes are evaluated and formally reviewed annually but are updated as working documents on an on-going basis.

Summary

Although this overview of regional planning for protected areas is but one example, from one region, of one state, of one country, in one IUCN 'region', the area of land



Cape Arid National Park, a large and relatively pristine park at the wilderness end of the protected area spectrum. Photo: John Watson

involved is significantly large, with a protected area system of over 2.4 million hectares derived from over 150 separate parks and reserves.

We have found that for such a protected area system it has been crucial to have in place a regional overview (i.e. the regional management plan) and a systematic method of addressing more detailed management plans for individual protected areas or groups of areas. The use of Interim Management Guidelines, although in essence a legislative requirement in our case, may have value elsewhere to deal with 'holding management' and to avoid inadvertently pre-empting the full management planning process.

The use of a hierarchy of planning is particularly valuable as it enables the setting of overall regional priorities and forms an overview basis for a bio-regional and geo-regional approach to a protected area system.

A regional plan can be particularly valuable in helping to set subsequent planning priorities and in setting the 'type' of national park within a user opportunity spectrum.

Acknowledgments

Several of the concepts and procedures detailed in this paper have evolved from discussions with existing and former colleagues, in particular Ian Herford and Richard May.

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Fitzgerald River National Park Biosphere Reserve 1978–1997: the evolution of integrated protected area management

JOHN WATSON AND ANGELA SANDERS

The Fitzgerald River National Park Biosphere Reserve is one of the most significant conservation areas in south Western Australia. Its high biological diversity was first recognised in the early 1800s when botanical collectors visited the area and transported valuable specimens to Europe. The park is also known for its reasonably intact vertebrate fauna populations. The local community has been involved in its management since the early 1970s and it is this involvement that has led to the evolution of integrated protected area management in this magnificent national park.

THE Fitzgerald River National Park (FRNP) is located on the south coast of Western Australia, about 420 km south-east of the capital city Perth. The park is managed by the Western Australian Department of Conservation and Land Management (CALM). In April 1978 the FRNP was designated as one of Australia's 12 biosphere reserves under UNESCO's Man and the Biosphere programme (MAB).

Ideally a biosphere reserve will include a large undisturbed core area that is an example of one of the world's biogeographical provinces together with an adjacent buffer zone where some human activity takes place and lastly, an adjoining transition zone where the most intense human activity takes place (Figure 1).

The FRNP fitted the core area requirements of this model very well, but it was not until 1986 that moves were made by the local community to recognise the buffer and transition zone. Since then there has an been increasing awareness of the biosphere reserve concept and acceptance locally of a 'greater' biosphere reserve. The term 'zone of cooperation' is now used in place of transition zone. The Fitzgerald Biosphere Reserve, in concept, now includes four local shires: all of Jerramungup Shire, half of Ravensthorpe Shire, and small portions of Lake Grace and Kent Shires. The boundary remains flexible to allow for the evolution of landcare catchment groups, who are usually delimited by patterns of water drainage, and also different 'social' catchments. The total land area covered at present is approximately 1.3 million hectares (Figure 2).

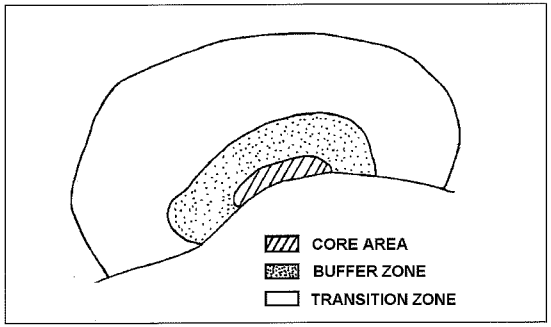


Figure 1. *Truncated model biosphere reserve.*

Despite the fact that the original nomination was made on the basis of the area's high nature conservation value

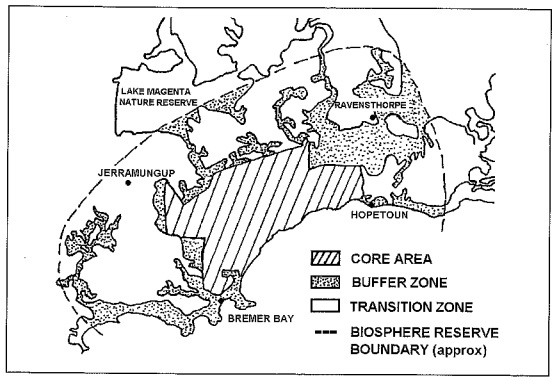


Figure 2. Fitzgerald River National Park Biosphere Reserve in 1997.

and its potential for research and not on the broader criteria that are expected in biosphere reserves today, the area has evolved as one of Australia's 'model' biosphere reserves (Parker 1993).

Natural features of the Fitzgerald River reserve

The climate of the FRNP has been described variously as Warm Temperate Western Marine (Dick 1975), Marine Mediterranean (Papadakis 1975) and Meso-mediterranean (attenuated) (UNESCO-FAO, 1963). The winters are cool and damp with the summers being warm to hot with erratic rainfall. Average annual rainfall in Bremer Bay, at the south-western corner of the FRNP, is 628 mm which decreases to 504 mm at Hopetoun at the south-eastern corner. The average maximum temperature at Ravensthorpe (situated at the north-eastern corner) for July is 16.3°C and January is 29.2°C, the average minimum for July is 6.7°C and January is 14.0°C.

The geological history of the FRNP is rich and it contains a variety of different landforms including a coastal chain of low quartzite mountains (Mt Barren System), drainage systems and associated swamps, lakes, creeks and estuaries, a former marine plain with incised river valleys, upland plains and some 60 km of rugged coastline. Some of these landforms are a result of the collision and subsequent rifting of the Australian and Antarctic landmasses. The quartzite rocks of the Mt Barren System are evidence of the massive heat and pressure that was generated to fuse and deform them during the collision that bonded Antarctica to Australia about 1.1 million years ago. About 53 million years ago much of the coast of the Fitzgerald was flooded by the sea coming in from the west as Antarctica drifted away from Australia's southern edge. This left the Barren Mountains as islands and enabled isolated plant populations to evolve, resulting in the high degree of endemism that we see there today.

The park has an exceptional botanical diversity comprising some 1,883 (23%) of the state's described vascular plant species, 78 of which are endemic and 250 of which are geographically restricted or represented by populations of less than 1,000 plants. This massive biological diversity is a result of the area's long, complex geological history, changing climates and the action of fire. This combination of processes has created a vast diversity of soil types and habitats.

The FRNP also has more recorded vertebrate fauna species than any other protected area in south Western Australia and includes 193 species of birds, 42 species of reptiles, 22 species of native mammals, 12 species of frogs and 4 species of inland fish. Nineteen of these are either threatened or in need of special protection. In addition, southern right whale maternity sites occur along the park's coastline. A total of 36 adults and calves were counted in one day in July 1993 within a few hundréd metres of the shoreline (J. Bannister and J. Bell, pers comm).

Vegetated corridors connect the FRNP with other bushland areas (Figure 2). A corridor of major importance in the north-east links the park with the large expanse of uncleared and ungrazed land between Ravensthorpe and the southern Goldfields which then stretches through to Central Australia. The FRNP has species in common with both the wetter south-west and the more arid east and north-eastern parts and this bushland link represents a significant 'evolutionary' corridor. In the face of any climate change this 'evolutionary' corridor will be important in allowing the contraction or expansion of species as the climate becomes more arid or wetter.

Another important corridor links the FRNP to the Lake Magenta Nature Reserve, which lies about 20km to the north. This reserve is the largest patch of uncleared vegetation in the wheat-growing area of Western Australia and is the site of a fauna reconstruction programme which is being made possible by an intense fox control programme (Bailey 1996; see also Gillen *et al.* 1997).

Other major corridors exist in the west of the biosphere reserve linking the large Corackerup and proposed Peniup Nature Reserves with coastal bushland to the south through vegetated riparian zones. Coastal corridors also run to the east and west connecting the park with bushland at Albany and Esperance and beyond.

The Fitzgerald as a national park and biosphere reserve

The FRNP evolved to become a 'working' biosphere reserve over the period 1985 to the present, and it is still evolving. In 1985 the FRNP had an area of 242,739 ha which formed the gazetted biosphere reserve. There was a local conservation group, the Fitzgerald River National Park Association (FRNPA) and an *in situ* management staff of three rangers, a field studies centre at the abandoned Twertup spongolite quarry site within the park, and a very simple 'outline working plan' which had been prepared in 1977 as a precursor to a more detailed area management plan. It was not until around 1984 that the managers of the park began to understand the additional purposes of a biosphere reserve over and above normal park management practices.

During the past twelve years some quite dramatic changes have occurred. The Fitzgerald is now recognised as a model biosphere reserve both nationally (Parker 1993) and internationally (Robertson Vernhes 1993, Watson 1993, Watson *et al.* 1995). The most significant change is that the biosphere reserve has notionally expanded to some 1.3 million hectares and now has a recognised buffer/corridor zone and a zone of community cooperation. The term 'notionally' is used quite deliberately because there has been no formal change in the gazetted biosphere area. There is increasing community awareness, however, and the name 'Fitzgerald Biosphere Reserve' rather than 'Fitzgerald River National Park Biosphere Reserve' is now in popular use.

Community involvement

Community involvement by a network of groups and individuals has occurred in all three zones of the Fitzgerald Biosphere Reserve: the original formally gazetted national park core area, the surrounding buffer zone with its major biological corridors, and the zone of cooperation.

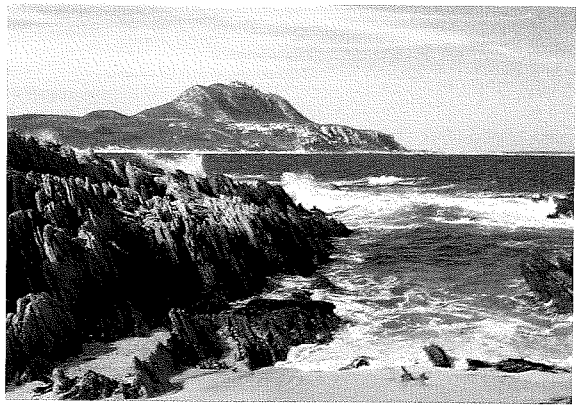
After several years in recess the FRNPA was re-established in 1980 and took up the offer of an old quarry house at Twertup for use as a field studies centre in 1981. The Association has continued to promote an awareness of the national park through numerous excursions, production of interpretive materials, educational courses and regular contributions to local newspapers. The association remains highly focused upon the National Park and has much direct liaison with CALM, who are legally responsible for its management.

In the mid-1980s a small number of local residents, mainly farmers and some members of the FRNPA, began to raise community awareness of the Fitzgerald in the context of the 1984 Action Plan for Biosphere Reserves (Batisse 1985). They formed a loose-knit group, the Fitzgerald Biosphere Project (FBP), which lobbied for recognition in Perth, Canberra and at UNESCO headquarters in Paris and organised major public awareness seminars locally at Bremer Bay (1986) and in Perth (1987). The group was highly effective in the period 1985–1987 and promoted the concept of the true biosphere reserve zoning extending out from the national park core area into the surrounding farming landscape, even though this was in name only and recognised by only a very small proportion of the community at that time. Fortunately, the importance of sustainable farming practices was being increasingly recognised through the 1980s *via* the activities of landcare groups. These developments are described in more detail below. The FBP group has been much less active since this period, mainly because its energies have been increasingly channelled into the landcare movement and community involvement in national park planning and management.

Two significant management plans were commenced in 1987, namely an area management plan for the FRNP and a regional management plan for the whole of the CALM South Coast Region (see Watson 1997 – pages 2–8, this issue).

The FRNP plan involved a major community liaison process with the establishment of a Planning Advisory Committee made up of local people and park users. A draft management plan was produced in 1989 and then opened to public comment through written submissions before a final plan was produced two years later (CALM 1991a). The planning process for the Fitzgerald created a great amount of interest from within the local community and from elsewhere within Western Australia. The plan included a short section on the park's biosphere reserve status and formally recognised a buffer zone and zone of cooperation outside the gazetted national park boundary.

CALM's Regional Management Plan was also produced in draft form and then in final form after public submissions had been received (CALM 1991b). This plan addressed the future tenure and management of many areas of Crown (public) land within the Fitzgerald buffer zone and zone of cooperation. Through this process much of the buffer zone has now been recommended to become managed by CALM for addition to the national park or as an alternative category of protected area. In addition the Regional Plan has recognised the special corridor values of the Fitzgerald River valley, Pallinup-Corackerup valley and Ravensthorpe Range (Watson 1991, 1994a).



The classical view of East Mount Barren with its wave-cut platform and quartzite cliffs, Fitzgerald River National Park. Photo: John Watson.

During 1990 we realised that our interactions with the local community could be strengthened by additional ties. We therefore established a network of volunteers from a geographical distribution around the park. These people were well known in their districts and were involved in key local community organisations. The Community-CALM-

Link (CCL) members, as they were called, were not necessarily expected to agree with CALM's policies or actions, or the recommendations of the Planning Advisory Committee. They did, however, agree to pass on and feed back information between CALM and the local community in a fair, accurate and unbiased manner.

The CCL played a crucial role during a very difficult period and it may well provide a useful model for use in other protected areas where better communication is required between the park managers and the local community (Watson 1993).

In 1991 a new advisory committee was established to help with the implementation of the park management plan and to undertake the community liaison role of the CCL. The committee provides valuable advice to CALM on the priorities as perceived by the local community in implementing the several hundred prescriptions of the park management plan.

Management and conservation in zones around the FRNP

In the early 1980s the area surrounding the FRNP experienced a succession of drought years and major land degradation occurred with massive wind erosion and loss of valuable top soil from some farm paddocks. It is also now widely accepted that the clearing of deep rooted natural vegetation and its replacement by shallow rooted cereal crops has allowed the water table to rise, bringing with it dissolved salt which has then surfaced in seepages killing vegetation (both crops and native plants).

