Royal National Park – Lessons for the Future from the Past

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The area now known as Royal National Park was one of the first sites in the world designated as a national park. In 1879 the concept of a national park was very different from that held today, and in the decades following establishment of the Park substantial alterations to large areas were carried out by the Trustees. Despite these disturbances the Park retains many of its biodiversity values and still meets current criteria for designation as a national park. What the history of Royal National Park tells us about reserve selection processes is explored.

One of the outstanding features of Royal National Park is the floristic diversity of its sclerophyll communities. In Australia such diversity is characteristic of areas with low soil fertility, and is a function of geological history. The consequences of the relationship between soils and flora for conservation in a changing world are discussed.

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The early years.

What we now know as the Royal National Park was established, as the National Park, in 1879. The appellation 'Royal' was conferred in 1954 in commemoration of the visit to Australian by Queen Elizabeth II. It was the first area designated as a national park in Australia, and one of the first in the world, although the early history of national parks is a matter of some debate.

In 1879 Australia was not yet a nation; New South Wales was still a colony, destined, after Federation, to be a state within a nation. Designating an area 'National' was slightly presumptuous, but this does not detract from the importance of the declaration, both within Australia and more widely. Indeed the terminology 'national park' was, and continues to be, used for a particular concept of land use and management rather than necessarily reflecting the geopolitical context of an area.

The process, from floating the concept of the National Park to its formal establishment, was remarkably quick, taking only weeks (Anon 1902, Pettigrew and Lyons 1979, Hutton and Connors 1999). In contrast some more recent park declarations have been years in gestation. While called National Park, the original objects for the declaration would not be compatible with current usage of the term. The term national park today is employed in different ways in different countries, but most widely in the sense of a category II reserve in the International Union for the Conservation of Nature (IUCN) classification of conservation reserves. While national park in IUCN terminology specifically allows for human access and use for recreational purposes, the prime objective is the conservation of nature (today nature would generally be regarded as synonymous with biodiversity).

In 1879 the intent of the Premier of New South Wales, Sir John Robertson, was to establish 'a national domain for rest and recreation' (Anon 1902). In particular there was seen to be a need to provide 'breathing spaces favoured by Nature' for the most densely populated of the inner suburbs of Sydney (such as Paddington and Surry Hills). The establishment of the National Park preceded by nearly a decade the founding of Centennial Park, situated much closer to the inner city.

There was also strong lobbying from the newly formed Zoological Society of NSW (now the Royal Zoological Society) for provision of an area which could be used for the acclimatisation of various

exotic species. Walter Bradley, a leading light in the Zoological Society, was one of the first trustees of the National Park.

The National Park was established as a separate entity, rather than being part of a department of government and was administered by a Trust Board established under the Public Parks Act, and as later parks were gazetted each in turn was established with an independent trust.

The by-laws for the National Park (the 1901 version of which are reproduced in Anon 1902) suggest some limited attention to what would now be regarded as nature conservation. For example – by-law '11. No person shall, without the permission of the Trustees, remove, cut or deface any rocks, trees, shrubs, plants, seats, gates, posts, or fences, or write thereon, or shall affix any bill or stencil-mark to any rock, tree, seat, gate, post, fence, wall, pillar, railing, or to any building or other erection within the Park, or interfere with, capture, or destroy any of the birds or animals therein, except with permission of the Trustees in writing.' The by-laws illustrate the limited grasp of taxonomy held by legal draftspersons, whereby trees, shrubs and plants are different categories, and birds are distinct from animals.

Other by-laws prohibited the presence of persons 'in a state of intoxication, or of reputed bad character' and skinny dipping in the Hacking River.

Notwithstanding passing nods to what would now be regarded as nature conservation, the second edition of the Official Guide to the Park (Anon 1902) documents with pride twenty years of 'improvements' carried out by the Trustees.

What would now be regarded as among the glories of the Park, the species rich heathlands and open dry sclerophyll woodland, were of little consequence. The Park 'consists mostly of high tableland, thousands of acres being barren stony moor, with high and dry patches of soil, superior in quality, suitable for military manoeuvres, recreation and camping grounds, or for plantations of ornamental trees and shrubs' (Anon 1902). The reference to the heathland as 'moor' continues a tradition going back to Captain Cook during his first visit to Australia, and reflects the paucity of the English language for the description of vegetation outside the scope of Britain. If Australia had been, as it almost was, colonised by the French we might have referred to the same vegetation as maquis or garigue which would perhaps have given a better impression of its species richness and ecological characteristics.