Land degradation in the zone of cooperation is an issue for the whole biosphere reserve because the increased water salinity and soil erosion results in a deterioration of water quality in the drainage systems, and in most cases the rivers drain into the FRNP. In other words there is a direct influence upon the riverine systems and estuaries of our biosphere core area and probably upon the adjacent coastal waters, which hopefully will become a marine protected area in the future (Marine Parks and Reserves Selection Working Group 1994, Watson 1994b).

In response to these farm management and land degradation problems there has been a strong landcare movement established throughout Western Australia under the auspices of Agriculture Western Australia and the Soil and Land Conservation Act (1945). This movement is active in all the Shires that have land included in the biosphere reserve. The Shire of Jerramungup, which forms most of the western half of the Fitzgerald Biosphere Reserve, has been especially active in this landcare movement and the local land conservation committees and catchment groups are fully committed to encouraging sustainable farming practices, particularly through the protection of remnant native vegetation, re-establishment of trees, whole catchment planning, planting of high water use crops and perennial pasture and use of minimum tillage cultivation. This activity is consistent with the biosphere reserve concept and forms the basis of major private and corporate management initiatives in the zone of cooperation.

During 1994 a regional strategy for the care and management of land and water resources on the south coast of Western Australia was initiated on the instigation of the State Soil and Land Conservation Council. The strategy was set up to ensure that funding for land and water care was directed to priority issues and areas and it involved extensive consultation with community groups and agencies involved in natural resource management on the south coast. The Fitzgerald Biosphere Reserve is one of six sub-regions represented in the strategy. After a long consultation process,

priorities for achieving sustainable agricultural development have been set and focus catchments are now being chosen for priority support by the State agriculture agency. In the Fitzgerald Biosphere sub-region the nature conservation values are recognised as being extremely high and the impact of farming practices on the park and other conservation reserves has been included in the process of ranking priority catchments for immediate help (Script 1997).

During 1996 funding was obtained via Environment Australia to produce an integrated vegetation management plan for the zone of cooperation. This was completed in March 1997 and it identified important remnant vegetation patches, poorly conserved vegetation types and rare vegetation communities (Robinson 1997). A review of all the catchments was carried out and priority actions were identified. Salinity prediction maps and also vegetation change maps, produced by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), were used to help to identify suitable areas where corridors could be established to provide east–west and north–south linkages between large remnant patches of vegetation. The next phase of the project will include the implementation of the recommended actions by providing information on species selection and placement.

The Malleefowl Preservation Group is a voluntary organisation based at Ongerup, just to the west of the Fitzgerald Biosphere Reserve. It is also involved in assisting with management of bushland in the zone of cooperation. Two of the group's study sites, where the threatened malleefowl *Leipoa ocellata* still survives, are located within the zone of cooperation at Corackerup Nature Reserve and the proposed Peniup Nature Reserve. The group has produced a Community Action Plan for malleefowl in its area (Orsini 1994). The group has been successful in promoting the malleefowl as a 'flagship' species which provides a focus for on-farm conservation of wildlife habitat.

As mentioned above, there are two major coastal corridors linking the FRNP with other bushland to the east and to the west all the way to the towns of Esperance and Albany. In 1992, the Shire of Jerramungup established its own advisory committee to help with the preparation of management plans for the section of coastline between the FRNP and the western boundary of the biosphere reserve at Pallinup. This area is essentially part of the buffer/corridor zone and this is recognised in their plan. It is public land which is to be vested in the Shire for recreation and landscape protection purposes.

A similar planning process to that being used by CALM has been adopted by the shire: public meetings, publicity in local newsletters, preparation of draft management plans, public comment on the drafts, and appropriate modification of the draft plans before final adoption (Craig and Carmen-Brown 1994, Craig 1994). This approach has been very effective so far and it may also be appropriate for use in other areas within the biosphere reserve including Crown lands within the Ravensthorpe Shire.

CALM and the federal government agency, Environment Australia, have jointly funded the first systematic biological survey of the buffer/corridor zone and zone of cooperation within the Fitzgerald Biosphere Reserve. This project commenced in 1993 and continues until the end of 1997. In its initial phase the project involved undertaking biological surveys in areas surrounding the national park core area, i.e. in the adjacent buffer zone, in the various corridors, and in remnant vegetation on farmland within the zone of cooperation. The project also involved community liaison through organisations, private landowners, landcare groups and tourism promotion groups (Sanders 1996).

The project has involved regular contributions to newspapers, community newsletters, meetings, and community workshops with associated field tours. A major

effort occurred with the local schools, all of which visited the fauna trapping sites and as a result asked to become more deeply involved in the project. After a pilot programme in 1994 with two schools, all five schools in the biosphere reserve participated from 1995 to 1997. Each school studied remnant bushland close to their schools in the zone of cooperation, with vegetation and fauna studies also being incorporated into the school curriculum. Funding for equipment and training was contributed by the Australian National Commission for UNESCO (small grants scheme) and by the Priority Country Areas Programme (PCAP) of the Western Australian Education Department.

We believe that this exciting programme provided a unique educational opportunity for the children and it also provided real data across a large area and further consolidated community interest in conservation and support for the biosphere reserve.

The second phase of the project involves resurveying flora and fauna monitoring sites that were set up during a major study from 1985 to 1987 (Chapman and Newbey 1995). A total of 64 monitoring sites were originally set up and a subset of these were re-monitored in 1996 and 1997. Monitoring included taking photographs, recording plant species and canopy cover in rectangular plots and vertebrate and invertebrate fauna trapping. The intention is for community groups to carry out some of the monitoring work in the future.

Key factors for success

There are five major ingredients for the success of integrated management of the Fitzgerald Biosphere Reserve since it was gazetted in 1978. These are:

1. Well-recognised high nature conservation value.
2. Notional rather than formal biosphere reserve designation.
3. Time factors.
4. Economics.
5. Involvement of people through networks between various levels.

These all include community involvement and we believe that they may have great importance in other protected areas.

Angela Sanders demonstrating fauna trapping techniques to local schoolchildren, Masons Bays, Fitzgerald Biosphere Reserve coastal corridor (buffer zone). Photo: John Watson.

High nature conservation value

There is no doubt that the FRNP is of outstanding nature conservation value. This is becoming more widely accepted and understood by the local community, park users and government. Clearly the biosphere reserve is something very special because of its natural value and the chance for people to participate. This knowledge creates a new cycle of quests for more scientific research and the study of flora, fauna and vegetation.

Notional rather than formal biosphere designation

In Australia there is a very strong personal attachment to private ownership of land

and government 'interference' is generally treated with suspicion. Unfortunately the word 'reserve' is equated with government control of land. Hence the thought of private property being located within a biosphere 'reserve' is perceived by many people as a risk through the perceived likelihood of imposed government control of their land in the future.

Currently the officially designated biosphere reserve is 242,739 ha of the FRNP. While there would be no objection to expansion of this area to include the whole of the park (329,039 ha since 1989) plus some of the buffer/corridor zone, there would be strong opposition to formal inclusion of the zone of cooperation.

Notionally, however, people are increasingly comfortable with the biosphere reserve concept and that is what really counts, because community cooperation is a key to success.

Time factors

Over a 19 year time period we have seen the development of the Fitzgerald Biosphere Reserve from a formally gazetted core of around 242,000 ha to an increasingly accepted notional area of approximately 1.3 million hectares including core, buffer, and zone of cooperation.

If it had been a requirement to identify the core, buffer and transition zones at time of nomination we would still be waiting to nominate.

Thus, in our case, it has been necessary to allow time for the biosphere reserve concept to evolve at a pace acceptable to the local community with resulting ownership and support rather than isolation and antagonism.

Another aspect of the importance of time can be recognised. In protected area management there is a concept variously referred to as 'incremental change' or 'incremental management'. This refers to the way in which a large number of small decisions, which in isolation seem acceptable at the time, cumulatively can produce a major shift to a position that would never have been sanctioned if fully recognised in the first place.

In the case of a biosphere reserve such as the Fitzgerald where we start with a core only and want to expand to a core, buffer, transition zone model, then time gives us the chance to use incremental change to the advantage of conservation by building support on opportunities or events as they arise – what may be termed the 'power of cumulative gains'.

This approach also means that change need never end, in contrast to the perceived 'finality' of a formal declaration of a 'complete' biosphere reserve.

Economics

Another key reason for our success is that the local community can increasingly see that sustainable farming practices and a well managed national park core area make good economic sense.

The land care movement has provided an ideal partner to help focus community awareness on improved farming practices in the zone of cooperation. Furthermore, as the traditional rural base has declined, the farming community has increasingly looked towards diversification into new crops or new economic activities. Nature-based tourism is one such growth industry and this has created an increased awareness of the economic value of the FRNP through bringing people into the area and helping to improve the economic base of the handful of small towns within the biosphere reserve.

Thus, the landcare movement and nature-based tourism have been recognised as allies in consolidating local acceptance of biosphere reserve principles. This too has contributed to our success.

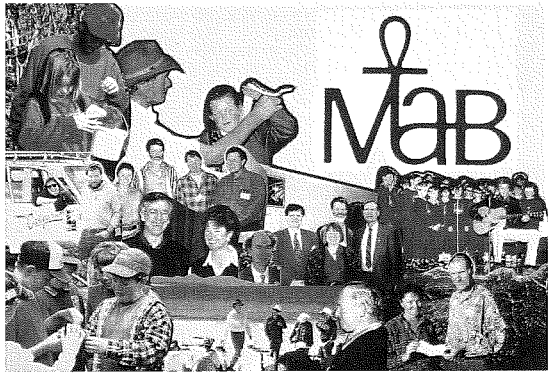
People

The Fitzgerald Biosphere Reserve is relatively isolated, several hundred kilometres from the nearest city (Perth) and is itself sparsely populated with about 2,800 residents mainly living on farms throughout the zone of cooperation and in four small towns. Thus we have not had to deal with an enormous population base pressure on any part of the biosphere reserve.

There has also been a high level of commitment by CALM staff over the years in managing the national park core area with a succession of supportive park rangers. The park management plan has now facilitated greater liaison between these staff and their communities. This has included a major role in assisting the various park advisory committees and in helping local farmers with advice on native vegetation and tree re-establishment on their farms. Indeed, local CALM staff are key players in terms of their twin roles as managers and as members of the local community.

Another key reason for our success has been the external support through national agencies, in particular Environment Australia in funding biological survey work, the National Landcare Programme (now part of the Natural Heritage Trust), and the Australian National Commission for UNESCO, which has provided much direct and indirect support over the past few years. The biological surveys in the buffer/corridor zone and zone of cooperation made an outstanding contribution and raised an unprecedented level of community interest in the biosphere project. National Landcare Programme funds have been extremely valuable in encouragement of improved farm planning and catchment management within the zone of cooperation.

UNESCO has also helped through early recognition of the Fitzgerald Biosphere Reserve as a working model with subsequent encouragement to relate our story at gatherings such as the 1992 World Parks Congress in Venezuela (Watson 1993), at the 1994 international conference "Nature Conservation: The Role of Networks", held in Geraldton, Western Australia (Watson *et al.* 1995), and at the major biosphere conference in Seville, Spain, 1995. Such exposure also yields increased recognition at the regional and State level as it demonstrates the high regard in which the Fitzgerald Biosphere Reserve is held at the international level. Similarly, the review of Australia's biosphere reserves (Parker 1993) has assisted greatly in raising our profile and helping to ensure on-going support for projects such as the biological monitoring programme.



A successful Biosphere Reserve programme requires cooperation at all levels – local, state, national and international, young and old alike.
Photo: John Watson.

Summary

The Fitzgerald Biosphere Reserve is an area of outstanding importance to nature conservation values but like many of the early biosphere nominations is officially only a 'core' area.

Through the activities of a small number of local residents the notion of a larger biosphere reserve with buffer and transition zones has evolved and has now been consolidated by a strong partnership between the national park managing agency (CALM) and key sections of the local community, particularly the Fitzgerald Biosphere Project Group and the landcare movement within the farming population.

Key support has also come at a national and international level particularly through financial help with biological surveys and with encouragement to relate our success story to the wider community.

Above all, there has been the long period of time (now 19 years) during which the Fitzgerald Biosphere Reserve has been allowed to evolve at a pace compatible with local community 'ownership'. The lack of formal 'imposition' of designated buffer and transition zones has also been a key factor – these may come in the future but will only be effective if they come through community initiatives and in a cooperative process with UNESCO involving all relevant parties.

Acknowledgments

This review was originally prepared as a case study for presentation at the International Conference on Biosphere Reserves, Seville, Spain, 1995. We have updated it to 1997 and made other amendments appropriate to publication in PARKS. Many people commented on drafts of the Seville paper including: Ian Anderson (Australian National Commission of UNESCO); Peter Bridgewater (Environment Australia); Nathan McQuoid, George Duxbury, Chris Hart, Martin Lloyd (former rangers in charge, Fitzgerald River National Park); Rex Edmondson (Chairman, Soil and Land Conservation Council, WA); Chris Haynes, Corinn Hine (CALM); Bill Lullfitz (Fitzgerald Biosphere Project Group).

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South Coast Ecovoyage

PETER COLLINS AND JOHN WATSON

An innovative interpretation opportunity along Western Australia's spectacular coastline.

THE SAIL training ship *Leeuwin* is a 55-metre, three-masted barquentine build in 1986. She is the largest sailing ship in the southern hemisphere and carries over 800 square metres of sail when fully rigged.

Each year the *Leeuwin* undertakes a regular series of ten-day sail training voyages for young people out of her home port of Fremantle, Western Australia. More recently she has also operated a small number of 'ecovoyages' with up to 38 passengers of all ages in addition to the sailing crew.