There was greater appreciation for the beauty of the tall wet sclerophyll forest and rainforest patches, although that appreciation involved the writing out of history the indigenous inhabitants of the land - the tall forests consisting of 'majestic trees, which for centuries have grown in solemn silences unbroken by man's footfall' (Anon 1902). The Trustees did, however, acknowledge the Park's first human inhabitants in the adoption of many Aboriginal names for geographical locations within the Park and the Official Guide describes a number of Aboriginal carvings, although from a twenty first century perspective reference to them as 'traces of a dead race' displays both inaccuracy and a lack of sensitivity.

Amongst the attractions of the area in terms of its suitability for being a National Park were its accessibility from Sydney by road and rail and the lack of other uses for the land. Low soil fertility and topography ruled out agricultural development. In order to make the Park suitable for the recreational opportunities the Trustees were intent on providing, they embarked on a substantial works program. One of the first constructions was the damming of the Hacking River at Audley, with dredging below the dam and desnagging above it. A considerable number of roads were built, the Official Guide (Anon 1902) stating that 'the road-making history of the Trust is emphatically the history of progress'. A large number of facilities were built at Audley.

The acclimatisation ambitions of the Zoological Society were also progressed. The Deer Park was established, white swans were introduced and an aviary was constructed for the acclimatisation of other bird species. A variety of northern hemisphere temperate freshwater fish were released into the Hacking River above the dam. Australia's first marine fisheries hatchery was established in Cabbage Tree Creek (Anon 1902).

Despite the protection of (some) fauna provided for by the by-laws the Trustees were obviously selective in applying the rules to themselves. The Official Guide (Anon 1902) saw no problem in reporting 'Sometimes, but very infrequently – for it is not the policy of the Trustees to nurture or foster the growth of pests, - on a still night the eerie howl of the dingo can be heard on the lonely mountain sides, and the handsomely – marked native cat has been known to leave evidences of nocturnal depredations'. Snakes were not in favour either; the Guide takes pleasure in reporting that they were 'so rapidly disappearing that no danger need be apprehended from their presence. During the last half-dozen years the presence or killing of only about the same number of snakes has been officially reported throughout the extensive reserve'.

In particular parts of the Park flora was also modified. 'Thousands of ornamental and shade trees have been planted in avenues, groups and border lines, acre upon acres of the best land have been under-scrubbed and thoroughly cleared, and the useless under-scrub has given place to nutritious and ornamental grasses' (Anon 1902).

Plans for further modifications continued until at least the 1930s. Carter (1933) discusses a 'fine scheme' to establish a native garden on two hundred acres of the Park at Waterfall, although the Depression prevented progress.

The construction and maintenance of the Park's facilities were expensive. The Trust received an annual allocation from Treasury augmented on occasion by donations from citizens (Anon 1902), as well as income from activities. Some material for the works program was won within the park – laterite caps were quarried for road gravel and trees were felled for timber. Extant laterite cappings further west, around Lucas Heights and in the Holesworthy Range, support a distinctive assemblage of species, of which the vulnerable shrub *Melaleuca deanei* is a characteristic member. The absence of this assemblage in the modern Royal National Park may be a consequence of disturbance and clearing of habitat in the late nineteenth century. For a time in the early 1920s the Trustees permitted a private sawmill to operate within the park boundaries (Pettigrew and Lyons 1979). There was extensive use of the Park for military training prior to the First World War, including the firing of artillery, while the main visitor complex at Audley provided opportunities for a range of activities including boating, tennis and picnicking. Concern over the approach of the Trustees, and the establishment of a lobby for what we would today regard as nature conservation surfaced prior to the First World War but did not really develop until the interwar period (Pettigrew and Lyons 1979, Hutton and Connor 1999)

The Park thus functioned as a pleasure ground along the lines of Hampstead Heath and Richmond Park in London, for which a semi natural setting was important but where ideas of conservation as it is now understood were not paramount. While the choice of the name National Park might have been influenced by the use of the term in the United States, the concept was very different from that which had emerged in America (Pettigrew and Lyons 1979).