In 1996 and again in 1997 a ten-day ecovoyage was undertaken from Esperance, along Western Australia's south coast, to Albany. This provided the Department of Conservation and Land Management (CALM) with a unique opportunity to enter into a business partnership with the *Leeuwin* by providing specialist interpretation and activities along the way.

Terrestrial protected areas along the south coast of Western Australia are known to have exceptionally high conservation values. They include the islands of the Recherche Archipelago near Esperance, the Fitzgerald River National Park, one of Australia's model biosphere reserves (see Watson and Sanders 1997), and Two Peoples Bay Nature Reserve, home to the noisy scrub bird, Gilbert's potoroo and numerous other threatened species (see Danks *et al.* 1997).

As yet, little is known of the conservation values of the marine environment and there are no established marine protected areas. However, several localities have been identified as potential additions to the State's marine protected area system and are now in the process of assessment (Marine Parks and Reserves Working Group 1994).

For the *Leeuwin* voyage we suggested that rather than have one CALM officer act as specialist for the whole ten days, we could use various landfalls as an opportunity to change staff. As a result we arranged for a wildlife officer to accompany the voyage for the first few days through the Recherche Archipelago Nature Reserve near Esperance. Fitzgerald River National Park rangers then joined the vessel for two sectors along the biosphere reserve coastline, and the Two Peoples Bay Reserve manager completed the final few days into Albany.

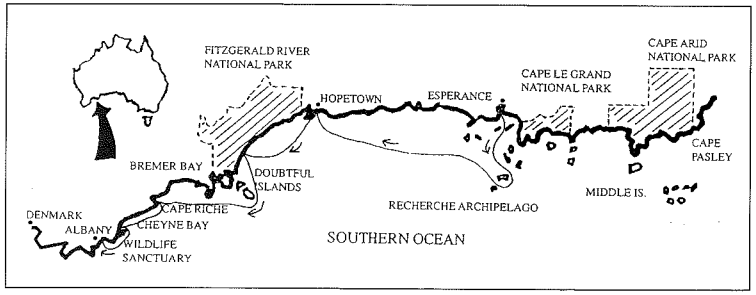


Figure 1. *1996 South Coast Ecovoyage.*

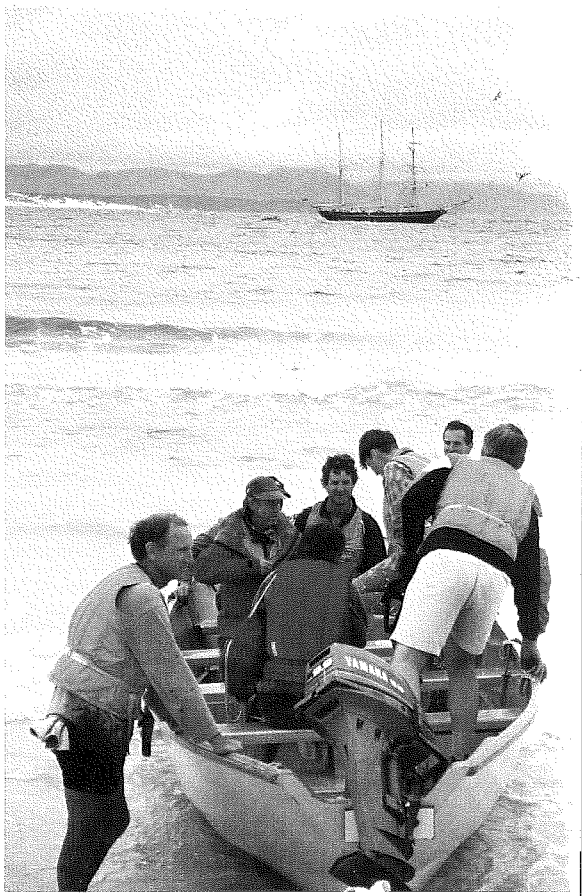
The 1997 ecovoyage of the *Leeuwin* gave us an opportunity to expand our knowledge of the marine environment and at the same time increase the awareness of the participants of the need to preserve it. For example, the participants used a submersible video camera attached to an umbilical cord to record the dominant community types at each anchorage. On each occasion an eager gathering surrounded the onboard monitor to view the habitat under the *Leeuwin* keel.

Additional marine activities included recording sea surface temperature for ground-truthing satellite sea surface temperature images. Water samples were also collected for salinity testing.

A range of rare fauna not often seen by the casual visitor was observed, including Australian sea-lion, New Zealand fur seal, Cape Barren goose, black-faced cormorant and the majestic black-browed albatross.

In the Recherche Archipelago the participants visited Mondrain Island where they observed blackfooted rock wallabies and carpet pythons, both threatened species. The 1997 programme included a visit to a fur seal breeding colony, at which the seal pups visually reinforced the importance of islands as refuge areas.

We also arranged three full days on shore, two in the Fitzgerald River National Park where biological survey work was demonstrated and recreation management issues explained, and one day at Two Peoples Bay, learning about various threatened species recovery programmes.



Disembarking at Point Ann, Fitzgerald River National Park. Photo: John Watson.

In all about ten staff from CALM were involved, covering a wide range of expertise including marine fauna, island ecology, biosphere reserves, national park management, biological surveys, threatened species management and planning.

The venture was extremely successful all round. First, the participants were exposed to the significant conservation values of this portion of Western Australia with excellent interpretation provided by a team of specialists, and secondly a large number of our own staff gained valuable experience in a rather more specialised interpretative situation than they would normally encounter.

The CALM staff played an integral part in sailing the vessel and were assigned to 'watches' like the rest of the participants, but they also gave evening slide shows and were able to help participants with their numerous queries on a more informal basis.

Visiting the New Zealand fur seal colony at Recherche Archipelago Nature Reserve, near Esperance. Photo: Peter Collins.

We also gained excellent media coverage for both the *STS Leeuwin* and for CALM with several articles in our newspapers and a television news crew on board for the final day into Albany.

We can genuinely say now that our protected area interpretation is occurring on land and sea!

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John Watson is the South Coast Regional Manager of the Western Australian Department of Conservation and Land Management (CALM). He initiated CALM's involvement in the 1996 ecovoyage and helped to design the programme in liaison with the STS Leeuwin *and other CALM staff.*

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Threatened species management on the south coast of Western Australia

KELLY GILLEN, ALAN DANKS, JACKIE COURTENAY AND ELLEN HICKMAN

Two Peoples Bay Nature Reserve and Stirling Range National Park are noted for their biodiversity and are examples of protected areas where management for threatened species is being conducted. Two Peoples Bay Nature Reserve is home to the noisy scrub-bird, rediscovered in 1961 after being considered extinct for the first half of this century. Management of habitat through exclusion of fire and a successful translocation programme have greatly improved the viability of this species. Gilbert's potoroo was also recently rediscovered in this area after not being seen for over 100 years. This species, one of Australia's most critically endangered mammals, appears to be present in very small numbers and is the subject of a research programme which includes the management of a captive breeding colony and further survey of likely habitat. Gilbert's potoroo (and several other threatened species in the area) has benefited from management undertaken for the conservation of the noisy scrub-bird.

The conservation management of a critically endangered montane plant community in the Stirling Range National Park has required the innovative application of new technology. The community, which includes nine localised endemics of which seven are declared rare species, is threatened by the introduced plant pathogen *Phytophthora cinnamomi* which is widespread over the eastern peaks of the range. Selected areas have been aerially sprayed with predetermined rates of phosphite (the potassium salt of phosphonic acid) which research has shown can stimulate the immune response of native plants to the invading pathogen. In this case the conservation of individual threatened species is being achieved through a plant community approach.

THE SOUTH COAST of Western Australia includes many areas of high biological diversity. This is reflected in a variety of threatened flora and fauna including many endemic species. Two Peoples Bay Nature Reserve and the Stirling RangeNational Park are two such areas where special natural features have enabled the survival of some unique plants and animals and where successful recovery programmes are being implemented.

Two Peoples Bay Nature Reserve

Two Peoples Bay Nature Reserve is located on the coast approximately 35 km east of the town and major regional centre, Albany (Figure 1). Its original name, Baie des Deux Peuples, commemorates the chance meeting between French and American mariners which occurred in 1803 some 23 years before the first European settlement was established at what is now the Albany town foreshore. The bay faces east and is protected at the southern end by a series of granite hills surrounding Mount Gardner (408 m). The Two Peoples Bay Nature Reserve was established in 1967 and protects this diverse landscape with its associated plant and animal communities, including many threatened species. The nature reserve is managed by the Western Australian Department of Conservation and Land Management (CALM).

A management plan for Two Peoples Bay Nature Reserve was recently published (CALM 1995). This plan formalises conservation of the noisy scrub-bird *Atrichornis*

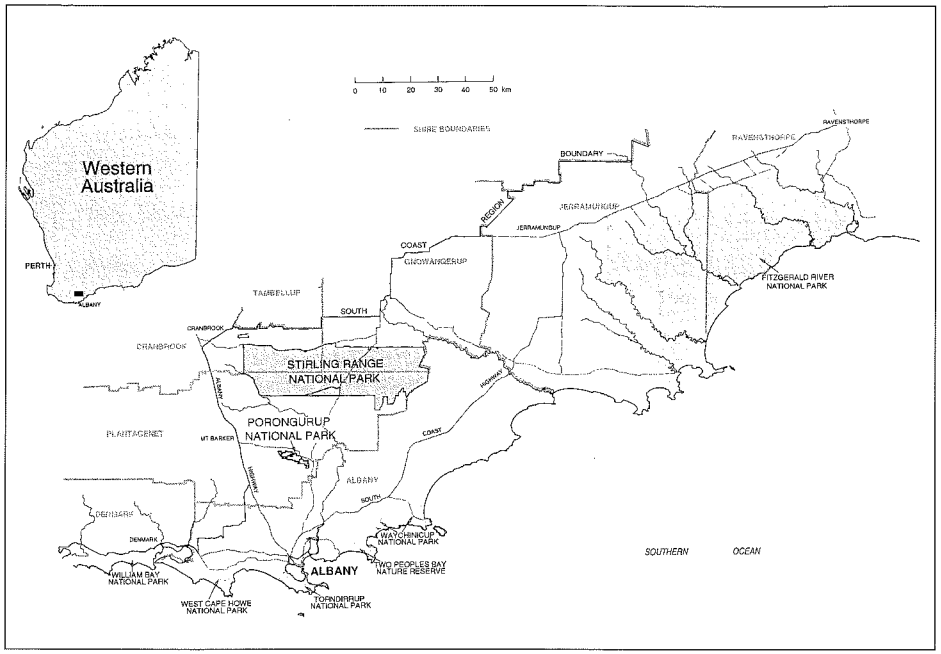


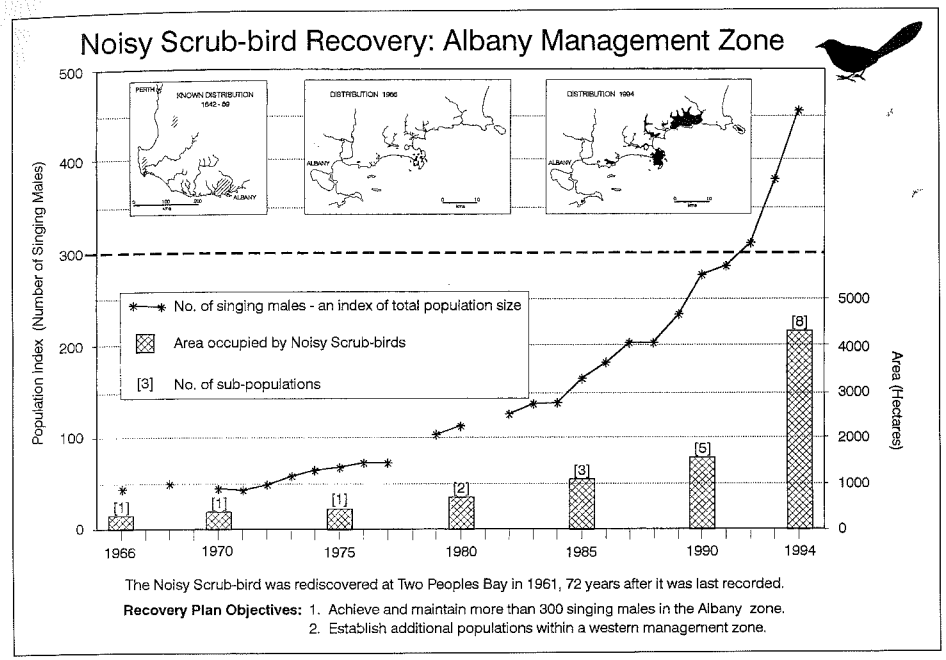
Figure 1. *Location of Two Peoples Bay Nature Reserve.*

clamosus (Endangered) and Gilbert's potoroo *Potorous gilbertii* (Critically Endangered) as the priority objectives for management of the reserve. Passive recreation activities, consistent with the major conservation goals are also allowed in a small area of the reserve, and this provides an opportunity to promote conservation through the presentation of information about threatened species and their successful conservation programmes at Two Peoples Bay. This important additional function of the reserve will be enhanced by the completion of a visitor centre now under construction.

Noisy scrub-bird

The noisy scrub-bird is a semi-flightless songbird which forages for small invertebrates in leaf litter and low shrubs in dense scrub and low forest. Despite many dedicated searches in its former haunts, there had been no official report of the bird for 72 years when, in 1961, it was rediscovered at Two Peoples Bay in a small area earmarked as a potential townsite. A small remnant population was found inhabiting the deep gullies of Mount Gardner, which dominates the landscape in this area. The importance of this discovery provoked local, national and international interest in the challenge to conserve a species on the brink of extinction and the Two Peoples Bay Nature Reserve was created to assist in the protection of the birds' habitat. The reserve of 4,700 ha included all known habitat in the area and a diverse array of vegetation types suitable for many other species.

An intensive period of research followed during the early 1970s by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) focusing

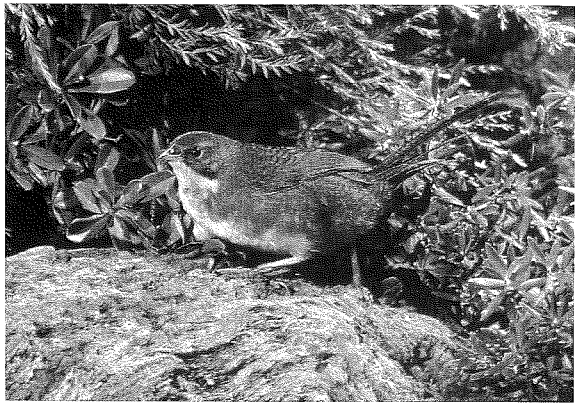


particularly on breeding biology and habitat characteristics. Research into the ecological requirements of the noisy scrub-bird showed that it was sensitive to fire and needed dense, long unburnt scrub with a well developed leaf litter fauna in order to survive. In fact, it was probably the change in fire regimes in addition to grazing and clearance of habitat following European colonisation that had brought the noisy scrub-bird so close to extinction. These were human-induced changes and based on this understanding, the exclusion of fire became the principal direction for vegetation management within the reserve.

Figure 2. *Noisy scrub-bird in the Albany management zone 1966–1994: trend in numbers of singing males recorded, number of sub-populations known, and area occupied.*

Since that time a fire management programme has been based on low fuel areas separating Mount Gardner from the remainder of the reserve, and a system of firebreaks with associated low fuel zones strategically placed throughout the reserve. The remainder of the reserve is managed in a long unburnt state. The Reserve Management Plan has promoted low fuel zones maintained primarily by mechanical slashing of vegetation rather than reliance on regular burning to provide fuel reduction. The plan emphasises the need for effective surveillance and firefighting resources and demands rapid response to any wildfire in the area with the objective of keeping fires to the smallest size possible. The successful application of this fire exclusion policy on Mount Gardner saw scrub-bird numbers begin to rise by the end of the 1970s (Figure 2).

Population growth made it feasible to contemplate removing some birds to create other populations outside Two Peoples Bay Nature Reserve. The importance of this step should not be underestimated. If confined to a single population, there could



The noisy scrub-bird Atrichornis clamosus, *rediscovered in 1961 at Two Peoples Bay.* Photo: Jiri Lochman.

never be much of a future for the noisy scrub-bird. The amount of habitat available to the bird within the reserve was limited and the population would always be vulnerable to wildfires or other catastrophic impacts such as disease or predation.

Since 1983 a regular noisy scrub-bird translocation programme has been maintained. The process consists of capturing scrub-birds from the wild population, usually in the Mount Gardner area, holding them in temporary captivity and then releasing them into suitable habitat in new locations. Great importance has been placed on monitoring the parent population to detect any deleterious effects of the removal of breeding birds. The strident song of the territorial male scrub-bird made annual counts of singing males a practical population index. Between 1970 and 1994, the entire population of the scrub-bird was monitored annually in this way (Figure 2).

To date the most successful translocation has been to Mount Manypeaks, 15 km to the east of Mount Gardner, where steep gullies running north and south of an extensive main ridge provide habitat essentially similar to Mount Gardner. Ten years after the first birds were released there, the new population was increasing rapidly and Mount Manypeaks now has more noisy scrub-birds than the parent population. The population explosion may be attributed to high quality habitat and its protection from wildfire. The birds have also spread beyond the protected areas through corridors of dense vegetation. Other successful translocations have been achieved at Bald Island Nature Reserve to the east and Gull Rock National Park to the west of Two Peoples Bay (Danks 1994).

Overall the total number of noisy scrub-birds has increased tenfold since its rediscovery, and the population is now spread along almost 50 kilometres of the coast around Two Peoples Bay. Current conservation management is carried out in accordance with a Recovery Plan (Danks *et al.* 1996) which seeks to have more populations established well to the west of Albany in addition to maintaining a population index of more than 300 singing males in the Albany area. During 1996, habitat evaluation, supported by leaf litter invertebrate studies, identified suitable habitat near the west coast of Western Australia, in areas which supported noisy scrub-birds last century. In a pilot project a group of male scrub-birds have been released in this area in 1997 and monitoring over the following twelve months will determine whether females will join them.

The biodiversity benefits which have resulted in the longer term from the initial decision to conserve the noisy scrub-bird are significant. A suite of threatened birds species (the noisy scrub-bird, western bristle-bird, western whip-bird and western ground parrot) survive in the dense heath and scrub of Two Peoples Bay Nature Reserve and surrounding areas such as Mount Manypeaks/Waychinicup National Park. Reservation of land, the protection of habitat and research carried out in the name of the noisy scrub-bird has seen populations of these other species increase

as well. Their conservation is now guided by a single recovery team which can adopt an ecosystem approach to threatened species management. A number of other threatened vertebrates and plants are found in this area too, but the most significant of these is Gilbert's potoroo.

Gilbert's potoroo

Gilbert's potoroo was rediscovered on Mount Gardner in December 1994 (Sinclair *et al.* 1996). Prior to this, the last specimen was collected between 1874 and 1879 and the species was presumed extinct. An interim recovery plan was prepared and, guided by a recovery team, primary research objectives since rediscovery have been to locate more animals or populations and to establish a captive breeding colony.

As at June 97 only 8 animals can be reliably caught in the wild. The total number in the wild is unknown but is considered to be very small. This species has survived in the dense heaths and scrub on Mount Gardner which have resulted from fire exclusion. Whether this is preferred habitat or a refuge which protected them from predation by foxes is not known. Interestingly a limited study using spool-and-line tracking indicated that animals were utilising all forms of available habitat and were foraging in open areas (Vetten 1996).

Like other members of the potoroid family, Gilbert's potoroo specialises in eating underground fungi. Preliminary analysis has revealed over 20 species of underground fungi from scats made up almost entirely from fungal spores. The Two Peoples Bay area is noted for its variety of fungi with more than 441 species known from the reserve. Of these some 17 hypogeal (underground) species have been positively identified (Sinclair and Courtenay, submitted).

"Wildflower dieback", a plant disease caused by the introduced fungal pathogen *Phytophthora cinnamomi,* is widespread in the Albany area and has been present at Two Peoples Bay for several decades. This disease has potential to severely impact available habitat by affecting plant species composition and therefore structure and cover. Management of research activity is critical to ensure that this activity does not lead to further disease spread, particularly as initial trapping suggests an association between potoroos and disease free vegetation.

Due to the terrain and limited access of Mount Gardner, considerable effort has been directed toward the use of 'hair tubes' to identify areas used by potoroos. Hair tubes are lengths of PVC pipe coated on the inside with sticky tape. The tape retains hairs from small mammals passing through the tubes (which can be baited to attract animals inside), and the hairs can then be identified. This has been a useful tool and has been used as a method to search for other surviving populations in areas outside of Two Peoples Bay such as the nearby Mount Manypeaks/ Waychinicup National Park and coastal sites in conservation areas close to Albany.

The potoroo is in the size range that is vulnerable to predation by the European

Gilbert's potoroo Potorous gilbertii, *rediscovered in 1994 at Two Peoples Bay.* Photo: Jiri Lochman.

fox *Vulpes vulpes*. Two Peoples Bay Nature Reserve has been regularly baited to kill foxes since 1988 and is now included in an extensive fauna recovery programme known as Western Shield which coordinates fox baiting in over a million hectares of conservation lands across south-west Western Australia. Dried meat baits are delivered aerially and egg baits are buried along strategic tracks within the reserve. The active ingredient is 1080 (sodium monofluoroacetate) which occurs naturally in local vegetation species. Endemic fauna has evolved a high level of tolerance to the poison but introduced species have not and are very susceptible to it.

Fire potentially poses the greatest threat to potoroos in the wild due to the very small size of the population. As described earlier, an appropriate fire management programme is being implemented according to the Two Peoples Bay Management Plan (CALM 1995).

As with the noisy scrub-bird, the vulnerability of a single population in one location is of great concern. A captive colony was established using six animals from Mount Gardner to provide insurance against loss of the wild population to the threats discussed above, as a potential source population for future translocation and in order to study the animals' behaviour and growth patterns.

Through successful captive breeding, the colony now (June 97) consists of 11 adults and one pouch young. Currently little is known about the reproductive biology of the species; however, early indications are that gestation and pouch life are shorter than in other potoroos.

If no other populations are discovered in nearby areas then translocation will be a critical means of ensuring the longer-term viability of the species. Provided fox control and habitat protection can be achieved and maintained, we are optimistic about the likely success of such re-introduction, as the potoroo was recorded as a common species around Albany by early European settlers.

Stirling Range National Park

The Stirling Range National Park is one of Western Australia's oldest protected areas, dating from 1913. It lies some 90 km inland and to the north of Albany (Figure 1) and contains the most significant mountain peaks in the south-west of the Australian continent. Maximum elevation is 1,073 m.

The area is recognised as a major node of plant species richness in the south-west of Western Australia, particularly for the families Proteaceae and Epacridaceae. The flora list for the area currently stands at 1,530 taxa including 82 endemic species.

Rare flora

A recent study on mountains along the south coast (Barrett 1996) identified the eastern Stirling Range mountain thicket as a significant sub-community within the Stirling Range. This vegetation community includes nine localised endemics of which seven are declared rare species. Three of these rare species are classified as Critically Endangered, the Stirling Range dryandra *Dryandra montana*, the giant andersonia *Andersonia axilliflora* and the mountain paper heath *Sphenatoma drummondii*.

At the time of publication of the management plan for the declared rare and threatened flora of the Albany District (Robinson and Coates 1995) Stirling Range dryandra was known from only 11 plants on the Bluff Knoll plateau. Giant andersonia and mountain paper heath were better represented; however, they were only listed as Priority Flora, as there had been insufficient survey to determine their status.

Considerable survey effort on the range has followed the mountains study to determine the status of the various threatened species. This has been hampered by extensive seedling death caused by *Phytophthora cinnamomi*, following 1991 wildfires, and also the slow growth rates of regenerating plants in this exposed mountain environment. This pathogen has been spread across the range via a combination of recreational and other use over a relatively long period of time. While surveys during 1996 greatly improved the known numbers of plants of each of the above species, they also illustrated the precarious nature of the surrounding mountain thicket community.

The community has subsequently been listed as critically endangered due to the serious threat posed by *Phytophthora*. The interaction of fire and *Phytophthora* have seriously reduced the extent of healthy thicket to a series of pockets spread across the eastern part of the range.

Management of Phytophthora

Options for the protection of threatened populations in *Phytophthora* affected and susceptible sites are limited, particularly in upland areas. Research in Western Australia has identified that the fungicide phosphite (the potassium salt of phosphonic acid), applied at predetermined rates, can provide protection to plants from the invading fungus. Phosphite has very low mammalian toxicity and degrades to phosphate in the soil.

Although the mechanism for this response is not well understood, the result is enhanced plant resistance and survival for up to three years. While treatment of individual plants can be achieved in some situations by either stem injection or foliar spray, the logistical difficulties and practicability of application over large areas of upland and the need for a plant community approach resulted in the decision to use broadscale aerial application of phosphonate to selected targets on the eastern Stirling Range.

This operation was supported by research trials and extensive monitoring to determine the most appropriate rates of application and potential impacts on a broad range of plant families and species.

The spraying was conducted using a fixed-wing agricultural spray aircraft during late autumn 1997, the time of year when the light wind conditions required for safe and effective spraying are most likely to occur. Spray targets were marked by coloured tags and exclusion plots were covered with strips of plastic prior to spraying. Recreational walkers were also excluded from areas while the operation was in progress.

An intensive monitoring programme is now associated with these target areas and exclusion plots, including assessment of the amount of active phosphite in plant tissues over time. It is hoped to be able to correlate these amounts with the resistance levels in plants.

Aerial application of phosphite with fixed wing aircraft, Stirling Range National Park. Photo: Malcolm Grant.

The identification of protectable pockets of healthy thicket is a priority for future survey. The risks to such pockets by continuing recreational activity can be addressed by management actions such as rerouting access, and marking designated footpaths.

Recovery plans for the critically endangered species of the eastern range are being prepared; however, the answer to managing the threat to individual species obviously lies in protection at a community level.

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Conservation on private land: Karakamia Sanctuary, Western Australia

BARRY WILSON

There has been extensive discussion recently in *Parks* and elsewhere about how important it is for park management to involve local communities. In Australia there have been several recent conferences about the contribution ecotourism can (and should) make to the management of the resource upon which that developing industry depends, acknowledging that a high proportion of wildlife sanctuaries, and scenic and wilderness sites, that have national icon status are vested in government authorities and managed by government agencies. This article considers the relevance of private land in meeting national biodiversity objectives and cites the example of Western Australia's Karakamia Sanctuary, a freehold property in the Perth hills.

IT IS outside the scope of this report to review the evidence of the extinction crisis confronting Australia. Enough to say that through habitat loss and massive ecological change across the nation, there is a progressive loss of native plant and animal species. For several decades the Australian response to this has been based primarily on a 'conservation through reserves' concept – reservation having the literal meaning of 'setting aside' areas dedicated solely or primarily to the conservation of wildlife. Area selection criteria embrace such concepts as *representativeness* and *high diversity*, with an assumption that it is possible to set aside a representative selection of areas that will provide habitat as sanctuaries where our native species may persist in perpetuity.