Public discussion about conservation had commenced in several of the Australian colonies before 1879, but the major focus of concern was saving forests (Hutton and Connors 1999, Mulligan and Hill 2001). In terms of national (and international) eminence the best known figure associated with calls for forest protection was the botanist Ferdinand Mueller in Melbourne, but papers advocating conservation were presented at meetings of several of the colonial Royal Societies (including in NSW), and newly formed natural history societies also added their voice (Hutton and Connors 1999, Mulligan and Hill 2001). The Zoological Society of NSW was active in lobbying the NSW government for the establishment of the National Park, albeit that the motivation was acclimatization of exotic fauna rather than conservation in its modern sense. Despite the fact that many of the leading members of the Royal Society of NSW were also members of the Linnean Society there does not seem to have been any great advocacy for conservation from the Linnean Society in the late nineteenth century. In the early twentieth century (1908) the then President of the Linnean Society of NSW, A. H. S. Lucas used his office to advocate greater measures for conservation of birds (Hutton and Connors 1999), and in the 1940s the Society was one of the bodies advocating for conservation of the NSW Alps (Mosley 1999). More recently the Society has been a member society of the Nature Conservation Council (NCC) of NSW and through the NCC has supported a range of conservation initiatives. In the early years of the National Park perhaps the most important role of both the Linnean Society and the Royal Society of NSW was to provide forums for the publication of descriptive papers on the biota of the state. Even if relatively few were based on studies in the Park they provide the context from which we can now assess the extent of change in the landscape and the importance of the Park in containing representation of landscapes and ecosystems once more widespread.

If conservation of what we now call biodiversity was not a major goal in the late nineteenth century, there was developing another conservation ethos which valued 'nature' in itself and as a source of inspiration and solace to humans. The landscape conservation movement which developed in Europe in the nineteenth century, associated with figures such as Wordsworth, focused on the protecting of areas of 'natural beauty' (the term used in the objects of the National Trust of England and Wales), but virtually all that was proclaimed 'natural' had been modified by many centuries of human use. This is not to say that, from a current perspective, many such areas of concern are not of continuing importance for biodiversity conservation, but rather that farming and forestry have created the observed landscape and thus continuing management intervention is required to maintain the landscape in its desired state. In an

analysis of sites proposed as nature reserves in Britain in 1915, Rothschild and Marren (1997) found that the most common cause of loss of conservation values in the following 75 years was 'neglect' – the failure to maintain management regimes.

In northern America, the writings of Thoreau and Emerson highlighted the importance of wilderness for humans, ideas converted into active lobbying for conservation by John Muir, who can be regarded as the progenitor of the modern concept of wilderness and promoter of National Parks (MacFarlane 2006). This early movement underestimated and undervalued the role of indigenous people in shaping the landscape and was not driven by any detailed understanding of ecology and biodiversity, although Muir was an experienced and enthusiastic field naturalist with especial interests in both botany and geology.

Muir visited Australasia briefly in 1903-1904 (Hall 1987, 1993), but, despite his contacts with a number of Australian activists, did not have a much influence on early conservation in Australia, although later he was an inspiration for the wilderness movement which blossomed from the late 1970s onwards.

The first expression in Australia of Muir's philosophical approach to conservation was seen in the successful advocacy by RM Collins and Romeo Lahey for the establishment of Lamington National Park in Queensland, gazetted in 1915 (Hutton and Connors 1999).

In NSW in the first half of the twentieth century the major advocate for national parks was Myles Dunphy (Thompson 1986, 2006) working through the Mountain Trails Club and other bushwalking groups. Dunphy was a leader in the establishment of parks in the sandstone country around Sydney, many of which are now incorporated in the Greater Blue Mountains World Heritage listing.

A prime objective was recreation, but recreation that was determined by, and sympathetic to, the landscape, rather than activities that required the modification of the environment and construction of facilities. The National Park was definitely not the model for these new parks. What is now Heathcote National Park, but was originally the Heathcote Primitive Area, with minimal facilities other than access tracks was an exemplar of a bushwalker's park (Dunphy 2006). The beauty of the bush in these areas was part of the attraction, but conservation of natural history was a secondary consideration in the establishment of parks. Even today, with suburbia abutting both Royal National Park and Heathcote National Park, it is the Royal which is the focus for mass visitation while Heathcote is comparatively unknown.

In 1939 ANZAAS (the Australian and New Zealand Association for the Advancement of Science – at that time the peak gathering of scientists in Australasia) passed the following resolution -

> "(ii) That the Commonwealth and State Governments should be warned of the immediate necessity for more adequate National Reserves for the preservation of the indigenous flora and fauna of Australia; that it is not enough to institute National Parks near the great cities, which become primarily popular resorts; that areas should be reserved in more secluded or more suitable situations with the definite aim of the preservation of wildlife; and that these reserves should be controlled by trustees chosen on account of their expert knowledge, and should be cared for by full-time and properly qualified rangers (ANZAAS 1939)."