While not seeking to denigrate the importance of the nationwide conservation reserves programme, by itself it is incapable of preventing a continental extinction catastrophe. It has been fashionable to argue that some percentage figure (often cited as 10%) of the overall land area should be reserved for conservation. Theoreticians have estimated that if 90% of a natural landscape is 'alienated' 50% of the regional biodiversity will be lost – an estimate that seems to have credibility judging from current Australian field experience.

Maintaining biodiversity on regional and national scales will require programmes for the sustenance of wildlife habitat on private land, as well as on conservation reserves. It will require a turn-around from a public perception that the matter can be solved by government management agencies on conservation reserves to widespread acceptance that it is everyone's problem. Protection and management of habitat for wildlife must become a significant planning item everywhere from urban streetscapes and country road verges to the remnant vegetation on farmland.

Karakamia Sanctuary

Stimulated by John Wamsley's example with Warrawong and Yookamurra Sanctuaries in South Australia, Martin and Lorraine Copley purchased a property at Chidlow in the Perth hills in 1990 to establish a sanctuary for endangered native species. The property comprises contiguous blocks of near pristine remnant Jarrah Forest, totalling 180 ha. (A second property has also been purchased in the Avon Valley, not far away, and will be developed for a similar purpose, but that is another story.)

The Copleys recognised the extinction problems facing the Australian native mammal fauna and set out to help do something about it, directly by establishing secure breeding colonies of selected species and indirectly by establishing a facility where people could have first hand experience of these animals in the wild. The effectiveness of conservation programmes depends on a well-informed and supportive public.

A tenet of the endeavour was that, far from being a drain on the taxpayer, conservation can be self-supporting. Though not intended to be profit-making, the Sanctuary was set up to become financially self-supporting through public entry charges and various associated revenue generating activities. (Government conservation agencies are now also expected to apply user-pays principles although the scale of their responsibilities makes recovery of all management costs somewhat unrealistic.)

Establishment of Karakamia Sanctuary followed a series of steps. First (that is, after the land was purchased) vegetation and fauna surveys were done to establish what remnants remain. As expected, it turned out that the flora was fairly intact, as were the bird and reptile faunas, but the mammal fauna was impoverished. Grey kangaroos were still common on the property, as they are throughout the region (this is a species that has done very well in the disturbed landscapes after partial clearing). Three western brush wallabies were sighted and brushtailed possums and echidna were also present. Another ten native ground mammals likely to have occurred in the region were not recorded. Most of them appear to be locally extinct.

Based on the experience of John Wamsley in South Australia and the Department of Conservation and Land Management (CALM) in Western Australia, the assumption was made that fox predation was the primary cause of ground mammal extinctions. An electrified, fox-proof fence was constructed around the entire property, about 6.5 km of it. Baiting, using 1080 baits, was carried out inside the fenced area and the results monitored for a period of several months until there was confidence that there were no foxes resident inside and no evidence of any entering to take the sacrificial chickens penned in appropriate places. The Sanctuary was then deemed ready to accept re-introduction of native mammals.

A list was made of target species, based on the long-term objective of reestablishing the suite of mammal species that once inhabited the area. This was done in collaboration with CALM wildlife researchers. The initial group of chosen species was governed by practicalities such as availability.

Given the perilous state of some of the desired species, not all were readily available. Other factors to be considered included the compatibility of species. Can numbats live together with predatory chuditch in an enclosed Sanctuary? How many grazing macropods can 180 ha support without damage to the habitat? The rudimentary state of knowledge about such things quickly became evident. In fact this is one area where the Sanctuary can make a major contribution to conservation science. Through careful monitoring of species populations following reintroductions to the fox-free, secure conditions of the Sanctuary, a great deal of information relevant to reintroduction programmes is generated.

An issue that had to be considered was the status of the animals within the Sanctuary. Were they in captivity or in the wild? How big must an enclosure be before it ceases to be a cage? In a 180 ha enclosure, are the animals wild and therefore the property of the Crown or in captivity and the property of the freeholder? The conclusion was that, since the animals are not fed but look after themselves in their natural habitats, albeit protected by a predator-proof fence, they are wild animals and remain the

property of the Crown. As the agent of the Crown, CALM provided founder stock for the Sanctuary reintroductions, including some threatened species, on that basis.

This agreement was reached in the context of a Management Plan prepared by the Sanctuary, endorsed by CALM, which set out in detail the principles under which the Sanctuary and the species were to be managed. In addition, each reintroduction was subject to a protocol, spelling out the management and monitoring procedures. The programme was formalised by a legal agreement between the Sanctuary and the Chief Executive Officer of CALM.

Mammals so far reintroduced to the Sanctuary include the numbat, quokka and western ringtail possum, all of which are listed as "Vulnerable" species, the woylie which is a "Lower Risk, Conservation Dependant" species, and the quenda (southern brown bandicoot) which is a "Lower Risk, Near Threatened" species. Additional individuals of the western brush wallaby, also a Near Threatened species, have also been released in the Sanctuary to boost the remnant population.

All of the reintroductions have been successful, although the degree of success has been mixed. In most cases the founder stock and their early progeny have been radio collared and their movements within the Sanctuary monitored. There have also been regular trapping programmes to assess the status of the populations.

The woylies and quenda, in the absence of fox predation, immediately responded so that, after only three years since the initial reintroductions were made, they have multiplied by a factor of ten or so and occupied the whole Sanctuary.

The numbats have bred successively but have suffered from raptor predation (being diurnal animals). Nevertheless, from the original pair, there are now up to seven numbats in the Sanctuary, which seems to be about its carrying capacity.

The ringtails have also bred but several have been lost – a carpet snake (itself a threatened species!) ate one, one was killed by a bush fire, and at least one escaped over the fence. The surviving animals have confined themselves, more or less, to a densely vegetated gully.

Of the three original quokkas, one adult male died from unknown causes and the other two (an adult female and her juvenile son) remain secretive in the dense gully. Additional founder stock are needed before this species can be regarded as successfully reintroduced.

The brush wallabies are also secretive animals and, because it is difficult to catch and handle them, the status of their population in the Sanctuary is uncertain, although it is known that they are breeding.

The remnant population of brushtail possums has responded to the absence of fox predation and increased in number without the need for the introduction of supplementary stock. In addition, since the removal of fox predation, common dunnart and pygmy possums have turned up in the trapping surveys.

These early results are most encouraging. They demonstrate, categorically, the importance of fox predation in the regional extinction of medium-sized ground-dwelling mammals. They also demonstrate that it is possible for these mammals to recover – with human intervention.

It is inevitable that problems will emerge as the populations of competing species establish themselves within the confines of the Sanctuary. The population of grey kangaroos within the Sanctuary has already reached the point where management has been obliged to remove some so that the habitat is not damaged. Has their presence been responsible for the apparent slowness of the other large macropod, the brush

wallaby, to multiply? What will happen when another grazing macropod, the tammar wallaby, is reintroduced as well? Can the Sanctuary support three macropod species? From what is known of these medium to large animals it seems that they do not occupy exactly the same niches but is the Sanctuary big enough for them to select the habitats they each need or will they eventually interfere with each other?

The woylies and quenda are still increasing their numbers and there must be a limit to how many the Sanctuary can support. Whether, when that time comes, there will be natural feed-back effects that control their populations or whether it will be necessary for management to intervene, is a question still to be confronted.

Resolving such problems as they emerge at Karakamia will make a significant contribution to the understanding of wildlife management on small reserves. Most conservation reserves in south-west Western Australia are small and surrounded by cleared farm land which may be as effective an ecological barrier as an electric fence.

But the principal value of this private sanctuary is that secure populations of several threatened species have been established. They already offer a source of founder stock for other areas, should regional baiting or other fox control measures be implemented within the region.

Long-term security

An essential feature of national (and State in the case of the Australian Federation) conservation reserves systems is security in perpetuity. That is the purpose of vesting them in a government agency with the protection of legislation. Unless special provisions are made, freehold land does not have such protection. A conservation programme on private property such as Karakamia Sanctuary is at risk in the long term.

For conservation programmes on private land to be a valid supplement to government, taxpayer-funded programmes, there must be some means of providing them protection in perpetuity. Many nations, and some Australian States, have legislation providing for conservation covenants that may be applied to titles of private land. Western Australia does not yet have such legislation, although it has been proposed.

Some private land owners do not want a covenant on their land. Others are afraid to invest money and effort in implementing conservation programmes without one. What is needed is a range of voluntary covenanting provisions and incentives that will encourage private land owners to protect wildlife habitat and to participate in conservation programmes.

Conclusion

Given the extraordinary biodiversity of the Australian continent and the impossibility of encompassing it all within public conservation reserves, participation of private land owners is essential if the national biodiversity objectives are to be met.

The case of Karakamia Sanctuary is perhaps exceptional. The cost of the Sanctuary's programme, including the cost of the land and the initial construction of the electrified fence, is very high and beyond the capacity of most private land owners. Yet it does make the point that conservation need not be left entirely to governments.

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Mountain protected areas of south Western Australia

SARAH BARRETT AND KELLY GILLEN

A study of selected mountain peaks in the south-west of Western Australia was conducted to assess the nature conservation values of these mountains and describe and qualify threats to them. Of the 750 plant species surveyed, 101 were restricted to a particular mountain or mountain range. The eastern Stirling Range montane thicket community was identified as a significant sub-community within the Stirling Range, with a high number of localised endangered species. The study provided the initial inventory of the mountain fauna which included 16 species of mammals, with five threatened or rare species. Reptile diversity was low. A litter invertebrate survey recorded high numbers of spider, ant and snail species. A number of Gondwanan relict spider and snail species are persisting in the moister mountain climates and a new population of a critically endangered spider was identified. *Phytophthora cinnamomi* was confirmed as a major threat to many of the mountain ecosystems. Fire, particularly in terms of frequency and scale, is also a critical factor due to the much slower growth rate of regeneration at higher elevations. The interaction of *Phytophthora* and fire can be devastating in ecosystems susceptible to the disease. Management needs to focus on these threats and obtain a balance between recreational needs and conservation value.

THE SOUTH COAST region of Western Australia contains a series of mountain peaks up to 1,073 m in height (Figure 1). Although the mountains are small by international standards they have significant conservation value and high recreational value (Watson 1991a, 1991b). The mountains are very isolated, being the highest peaks for at least a thousand kilometres. The peaks are effectively biological islands, in a landscape of otherwise low relief, which formed an archipelago in the Eocene

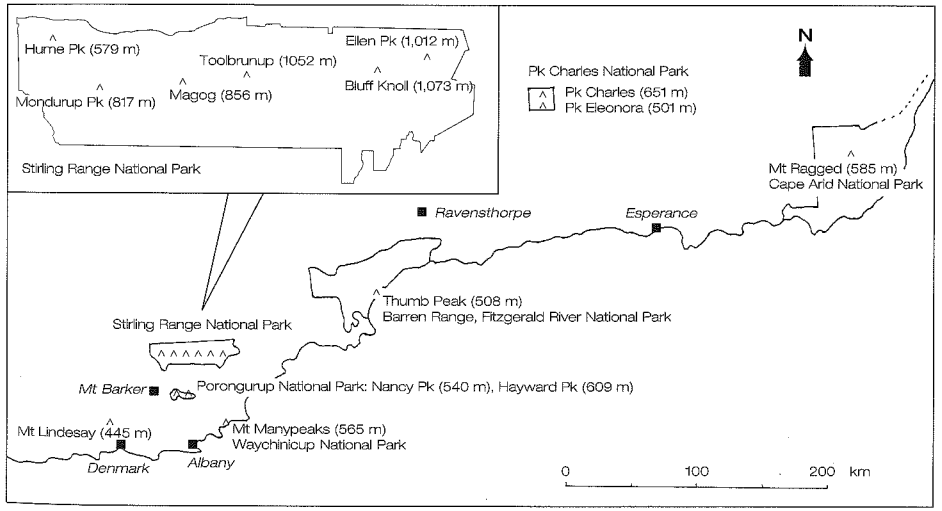


Figure 1. *Mountain survey sites in south Western Australia.*

seas. The mountains occur in an area of high species richness with numerous rare and geographically restricted species. In the most recent estimate 1,517 plant species have been recorded from the Stirling Range National Park alone (Keighery 1993). The stress of past climatic oscillations appears to have been a major factor in this extensive speciation (Hopkins *et al.* 1983).

The mountains experience a Mediterranean climate, but orographic effects have a strong influence and the higher peaks of the Stirling Range may experience extended periods of drizzle even in summer months. Snowfalls occur occasionally in winter months.

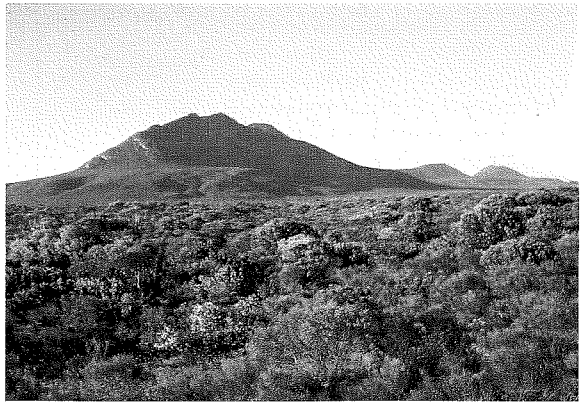
The geology consists of metamorphic rocks and granites of Proterozoic age dated between 1300 and 1700 million years ago. The Stirling and Barren Ranges share a common geological history and are characterised by quartzites derived from metamorphosed sediments.

A biological survey of these mountain protected areas was conducted from 1994 to 1996 (Barrett 1996). The study was conducted by the Western Australian Department of Conservation and Land Management (CALM) with the financial assistance of the Australian Nature Conservation Agency (ANCA). The aims of the project were to compile and collect data to assess the nature conservation values of these mountains and to describe and quantify threats to these areas and to recommend management strategies.