This resolution was clearly critical of the 'National park as pleasure ground' model epitomized by the National Park and sought the establishment of reserves whose principal purpose was nature conservation. These reserves would not be promoted for visitation and could be remote from centres of human inhabitation. However, the resolution refers to trustees so that the concept of a system of reserves, administered in an integrated way had yet to dawn.

In NSW the idea of a systematic network of nature reserves became reality in the late 1940s with the creation of the position of Chief Guardian of the Fauna. The Chief Guardian had responsibility statewide for the protection and management of native fauna (or at least that small proportion of the total fauna which was recognized by legislation) throughout the State, but was also charged with the selection of sites to be designated as Nature Reserves. Given the title of the office it was clearly the intent of the legislature that the focus for creating reserves was habitat for specific fauna, but in practice the scope of Nature Reserves was much broader. Although the designation of sites could be justified on faunal grounds, there were also sites which were important exemplars of major plant communities and habitats of rare plants. Although there had been controls on the collection and sale of some native plants since the early 20th century, in general plant conservation did not enjoy a high profile, so that to an extent creating reserves of high value for flora conservation was ahead of public opinion. Importantly expectations of open public access and provision of visitor and recreational facilities were not a major part of the nature reserve model.

In 1967 there was a major change in approaches to nature conservation when the NSW National Parks and Wildlife Service was created, the first such service in Australia. This new Service was based on American models, although as it had both reserve and off reserve functions it embodied elements of both the US National Parks and the Fish and Wildlife Service. The new Service subsumed the roles of the Chief Guardian of the Fauna and management of Nature Reserves. The then existing National Park trusts were disestablished and management of parks was taken over. When I first had involvement with the NPWS in the late 1970s and early 1980s there was still a residual resentment in some parts of the State over the loss of local Trusts and imposition of a central bureaucracy. In some rural areas today there are still pockets of opposition to National Parks, but these are more generally based rather than being a hankering for a return to pre-1967 arrangements.

The establishment of NPWS allowed for the adoption of state-wide policies and procedures and heralded the expansion of the reserve network, both National Parks and Nature Reserves; an extension still continuing today. In this expansion nature conservation objectives are to the fore, but management of National Parks still had to allow for recreational visits, so that in the few parks with very high visitation rates there have continued to be conflicts between nature conservation and satisfying the demands of the general public. In some cases particular recreational demands are inevitably in conflict with conservation requirements, leading to compromises which are never fully accepted by either side.

The extension of the reserve network post 1967 was achieved through a mixture of idealism, science, pragmatism and political reality. Over the years there have been a number of reviews that have created 'shopping lists' for potential reserves. Some of these lists were based on long standing proposals from non-government organisations such as bush-walking groups, the National Parks Association and local lobby groups. Others were in response to emerging public concerns (for example rainforests in the early 1980s), while some were the result of detailed targeted surveys.

NSW has been amongst the world leaders in developing increasingly sophisticated algorithms for evaluating options for nature conservation, particularly as more data about the distribution of components of biodiversity has become available (Margules and Pressey 2000). There is no reason why application of such methodologies should necessarily be restricted to biodiversity and at least some other attributes could be incorporated, for example geodiversity and archaeology. However, while we may be able to design the ideal (at least at one moment in time) conservation reserve system, converting it to reality is a much less objective task. If the key components are privately owned, and the owners are not willing sellers, then progress is unlikely. Increasingly it is being realised that the achievement of the effective conservation outcome does not necessarily imply public ownership, despite this having been the prevailing paradigm in Australia. Progress also requires political will, which is not a given and varies over time.

On what basis do we decide that in the area should be part of the reserve system? For the last two decades the dominant paradigm has been the maximising the conservation of biodiversity. The national reserve system is seen as the means through which conservation of biodiversity is to be achieved. Biodiversity conservation is clearly an important, indeed essential, goal but it is not the only reason that can be advanced to justify reserving an area. Other reasons could include geodiversity, a broad term encompassing a range of features (Gray 2004, 2008). There is a long history of recognising significant geological and geomorphologic features within conservation reserves. In the USA reserves to conserve striking geomorphologic features and landforms are sometimes identified as Natural Monuments. Amongst the nature reserves proposed at the end of the Second World War in England and Wales were a number of geological reserves and both in the reserve system and in statutorily protected lands designated in the UK as Sites of Special Scientific Interest (SSSI), geological interests have been given a great deal of attention (see May and Hansom 2003).

The concept of geodiversity as a geological equivalent of biodiversity was developed in the 1990s in Tasmania, but while it is now well established internationally (Gray 2008) the concept has had relatively little impact in mainland Australia, although it is surprising that concern to protect major caves in NSW predated the development of conservation of surface features by more than a century (Horne 2005). Nevertheless Royal National Park has a number of features which collectively would result in recognition of high geodiversity value.

From the 19th century onwards there has been a keen interest in conserving landscapes - 'places of outstanding natural beauty'. Landscape is determined primarily by geology and geological processes, but it is the living skin of vegetation over the geological skeleton which contributes much to our appreciation of landscape. Human perceptions of beauty in the landscape vary between individuals, and fashions in landscape appreciation have changed over time.

Conserving vegetated landscapes necessarily involve collateral conservation of biodiversity.

'Heritage' has also been a major justification for conserving places and sites, although the definition of heritage is extremely elastic, and, can encompass both physical items and intangible elements. Indigenous heritage is of great significance and Royal National Park is acknowledged as being of continuing relevance to the indigenous community. In European (and European derived) cultures there is little questioning of the importance of preserving major elements of history, including Civil War battle sites in both England and the USA, sites where turning points in history occurred (such as Runnymede or Captain Cook's landing place), or grand buildings (the cathedrals and castles of Europe). Perhaps more controversial is whether or not the less grand, such as industrial buildings or vernacular housing, is also worthy of protection. To retain the history of European Australia and the National Park, should elements of the past in the form of the facilities at Audley or the shacks at Garie be conserved? Are the Rusa deer pests to be destroyed or are they part of the Park's heritage (or are they both)?

The original justification for the National Park was as green lungs for urban Sydney, and for the past 130 years the Park has provided the needs of large numbers of human visitors, many of whom have little knowledge or understanding of biodiversity or heritage. A publicly funded conservation reserve system will necessarily, and properly, be sensitive to the needs of its paymaster while giving prime attention to sustainable management of nature. There will inevitably be tension between the needs of nature conservation and the provision of recreational opportunities and facilities. There will also be the potential for questioning public spending on conserving nature reserves which most members of the public will be unable to visit. Curiously, nature reserves, although being part of the NSW government response to the need for conservation since the 1940s, have largely escaped widespread recognition. However, filling in the gaps in the biodiversity conservation network is likely to involve more new nature reserves than national parks. One of the recent shifts in conservation practice in Australia has been the increasing involvement of private organisations and individuals as conservation landholders, but the State is likely to remain the major player, and expenditure on public conservation will continue to be exposed to questioning and audit.

In the northern hemisphere the interest in nature (biodiversity) conservation developed much earlier than in Australia. In the early 20th century there was, across Europe, strong pressure to establish nature reserves, based on concerns about the increasing rate of loss of natural (or semi-natural) areas. In 1913 the first meeting of the International Committee for the Protection of Nature was held in Berne. The Society for the Promotion of Nature Reserves (SPNR) was formed in Britain in 1912. The leading light in the SPNR was Charles Rothschild, who as well as being a prominent businessman was also an active entomologist (describing 500 species of fleas) and maintained a keen interest in many areas of natural history (Rothschild and Marren 1997). The first objective of the SPNR was to prepare a list of potential nature reserves in the UK, and in 1915 a provisional list of 282 sites was presented to the British government. The remit of the SPNR encompassed not just Britain but the Empire, and Rothschild also compiled data for reserves in Australia and New Zealand and suggested that the SPNR ask governments throughout the Colonies and Dominions to consider making reserves (Rothschild and Marren 1997). At the International Conference for the Protection of Nature in 1913, Rothschild stressed the importance of measures for conservation of nature outside the jurisdiction of individual countries as a global communal responsibility, in particular in the oceans and in the polar regions.