Threats to mountain ecosystems

Mountain environments are generally fragile, both biologically and physically, due to their steepness, extreme weather conditions and the instability of their soils (Moore and Black 1993). In addition land use changes in their hinterland may isolate them as ecological islands in the sky (Costin 1983). Montane communities, occurring at climatic limits, are susceptible to impacts resulting from climatic change (Bridgewater 1996).

Problems encountered in mountain regions of the world include altered fire regimes, recreational trampling and other physical damage to vegetation and soils, pollution and waste disposal, the introduction of alien organisms and the dispersal of plant and animal pathogens (IUCN 1992). As mountains are essentially island habitats they are often highly susceptible to harm from introduced organisms. The risk may be enhanced because of the high proportion of disturbed ground (from natural and man-made causes) and the slower growth of plant communities. Plant or animal pathogens may be more easily dispersed in a mountain area because of their tendency to spread rapidly downhill and infection may therefore have wider implications (IUCN 1992). Successful invasion by plants and animals is generally dependent upon a mammalian vector (O'Connor 1993). Studies from different mountain ecosystems show that up to a certain level



Mount Ragged in Cape Arid National Park is an isolated peak that was once an island in an Eocene sea. Photo: John Watson.

recreational pressures have little or no negative impact on the environment; beyond that point problems quickly intensify (Mercer 1992). Recreation may impact on the environment directly, e.g. trampling effects, or indirectly, e.g. spread of disease.

The mountains of south Western Australia have their own particular suite of problems, foremost of which are believed to be the impact of plant disease, fire, feral animals and recreation (Watson 1991b).

Vegetation and floristics

The surveyed mountain flora of south Western Australia was characterised by a high number of narrow range endemic species. Of the 750 plant species surveyed 101 were restricted to a particular mountain or mountain range. Endemic plant species were most common in the families Proteaceae, Epacridaceae, Myrtaceae and Papilionaceae, in particular in the genera *Darwinia* and *Nemcia*. The flora included 16 Declared Rare and 69 "priority" or "poorly known" taxa (Department of Conservation and Land Management 1995a).

High levels of speciation may be attributed to geographical isolation and fluctuating climatic conditions in the past (Hopkins *et al.* 1993). The mountains are refugia, providing a more mesic environment compared with that of the surrounding lowlands. The over-lap of endemic species between mountain areas, for example between the Stirling Range and the Barren Range suggests a flora that was perhaps more widespread in wetter conditions in the past. The extinction of nearby lowland populations is probably related to the onset of dry conditions in the Holocene. The persistence of mountain populations may be attributed to a more favourable moisture balance on the mountains (Hopkins *et al.* 1993). In the case of the genus *Darwinia*, in the Stirling Range, it has been suggested that landscape dissection, combined with climatic and microclimatic factors, provided geographical isolation and thus facilitated taxonomic divergence (Hopkins *et al.* 1993). It is possible also that a few of the restricted species have never been widespread, either due to being recently derived or through being unable to spread as a result of conservative breeding or dispersal systems.

Eleven plant communities, largely heath, mallee eucalypt-heath and thicket formations, were identified by means of floristic analysis of quadrat data. The eastern Stirling Range montane thicket community was identified as a significant sub-community within the Stirling Range with a high number of localised endemic species.

Fauna

The fauna survey provided an initial inventory of the mountain fauna in the absence of previous systematic fauna surveys. Sixteen mammal species, including five threatened or rare species, were recorded using a range of survey techniques including hair sampling devices and scat analysis. Standard trapping techniques proved limited in the mountain environment. Threatened marsupial species (Department of Conservation and Land Management 1995b) recorded included quokka *Setonix brachyurus*, quenda *Isoodon obesulus*, ringtail possum *Pseudocheirus occidentalis* and dibbler *Parantechinus apicalis*.

Twenty-six reptile and nine frog species were recorded, including one rarely collected snake – the Lake Cronin snake *Brachyaspis atroceps*. Reptile diversity was however generally low in the cooler mountain environments.

Three rare bird species occur within the mountain areas. The most notable of these is the noisy scrub-bird *Atrichornis clamosus*, presumed extinct until its rediscovery

in 1961. Successful translocations to Mount Manypeaks have resulted in a substantial population on the mountain (Danks *et al.* 1994).

An invertebrate survey identified a significant range of endemic and 'Gondwanan' relict species, particularly among spiders and snails. Pockets of habitat remaining in sheltered gullies and slopes with a more mesic climate provide refuge for invertebrates that can no longer exist in drier sites (Main 1993). Many species have a closer relationship to groups in mountainous areas of eastern Australia, Tasmania, New Zealand and other Gondwanan continents than they do to species in the surrounding lowlands.

A new population of the critically endangered mygalomorph (trapdoor spider) *Moggridgea* sp. was located during the survey. Newly recognised mygalomorph species of the genus *Neohomogona* recorded from Toolbrunup and Mount Manypeaks indicate the potential for narrow range invertebrate endemics to occur in mountain areas. Other Gondwanan relic taxa of significance recorded included spider species from the genera *Toxops* and *Austrarchaea*. Several of the snails recorded in the survey had a restricted distribution or were endemic to a particular mountain area.

Boot cleaning stations at trailheads are part of the strategy to reduce artificial spread of Phytophthora cinnamomi *('dieback'). Walkers must clean their footwear before commencing their mountain ascents.* Photo: John Watson.

Threats to mountain protected areas of southern Western Australia

The survey confirmed that the major threats to these mountain ecosystems are the impact of the introduced fungal pathogen *Phytophthora cinnamomi*, frequent fire, feral animals and public recreation.

Dieback disease caused by Phytophthora cinnamomi

The foremost threat identified was unequivocally the fungus *Phytophthora cinnamomi*. Where active it is dramatically altering plant communities and threatening rare and endemic species with extinction. The impact of the disease has major implications for mountain ecosystems including both direct effects on plant community composition and indirect ecological effects (Wills 1993, Wills and Keighery 1994). Many of the species lost from areas with a high disease impact are long-lived species which form a major component of the overstorey.

In the Stirling Range it is apparent that the fungus has been spread to many of the peaks through the transport of infected soil, mainly by foot access. Infections

high in the landscape have led to considerable down-slope spread of the fungus in broad fronts. There also appears to be a correlation between the higher and more significant peaks – notably the eastern Stirling Range – and the distribution of the fungus (Department of Conservation and Land Management 1997). It is difficult to determine when the fungus may have been introduced. The construction and use of an extensive firebreak system in the 1960s presented an ideal opportunity for the spread of the disease over much of the Park. CSIRO researchers noted that the disease was evident in 1974 (Department of Conservation and Land Management 1997).

In mountain areas long infected by *Phytophthora cinnamomi* there was found to be a significant change in community floristic composition due to the death of susceptible species. On the basis of the changes in floristics and structure observed in the eastern Stirling Range montane thicket as a result of *Phytophthora cinnamomi*, the community was proposed and subsequently listed as a "Critically Endangered" Threatened Ecological Community. Nine plant species are endemic to this community and eight are Declared Rare, including the Critically Endangered mountain dryandra *Dryandra montana* known from less than 100 individuals. Prominent among the rare and endemic species are members of the families Proteaceae and Epacridaceae, both of which are highly susceptible to *Phytophthora cinnamomi*. Widespread plant deaths were observed in species from these families. In some areas Proteaceous species were locally absent although their former abundance could be determined from examination of old photography or by the presence of old fire killed plants.

The impact of fire

While fire is a natural phenomenom in these mountain ecosystems with lightning strikes occurring intermittently, the now isolated and remote nature of these protected areas is a complicating factor. The survival of fauna is threatened if a particular National Park were to burn in one event. Appropriate fire management is needed to ensure that fires are patchy in nature. Fire management is further complicated by the presence of dieback and the rate of post-fire recovery.

Slow rates of post-fire regeneration were most evident on exposed areas of the higher eastern peaks of the Stirling Range. Suitable conditions for plant growth may be limited to times when both sufficiently high temperatures and soil moisture co-occur. Low mountain temperatures may be a limiting factor while high wind speeds encountered on exposed mountain areas, in particular on the higher peaks, will also limit plant growth both directly (wind-pruning) and indirectly (evaporation). Slow rates of seedling growth in turn influence the time it takes to replenish seed banks.

An apparently high level of disease impact was observed in more frequently burnt sites. This suggests that in this community, when the disease is present, fire may increase site susceptibility to the disease. This may be attributed to changes in soil microclimate or hydrology, both of which are exacerbated by the slow regeneration of this community, or to the greater susceptibility of seedlings.

All the above factors, as well as the fire-sensitivity of relic mygalomorph spider species (Friend and Williams 1993, Main and Gaull 1993), suggest the need to ensure an adequate fire-free interval in this community.

Feral animals

Feral animals recorded in the mountains included European fox *Vulpes vulpes* and rabbit *Oryctolagus cuniculus*. The presence of the former was detected even in

more remote areas. The impact of fox on native marsupials in south-west Western Australia has been well documented (Kinnear 1989). The Department of Conservation and Land Management has embarked upon an extensive Fox Control Programme which covers the mountain protected areas. The programme utilises "1080" baits which contain mono-fluoroacetate, a chemical which occurs naturally in certain Western Australian plant species and to which native species have a natural immunity.

Recreation

The mountains of south Western Australia are significant areas for tourism, recreation and nature study. Major attributes of the mountains include their natural beauty, geology, flora and fauna, remoteness and 'wilderness' qualities. Bluff Knoll in the Stirling Range is significant as the highest mountain in the south-west of Western Australia and provides good rock climbing conditions in a State of generally low relief. Activities pursued in the mountains include bushwalking, mountain climbing, rock climbing, abseiling, photography and observing wildflowers, particularly in the spring season. The eastern end of the Stirling Range from Ellen Peak to Bluff Knoll is used for a two to three day ridge walk with over-night bivouac stops on the ridge.

The major implication for recreational activity is the potential to introduce and spread disease through the transport of infected soil, which in the case of the mountains is largely by foot. The management of access is critical in minimising the spread of *Phytophthora*, and the requirements for access must be balanced by the need to protect areas from the introduction of disease (Gillen and Napier 1994). The permanent or seasonal closure of un-infected areas and tracks are management options which help contain disease spread. Other strategies include the construction of boot cleaning stations so as to prevent the introduction of the fungus through soil carried on footwear.

Path maintenance is an ongoing concern in an environment subject to high rates of erosion (Gillen and Watson 1993, Watson and Passmore 1993). Well-drained paths are also important in order to minimise the spread of *Phytophthora*.

The management of *Phytophthora cinnamomi* – recent advances

Until recently management options for controlling dieback have been largely confined to those which limit the spread of the disease. However research by the Department of Conservation and Land Management, Western Australia, (Komorek *et al.* 1995) has developed aerial application techniques for the fungicide Phosphonate – the potassium salt of phosphonic acid – which has proven to be a powerful prophylactic fungicide and is the best currently available option for the control of the disease. The chemical is cheap, biodegradable, has very low mammalian toxicity (Guest and Grant 1991) and degrades to phosphate in the soil (Adams and Conrad 1953).

On the basis of the critically endangered status of the mountain dryandra *Dryandra montana* and the threatened status of the eastern Stirling Range montane thicket community, selected areas of the community were sprayed with Phosphonate in early 1997. These areas included infected areas and pockets of dieback-free vegetation where susceptible species continue to survive. It is hoped that the phosphite

residues retained in plant tissue may protect susceptible species for up to three years during which its effectiveness will be monitored.

Conclusions

The mountain protected areas of the south coast of Western Australia have a very significant conservation value. In particular the flora has a high number of rare and endemic species. The mountains are also popular destinations for recreation and tourism. These mountain ecosystems are however fragile and subject to a range of threatening processes, in particular the threat to plant communites and individual taxa posed by the fungal disease *Phytophthora cinnamomi*. Management of these processes presents an ongoing challenge for land managers to ensure the preservation of these mountain ecosystems. The use of phosphite application provides some hope for the protection of the most threatened plant species and communities from *Phytophthora*.

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Habitat linkages – a key element in an integrated landscape approach to conservation

ANDREW F. BENNETT

Concern is growing that designated protected areas may not in themselves be adequate to ensure long-term conservation of native flora and fauna. Attention must also be directed at enhancing nature conservation through management of the entire landscape. An essential element of this approach is the need for ecological interation between reserves and habitats, and this will require some degree of habitat linkage. Three aspects of habitat linkage are discussed: the need for connectivity of various sorts rather than a narrow focus on 'corridors', the recognition that major conceptual approaches to conservation support the importance of habitat linkage, and the need to address habitat linkage over a range of spatial scales. Habitat linkage has an important role as one of the measures available to counter the effects of habitat loss and fragmentation, and is now being implemented as a practical strategy in many parts of the world, but there is much to learn and research and monitoring programmes are urgently needed to assess habitat linkage projects.

HISTORICALLY, nature conservation has been based primarily on designating selected areas as conservation reserves, usually national parks or similar reserves, and managing them for the protection of the flora and fauna. The resulting pattern of reserves is typically a set of separate parcels of land, scattered across a particular region or country, representing a range of different ecosystems. A growing view among conservation biologists is that in many regions such a reserve-based approach will not be adequate, on its own, to ensure the long-term conservation of the native flora and fauna. There is concern that reserves do not represent all natural communities; that most reserves are too small to maintain viable populations of all species and to maintain natural ecological processes; that movement patterns of many animals regularly cross reserve boundaries; and that reserves are not protected from surrounding land uses and may be degraded by processes arising in the surrounding landscape.