For the British list, information and recommendations were sought from natural history clubs and societies, and from experts in particular taxonomic groups. Rothschild stressed that the aim was to identify important areas of habitat (although a small number of the sites listed were identified for their geological significance). The list deliberately excluded sites where it was considered conservation was already guaranteed, and Rothschild and Marren (1997) demonstrate that the sites on the list were not an unbiased sample of the habitats in Britain, being weighted in favour of habitats for which Britain had excellent representation compared to mainland Europe (for example, shingle beaches), and the data assembled were taxonomically biased reflecting the interests and expertise of the informants. Nevertheless, the SPNR list represents one of, if not the, first attempts to 'design' a reserve system. The early death of Charles Rothschild took away the driving force behind the SPNR, and although the Society continued to exist there was little progress in reserve declaration. The next major initiative in Britain arose towards the end of the Second World War, with proposals that the national government assume a major role, both in the establishment of a national ecological organisation to be responsible for the conservation of nature reserves and through National Parks (the UK model of national parks is essentially

a planning scheme which aims to protect landscapes). In terms of nature reserves a committee chaired by Julian Huxley argued the case for conservation and presented a 'shopping list' of desired sites (Cmd 7122 1947). This list included many of the sites proposed thirty years earlier by the SPNR but added new areas. In terms of the broad case for conservation the report reflected the manifesto addressed to the wider public by Tansley (1945), but when it came to promoting the establishment of a government agency and reserve system the importance of reserves for education and research was emphasised. The sites proposed as reserves were to be representative of the major habitats, rather than being rare or special, and this representative characteristic was particularly relevant to their use as research and teaching sites. Looked at more than 50 years later, the list includes many sites now recognised for the occurrence of rare and threatened species. This may reflect unconscious bias by the members of the committee applying their own specialist knowledge in making recommendations, or the importance of the research and teaching function. By virtue of being centres for research they have been more intensely studied, leading to new discoveries. A further factor may be that there is now a greater contrast between reserves and the agricultural matrix; the Huxley committee certainly did not foresee the changes in agricultural practice which were about to change the British landscape, and extend the impacts of intensive agriculture even beyond the then new boundaries created during the war time emergency food production effort.

This focus on representativeness is also reflected in the current proclaimed objective for the national reserve system in Australia – that it be 'comprehensive, adequate and representative' although all three pillars of this approach are capable of accommodating a wide range of meanings. Robin (in comment at the symposium) referred to the approach as philatelic. The approach can be criticised for not considering ecosystem functions and services at the landscape scale but in terms of designing a systematic reserve system an element of stamp collecting is inevitable.

Many of the sites on the Cmd 7122 list did become nature reserves, but many did not and some remain on the wish list.

In the 1970s a broad national review of conservation in the United Kingdom was carried out (Ratcliffe 1977), which identified many more sites as being of national (and in some cases international) significance. None of these listing processes (The SPNR list of 1915, Cmd 7122 in 1947, Ratcliffe 1977) involved formal analysis of the type advocated by Margules and Pressey (2000). The methodology they adopted is perhaps best summarised as Delphic. The important point is that they utilised the best data available, and recognised that they were not the last word. Today, systematic approaches are increasingly being used in many parts of the world. This is an important advance, as long as we keep in mind the inevitable deficiencies and patchiness in available data, that changes in the environment (including changing human perceptions of, and demands on, the environment) are inevitable and the need to temper idealism with pragmatism.

Despite many of the professional biologists and ecologists in Australia in the early twentieth century having trained in Britain, with in some cases direct connection to Tansley and his colleagues, and the general support for conservation from academics and others, there seems to have been little attempt to follow in the footsteps of the SPNR. Neither did there appear to have been much interest in establishing National Parks with the primary intent of conserving wildlife, even though the colonial powers in Africa were promoting the concept from the early 20th century. Today Australia is a global leader in developing conservation practice, but prior to the Second World War, it was somewhat of a backwater. Marshall (1966) writing just before the establishment of the NPWS in NSW, compared conservation practice in Australia unfavourably with that in both the United States and Britain, but praised the Victorian Department of Fisheries and Wildlife as a potential model for a national conservation authority.

A world without Royal?

The choice of the National Park site was doubtlessly influenced by many factors, but two at least were its accessibility by a variety of modes of transport, and its unsuitability for agriculture because of low soil fertility; if nothing else the first decades of European settlement had taught the colonists that species richness of native vegetation did not signify potential for agricultural development. The enthusiastic expectation of a fertile future shown in the naming of Botany Bay was very soon dashed. If the Park have not been declared it was extremely unlikely that it would have been developed for agriculture, while its potential for forestry was limited to a few small pockets.