One solution is to substantially increase the number and extent of reserves with the goal of establishing a representative network of reserves throughout the area of concern. This is an admirable and worthwhile goal, but may not be possible in many areas because of the scarcity of natural areas that are available for incorporation into a conservation reserve network. A complementary proposal is to move beyond a strictly reserve-based approach and find ways to enhance nature conservation through management of the entire landscape. This concept of an integrated landscape approach to conservation has been advocated by workers in relation to different types of developed landscapes, including managed forests (Franklin 1992), extensive rural landscapes (Hobbs *et al.* 1993) and intensive cultural landscapes (Jongman 1995; Kubes 1996). The latter approach does not downplay the significance of conservation reserves, or the need for further reserves, but emphasises the potential for integrated

systems of habitat that incorporate conservation reserves *together* with other areas of habitat on private and public lands that may be used for a range of purposes.

An essential element in both of these alternatives is the need for ecological interaction between multiple reserves or multiple habitats, rather than management of separate isolated components. However, reserves cannot form a 'network', and habitats can not function as 'integrated systems' in the landscape, unless there is some capacity for interchange of plants and animals and continuity of populations, communities and ecological processes between the various parts of the system.

Habitat linkages as a conservation measure

The concept of providing 'corridors' of habitat to connect natural environments and populations that would otherwise be isolated by human impacts was one of the earliest practical recommendations arising from worldwide concern over the ever-worsening loss and fragmentation of natural habitats (Diamond 1975). The concept has been highly successful in catching the attention of planners, land managers and the community, and a wide range of 'wildlife corridors', 'dispersal corridors', 'greenways' and 'landscape links' are now being developed throughout the world. Such connections may be implemented at a range of scales – from local links between small forest fragments in farmland, to national and international links between major reserves and protected areas.

However, the concept has not been without scepticism, criticism and debate. Concerns have been raised about whether there is sufficient scientific evidence in support of the proposed benefits of corridors; whether there may be negative effects that outweigh any conservation benefits; and that scarce conservation resources may be better spent in other ways (Simberloff and Cox 1987, Simberloff *et al.* 1992, Bonner 1994). This has now become an issue of intense interest and activity. On the one hand, a host of projects and activities around the world are actively directed toward identifying, managing and restoring links between natural environments. On the other hand, scientific reviews have stressed the scarcity of scientific knowledge (Hobbs 1992), and there is now a growing number of studies addressing this topic.

Three important points can be made in order to promote understanding of this issue: the focus should be on 'connectivity' not corridors *per se*; movement and population continuity are fundamental to the survival of species in patchy environments; and connectivity is important at a range of spatial scales.

Focus on connectivity rather than corridors

The fundamental issues at stake are the conservation of the flora and fauna and the maintenance of ecological processes in landscapes heavily disturbed by humans. We can ask: *"Are populations, communities and ecological processes more likely to be maintained in landscapes that comprise an interconnected system of habitats, than in landscapes where natural habitats occur as dispersed ecologically-isolated fragments?"*. Few ecologists would argue for the latter case. A second question can then be posed: *"What is the most effective pattern of habitats to ensure ecological connectivity for species, communities and ecological processes?"*. There is much room for debate and research on this latter question, and it is in this context that the merits of corridors should be considered.

Much of the scientific debate has had a narrow focus on a particular type of linkage, namely corridors, and on a particular type of movement, the direct dispersal of individuals between fragments. The scope of the debate must be broadened to the

wider theme of maintaining 'connectivity' in developed landscapes. This term is used to describe how the spatial arrangement and quality of habitats in the landscape affect the movements of organisms between resource patches (Taylor *et al.* 1993). Connectivity is not synonymous with corridors. Landscape connectivity may be provided for species and communities by different types of habitat configurations. It may be achieved by managing the entire landscape mosaic, or by managing specific patterns of suitable habitat such as 'stepping stones' or habitat corridors. The purpose is to maintain effective links between habitats, and so the terms 'link' and 'linkage' can be used to refer to any of a variety of habitat configurations that achieve this purpose. The most suitable approach depends upon the extent of habitat modification in the landscape and on the species concerned, especially their tolerance of modified habitats. The most attractive option for maintaining connectivity is to manage entire habitat mosaics, but this is likely to be effective only where there is natural vegetative cover throughout most of the landscape, or for species that have a high tolerance of modified habitats.

Movement and population continuity are fundamental to the survival of species in patchy environments

Field biologists and wildlife managers have long recognised that in environments heavily modified by humans it may be necessary to assist species that must move through inhospitable environments and cross ecological barriers on their daily, regular or migratory movements. However, it is also particularly notable that all of the major *conceptual approaches* that underpin our understanding of the status and conservation of animals in patchy environments implicitly recognise the necessity for animals to be able to move between habitat and resource patches.

- The *equilibrium theory of island biogeography* predicts that increased movements of animals will sustain a greater species richness in isolates by enhancing the rate of species colonisation and reducing the rate of species extinctions. Inhibition of movement and consequent isolation of populations will lead to loss of species. The equilibrium theory is now perceived as having limited relevance to nature conservation in terrestrial environments, largely because habitat isolates differ from true islands in the nature of their isolation.
- *Metapopulation models* are concerned with the dynamics of subdivided populations in heterogeneous environments, and have generally superseded the equilibrium theory as the main theoretical framework in this field. They adopt a species-level approach and contend that movements between habitat patches are important because they may supplement local populations that are declining, allow recolonisation of habitats where populations have disappeared, or assist the colonisation of new habitats as they become available.
- *Landscape ecology* seeks to understand how land mosaics are structured, how they function and how they change over time. The flow of energy, nutrients, biota and abiotic matter between different elements in the landscape is central to how land mosaics function. Such movements depend on three primary vectors; wind, water and animals. Thus, movement of animals is not only critical to the survival of local populations, but also to the ecological function of the wider landscape.

Connectivity is important at a range of spatial scales

Organisms move at a range of spatial scales, from metres to hundreds of kilometres, as part of their daily or seasonal activities. Conservation of these species, and the

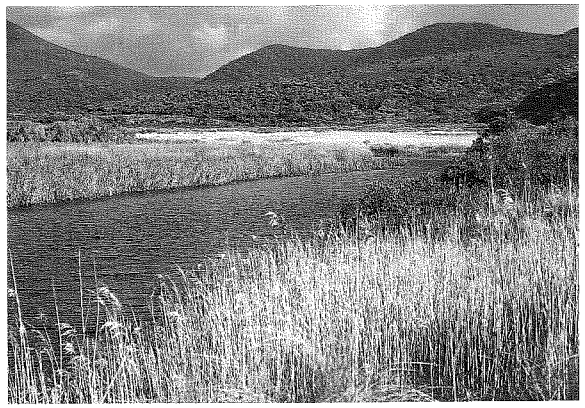
ecological processes in which they are involved (such as seed dispersal, pollination of plants, predation, parasitism), depends on the maintenance of connectivity at scales relevant to the species concerned. At one level, small mammals may use linear habitats such as fencerows or streamside strips to move several hundred metres between small woodland patches in farmland (Bennett *et al.* 1994). At another level, migratory species use key 'stopover' habitats along their migration path, that act as stepping stones where birds may 'refuel' before moving further (Russell *et al.* 1994). Thus, linkages are required at multiple spatial scales to provide for the diverse ways in which organisms live within natural environments (Noss 1991).

The question of spatial scale is also central to debate over the relative merits of corridors. Many of the studies of animal movements and their use of habitat linkages are at the local scale, dealing with small populations that may be separated by distances of a kilometre or less. However, from a conservation perspective, many of the most important linkages are at the landscape or regional scale, such as broad links between major conservation reserves, migration paths of large mammals, or regional systems of interconnected habitats (Baranga 1991, Harris and Scheck 1991). The desire for experimental evidence of the value of corridors is difficult enough to achieve at a local scale, but impossible at a regional scale where linkages are unique (i.e. a sample size of one) and the benefits must be assessed over decades or longer.

Values of linkages

There are numerous documented examples of animals using a range of types of linkages as pathways for movement (Bennett 1990). For example, these may be movements undertaken on a daily or regular basis by animals moving between foraging sites and shelter; migratory movements of animals between different geographic areas in response to seasonal climatic change; dispersal movements whereby individuals move to establish residence in a new location; or the expansion of a species' range into new environments and areas. But what are the benefits that accrue from an increased capacity for animals to move through inhospitable environments?

Insights into the range of benefits that arise are revealed by several different types of studies. First, underpasses and tunnels are now widely used to assist the local movements of species as diverse as elk *Cervus elaphas*, mountain goat *Oreamnos americanus*, badger *Meles meles*, Florida panther *Felis concolor coryi*, mountain pygmy-possum *Burramys parvus* and frogs, to cross local barriers such as roads and railway lines. Studies of the use of these structures show that they reduce the level of mortality among moving animals, allow continued access to habitat resources, and may restore disrupted social structures (Singer *et al.* 1985, Mansergh and Scotts 1989). Second, experimental studies to investigate the consequences of differing levels of connectivity are difficult to undertake,



Streamside vegetation can form ecological linkages and also fulfils a range of other functions: regulating water flow, reducing erosion, filtering sediments and nutrients, protecting water quality, and sustaining aquatic habitats. Photo of Wilson's Promontory, Victoria, south-east Australia: Paul Goriup/Pisces Nature Photos.

but limited results provide evidence that linkages (compared with modified habitats) enhance the movement of animals to ecological isolates, thus improving the status of populations in isolated habitats (Stouffer and Bierregaard 1995, Machtans *et al.* 1996). Third, predictive models based on analyses of the factors influencing the pattern of occurrence of animal species in patchy environments indicate that habitats with high connectivity are more likely to be occupied than those that are isolated. Thus, species such as grey squirrel, eastern chipmunk, dormouse and woodland dependent birds have a greater capacity to persist in small woods linked to nearby woodlands than in those isolated by cleared land (Bright *et al.* 1994). Finally, computer simulation models provide evidence that landscape connectivity is an influential factor in determining the risk of extinction for small and otherwise-isolated populations. The practical value of such models is greatly increased when they are developed in conjunction with field-based studies of the species concerned (Beier 1993).

Overall, these different approaches consistently infer that high levels of habitat connectivity are associated with a greater occurrence and persistence of populations in fragmented and isolated habitats.

The conservation benefits of maintaining connectivity through effective linkages extend beyond the increased level of movement they may foster. Landscape-scale links can be of great value as habitats in their own right; examples include the 18 km tract of tropical forest spanning a 2,900 m elevational gradient between the La Selva Biological Reserve and the Braulio-Carillo National Park in Costa Rica; the networks of mesic gallery forest extending through the dry Brazilian cerrado region (Redford and de Fonseca 1986); and the 7,000 ha of protected land connecting Liwonde National Park and the Mangochi Forest Reserve in Malawi (Bhima 1993). Streamside vegetation, often the basis for ecological linkages, also fulfils a range of other ecological functions: it contributes to regulating water flow, reducing erosion, filtering sediments and nutrients, protecting water quality, and sustaining aquatic habitats.

Role of connectivity in conservation strategy

Promoting linkages to maintain and restore landscape connectivity within a network of reserves and other habitats is not a panacea for problems arising from fragmentation. It is one of four general measures that can be taken to counter the effects of habitat loss and fragmentation in developed landscapes:

- expand the area of protected habitats for flora and fauna
- maximise the quality of existing habitats through management practices
- minimise detrimental impacts arising from surrounding land uses
- maintain and enhance connectivity of natural environments.

The first three measures each result in improvements to the conservation value of individual areas of habitat. However, where measures are effectively taken to maintain or increase connectivity among habitats, there is the opportunity to achieve conservation goals through linked systems of habitat. Thus, the distinctive role of connectivity in a conservation strategy is to 'tie together' habitats, large or small, in order to maintain the natural flow and interchange of biota across the landscape, and so that the otherwise separate habitats may function as an integrated system.

Linkages may be established for a number of specific purposes and consequently there is no uniform set of guidelines for their design and management. To determine the most appropriate design and management for a particular linkage, it is necessary to understand both the biological issues and socio-political issues that may influence

its effectiveness. Biological issues include: the biological purpose of the link, the ecology and behaviour of the animal species concerned, the structural continuity and quality of habitats of the link, and its location, width and potential vulnerability to edge effects. Socio-political issues that influence implementation, management and ecological effectiveness of a particular link include: the status and tenure of the land, management responsibilities and resources, the level of support and involvement by the local community, and the degree of integration with other resource management programmes.

Future directions

Recognition of the role of landscape connectivity in the conservation of biodiversity within human-dominated environments has now moved from the conceptual stage to that of practical implementation in conservation strategies. In many countries throughout the world a diverse range of linkages are now protected, or are being managed or restored to enhance the continuity of animal populations and to maintain ecological processes in fragmented ecosystems. Implementation is as yet in an early stage and there is much to learn. There is an urgent need for research and monitoring programmes to accompany these projects to assess their value and effectiveness, and to resolve issues involved in their implementation. Such knowledge should provide the basis for ongoing improvements in the way that linkages are planned and managed, so that we may more effectively conserve biodiversity in environments increasingly subject to the varied impacts of human land uses.

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This article is based on a forthcoming book, "Linkages in the Landscape", to be published by the IUCN Forest Conservation Programme. Issues relating to the values of linkages and their role in wildlife conservation are explored in greater detail in the book, with reference to numerous examples and case studies from around the world.

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Resumenes

Planeamiento regional y las áreas protegidas en el sur de Australia Occidental

JOHN WATSON

El planeamiento regional es una herramienta valiosa para el establecimiento de una base amplia de un nivel de planeamiento más detallado. Particularmente, puede proveer un sistema lógico de prioridades para el plan de manejo de áreas individuales,cuando se trata de un sistema de áreas protegidas dentro de una categoría única IUCN, similar al concepto de ROS, (Espectro de oportunidades de recreatividad). El planeamiento regional provee tambien una base sólida para planes operacionales estratégicos y para el establecimiento y evaluación de programas de trabajo individuales.

La reserva de la biosfera del Parque Nacional del río Fitzgerald 1978–1997: la evolución de un área protegida de manejo integrado

JOHN WATSON Y ANGELA SANDERS

La reserva de la biosfera del Parque Nacional del río Fitzgerald es una de las áreas de conservación más significativas en el sur de Australia Occidental. Su alta diversidad biológica fue reconocida por vez primera a principios de 1800 cuando los coleccionistas botánicos visitaron la zona y transportaron a Europa especímenes valiosos. El parque es famoso también por su población de fauna invertebrada que se conserva bastante intacta. La comunidad local ha estado envuelta en su administración desde principios de los años setenta y es este envolvimiento el que ha permitido la evolución de la administración de las áreas protegidas en este magnífico parque nacional.

La administración de las especies en peligro en la costa sur de Australia Occidental.

KELLY GILLEN, ALAN DANKS, JACKIE COURTENAY Y ELLEN HICKMAN

La reserva natural de la bahía "Two Peoples" y el Parque Nacional de la cordillera Stirling son notables por su biodiversidad y son ejemplos de las áreas protegidas donde se lleva a cabo la administración de especies amenazadas. La reserva natural "Two Peoples" es el hogar del ruidoso pájaro fregón, redescubierto en 1961 después de haber sido considerado extinto durante la primera mitad de la centuria. La administración del habitat a través de la exclusión del fuego y de un programa de transalojamiento han mejorado mucho la viabilidad de esta especie. El potoroo de Gilbert también ha sido redescubierto en esta zona luego de más de cien años sin verle. Estas especies, uno de los mamiferos en más peligro crítico, parece estar presente en pequeñas cantidades y es el sujeto de un programa de investigación que incluye el manejo de una colonia de crianza en cautividad y más investigación del habitat adecuado. El potoroo de Gilbert (y un número de especies en peligro dentro del área) se ha beneficiado con las acciones administrativas ejecutadas para la conservación del ruidoso pájaro fregón.

La administración de la conservación de una comunidad de plantas montañosas en peligro dentro del Parque Nacional de la cordillera de Sterling ha requerido la aplicación novedosa de una tecnología nueva. La comunidad, que incluye nueve endémicas localizadas de las cuales siete han sido declaradas especies raras, ha sido amenazada por la introducción de la planta patógena *Phytophthora cinnamomi*, que se expande sobre los picos al este de la cordillera. Se seleccionaron áreas que fueron rociadas desde el aire con dosis predeterminadas de fosfato (la sal de potasio del ácido fosfónico) y cuya investigación ha demostrado que puede estimular la reacción inmunológica de las plantas nativas frente al invasor patógeno. En este caso, la conservación de especies individuales amenazadas se logra a través de la comunidad de plantas.

Conservación de tierras privadas – El Santuario de Karakamia, Australia Occidental

BARRY WILSON

Recientemente, ha habido, en Parques y otros lugares, discusiones extensivas sobre la importancia de la participación de las comunidades locales en la administración de parques. En Australia, ha habido una serie de conferencias sobre la contribución que el ecoturismo puede (y debería) aportar a la administración de un recurso en el cual esta industria en desarrollo depende, reconociendo que una gran

proporción de los santuarios de la vida salvaje, y los sitios salvajes y panorámicos, que tienen el status de íconos, están en manos de las autoridadess gubernamentales y son administrados por las agencias de gobierno. Este artículo considera la relevancia de las tierras privadas en el logro de los objetivos de la biodiversidad nacional y menciona el ejemplo del santuario de Karakamia en Australia occidental, una propiedad a perpetuidad en las colinas de Perth.

Areas protegidas montañosas del sur de Australia Occidental

SARAH BARRETT Y KELLY GILLEN

Se condujo el estudio de unos picos de montañas seleccionados especialmente y situados en el suroeste de Australia Occidental para determinar los valores de conservación de la naturaleza de estas montañas y para describir y calificar la amenaza sobre ellas. De las 750 especies de plantas examinadas, 101 estaban restringidas a una montaña en particular o a una cordillera. La comunidad de matorrales montañosos del lado oriental de la cordillera Stirling fue identificada como una subcomunidad significativa dentro de la cordillera con un gran numero de especies localizadas en peligro. El estudio proveyó el inventorio inicial de la fauna montañosa que incluyó 16 especies de mamíferos, con cinco especies en peligro o raras. La diversidad de reptiles no era muy grande. Un sondeo de camadas de invertebrados registró un gran número de especies de arañas, hormigas y caracoles. Un número de arañas viudas Gondwanan y especies de carocoles que persisten en los climas montañosos húmedos así como una población nueva de arañas en peligro crítico. La *Phytophthora cinnamoni* fue confirmada como la mayor amenaza de muchos de los ecosistemas montañosos. Los incendios, especialmente en términos de escala y frecuencia, son también un factor crítico, debido a la lentitud de la tasa de crecimiento regenerativo a grandes altitudes. La interacción de la Phytophthora y el fuego puede ser devastadora en los ecosistemas susceptibles a esta enfermedad. La administración necesita poner su foco en estas amenazas y obtener un equilibrio entre las necesidades recreativas y el valor de la conservación.

La vinculación del habitat – un elemento clave en una aproximación a la conservación dentro de un paisaje integrado

ANDREW BENNETT

Está aumentando la preocupación de que las zonas designadas como protegidas, no pueden ser adecuadas, por sí mismas, para asegurar una conservación, a largo término, de la fauna y flora nativas. También debe dirigirse la atención a realzar la conservación de la naturaleza a través de la administración del paisaje total. Un elemento esencial de este acercamiento es la necesidad de una interacción ecológica entre reservas y habitat, lo que requerirá un cierto grado de vinculación del habitat. Se discuten tres aspectos de esta vinculación: la necesidad de distintos tipos de conexión en lugar de un enfoque estrecho de "corredores", el reconocimiento de que los acercamientos conceptuales mayores hacia la conservación sostienen la importancia de la vinculación del habitat y la necesidad de contemplar la vinculación sobre una serie de escalas espaciales. Este vínculo del habitat tiene un papel importante como una de las medidas disponibles para contrarrestar los efectos de la pérdida y fragmentación del habitat, y ahora está siendo implementado como una estrategia práctica en numerosas partes del mundo, aunque todavía hay mucho que aprender e investigar, y se necesitan urgentemente, programas de control para estimar los proyectos de vinculación del habitat.

Résumés

Planification régionale et zones méridionales protégées en Australie occidentale

JOHN WATSON

La planification régionale est un outil important pour définir un grand cadre de travail pour des niveaux de planification plus détaillés. En particulier, il peut permettre à un système de zone protégée d'avoir un ensemble logique de priorités pour les plans individuels de gestion des zones protégées, et il permet d'identifier une "portée" de types de zones protégées à l'intérieur d'une seule catégorie IUCN – similaire au concept de portée d'opportunité récréative (ROS soit *Recreation Opportunity Spectrum*). La planification régionale fournit aussi une base solide pour des plans stratégiques d'exploitation et pour définir et évaluer individuellement les programmes de travail.

Réserve biosphère du parc national de Fitzgerald River 1978-1997: l'évolution d'une gestion intégrée d'une zone protégée

JOHN WATSON ET ANGELA SANDERS

La réserve biosphère du parc national de Fitzgerald River est l'une des zones méridionales de conservation les plus importantes en Australie occidentale. Sa haute diversité biologique a été d'abord reconnue au début des années 1800 lorsque les collecteurs botaniques ont visité la zone et ont ramené des spécimens importants en Europe. Le parc est connu aussi pour ses populations presque intactes de vertébrés dans sa faune. La communauté locale s'est engagée dans la gestion de la zone dès les années 1970 et son rôle a permis d'amener l'évolution d'une gestion intégrée de la zone protégée de ce parc nationale admirable.

Gestion des espèces en voie d'extinction sur la côte sud d'Australie occidentale

KELLY GILLEN, ALAN DANKS, JACKIE COURTENAY ET ELLEN HICKMAN

La réserve naturelle de Two People's Bay et le parc national de Stirling Range sont reconnus pour leur biodiversité et sont des exemples de zones protégées où on a effectué une gestion des espèces en voie d'extinction. La réserve naturelle de Two People's Bay est le milieu naturel de l'oiseau bruyant des broussailles Scrub-bird, redécouvert en 1961 après avoir été considéré comme étant une espèce disparue pendant la 1ère moitié du vingtième siècle. La gestion de cet habitat par l'exclusion des incendies et un programme réussi de transposition ont grandement amélioré la viabilité de cette espèce. Le Potoroo de Gilbert a été redécouvert récemment aussi dans cette zone après avoir disparu pendant cent ans. Cette espèce, l'un des mammifères en grand danger d'extinction d'Australie, apparaît être présente en petits nombres et est le sujet d'un programme de recherche comprenant la gestion d'une colonie d'élevage en captivité et une autre enquête d'un habitat vraisemblable. Le Potoroo de Gilbert (et un certain nombre d'autres espèces menacées dans cette zone) a bénéficié d'actions de gestion entreprises pour la conservation de cet oiseau bruyant des broussailles à savoir le Scrub-bird.

La gestion de la conservation de la communauté d'une plante montagneuse en grand danger d'extinction dans le parc national de Stirling Range a nécessité l'application innovatrice d'une nouvelle technologie. La communauté, qui comprend neufs endémiques localisées dont sept sont déclarées des espèces rares, est menacée par l'introduction d'un pathogène de la plante à savoir le *Phytophthora cinnamoni* qui s'est bien développé sur les pics orientaux de cette chaîne montagneuse. Des zones bien choisies ont été traitées par voie aérienne à des taux prédéterminés de phosphite (le sel de potassium de l'acide phosphonique) dont la recherche a montré qu'il peut stimuler la réponse immunitaire des plantes autochtones au pathogène envahissant. Dans ce cas, la conservation des espèces individuelles en voie d'extinction est obtenue par l'approche de la protection de la communauté de la plante.

Conservation sur les propriétés privées - Sanctuaire de Karakamia, Australie occidentale

BARRY WILSON

Il y a eu beaucoup de discussions récemment dans *PARKS* et ailleurs sur l'importance de la gestion des parcs en association avec les communautés locales. En Australie, nous avons eu récemment plusieurs conférences sur la contribution de l'écotourisme (actuelle et future) vis-à-vis de la gestion des ressources permettant de développer cette industrie, tout en reconnaissant qu'une forte proportion des sanctuaires naturels et des sites sauvages et scéniques ayant un statut national important sont à la charge des autorités gouvernementales et sont en fait gérés par les agences gouvernementales. Cet article prend en considération l'intérêt des propriétés privées pour répondre aux objectifs nationaux de biodiversité et il cite notamment l'exemple du sanctuaire de Karakamia d'Australie occidentale, une pleine propriété dans les montagnes de Perth.

Zones montagneuses protégées de l'Australie occidentale méridionale

SARAH BARRETT ET KELLY GILLEN

Une étude de certaines montagnes du sud-ouest de l'Australie occidentale a été faite pour évaluer les valeurs de conservation de la nature de ces montagnes et pour décrire et qualifier les menaces à ces montagnes. Sur les 750 espèces de plantes recensées, 101 étaient restreintes à une montagne en particulier ou une chaîne montagneuse. La communauté des fourrés montagneux orientaux de la chaîne Stirling

Range a été identifiée comme étant une sous-communauté importante de la chaîne Stirling Range, avec un grand nombre d'espèces locales menacées d'extinction. L'étude a fourni un inventaire initial de la faune montagneuse comprenant 16 espèces de mammifères dont cinq menacées d'extinction ou rares. La diversité reptilienne était faible. Une enquête des invertébrés vivant des détritus végétaux et organiques a noté un grand nombre d'araignées, de fourmis et d'escargots. Un certain nombre d'araignées de relique Gondwanan et d'espèces d'escargots ont persisté dans les climats montagneux humides et une nouvelle population d'araignées en voie d'extinction a été identifiée. *Phytophthora cinnamoni* a été confirmée comme étant une menace importante pour de nombreuses écosystèmes montagneux. L'incendie, notamment en terme de fréquence et son échelle de destruction, est aussi un facteur critique car la nouvelle croissance de régénération à hautes altitudes est bien plus lente. L'interaction du *Phytophthora* et d'un incendie peut être dévastatrice pour les écosystèmes susceptibles aux maladies. La gestion des ressources doit se concentrer sur ces menaces pour obtenir un équilibre entre les besoins récréatifs et les valeurs de la conservation.

Liaisons avec l'habitat naturel - un élément clé pour une approche intégrée du paysage à la conservation

ANDREW F. BENNETT

Une certaine préoccupation croît que les zones protégées ne sont pas adéquates pour assurer une conservation à long terme de la flore et faune autochtones. On doit porter l'attention sur l'amélioration de la conservation des réserves naturelles par la gestion globale du paysage. Un élément essentiel de cette approche est le besoin d'une interaction écologique entre les réserves naturelles et les habitats, et il faut un certain degré de liaison avec l'habitat. Trois aspects de liaison avec l'habitat sont présentés ici: le besoin d'un rapprochement de plusieurs sortes plutôt que d'effectuer une toute petite passerelle, la reconnaissance que les grandes approches conceptuelles à la conservation des ressources naturelles soutiennent en fait l'importance d'une liaison avec l'habitat, et le besoin d'adresser ce problème de liaison avec l'habitat sur plusieurs échelles spatiales. La liaison avec l'habitat représente un rôle important comme étant l'une des mesures disponibles pour contrecarrer les effets de la perte de l'habitat naturel ou sa fragmentation, et on exécute cette politique maintenant comme stratégie pratique dans beaucoup de régions du monde mais nous avons encore beaucoup à apprendre et il est nécessaire d'effectuer rapidement des programmes de recherche et de contrôle pour évaluer les projets de liaison avec l'habitat.

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