In the absence of the Park perhaps there would have been greater development of recreational facilities, and maybe more extensive and permanent use by the army. Real estate development may have linked the settlements on the southern side of the Hacking estuary, and there could have been greater expansion of the suburbs along the western side of

the park. Parts of the plateau not subsumed by urban development could, by the early 21st century, have been industrialised with wind turbines or coal seam gas wells. If nothing else the Park can be seen as inspired farsighted piece of town planning, putting a gap between Sydney and Wollongong.

Would we declare a national park today?

If the area had remained Crown land until now, would it be a candidate for declaration as a National Park? I would argue that there would still be an exceptionally strong case for national park status.

The values of the area in terms of landscape and natural beauty, geodiversity, heritage (Indigenous and European cultural), accessibility and for recreational activities are still relevant considerations for making decisions about reservation as a National Park, and on these grounds alone a park declaration would be eminently justifiable. For the past two decades the dominant factor in declaring reserves has been biodiversity values, but this should not make other considerations irrelevant. On biodiversity grounds alone the area would still be ranked highly for conservation reservation.

Despite its long history as a conservation reserve there are many components of its diversity about which we know little. In this respect the situation would be similar for most areas in Australia and overseas. We have lists of the vascular flora, vertebrate fauna and at least some insect groups which are close to comprehensive (although even in these groups surprises still occur – I would not have predicted that the endangered *Wilsonia rotundifolia* (Convolvulaceae) would occur in the park until it was discovered a few years ago). For groups such as fungi and bryophytes we have some information, but investigation has been far from intensive or extensive, and for microorganisms and many invertebrate phyla almost nothing is known.

Nevertheless, what we know of the richness of the vascular flora, and of the community diversity of the park is sufficient to identify the area as outstanding amongst sandstone lands of the NSW central coast.

Marsupial ghost-town?

Flannery (2003) ignited debate by suggesting that 'If we look around our national parks today, what we see in the great majority of cases are marsupial ghost-towns, which preserve only a tiny fraction of the fauna that was there in abundance two centuries ago'. He supported his thesis by reference to Royal National Park.

Does this, if true, destroy my argument that, from several perspectives, Royal National Park amply justifies its status?

Flannery's case, it seems to me, is weak. For a mammalogist to stir the possum is not inappropriate, but mammals are only part of the vertebrate fauna, which, in itself, is only a small fraction of the total fauna. Even amongst the mammals, recent surveys and studies indicate the continuing survival of a considerable number of species. We have no idea of the total fauna of the area two hundred years ago, nor the abundance of individual species. Even today, data are limited for most taxa, so that a fundamental plank of the argument is the based on assumption rather than evidence. Certainly there been severe declines and local population extinctions amongst the mammals and this is regrettable, but for many faunal groups there is no evidence of decline in either total abundance or of individual species, although it may seem reasonable to suggest that changes have occurred. There may have been decline and losses amongst the plants, although evidence is lacking, but the ecosystems of the park appear still to be functioning and to be in generally good condition.

Royal National Park was discussed by Flannery (2003) to support a more general argument against 'small' near-urban national parks. In this he was, perhaps unwittingly, expressing sentiments similar to those voiced by ANZAAS in 1939. Such parks were seen by Flannery as too small to maintain viable populations, and to be isolated from other areas so that movement of biota between reserves was impaired or prevented.

I would not wish to argue against the importance of large reserves (although pointing out that if global comparisons were made Royal National Park would, in many countries, be a large reserve) nor deny the importance of connectivity. However, the empirical evidence is clear that small areas can still retain significant values, if not indefinitely then certainly for extended periods (for example many of the most valued ancient woodland reserves in Europe have been in their present configuration for centuries).

Considerations of the maintenance of populations and diversity in reserves of different sizes are often based (frequently in very general terms) on the application to terrestrial situations of the theory of island biogeography. While this is not inappropriate, for every site there are likely to be unique factors over and above general theoretical considerations. In the case of Royal National Park an important factor is the early management history. The 'improving' activities promoted by the Trustees, including selective clearing, planting and introducing exotic fauna, will have had long term consequences, and separating out these from the effects of size and isolation will be difficult.

Royal National Park is not pristine wilderness, but in the context of the early twenty first century this is neither surprising nor particularly relevant to an assessment of its conservation value. The evidence from various papers in these proceedings is that the conservation values remain high. Even if the focus of assessment is solely on biodiversity values this is so. Even if attention is concentrated upon one small part of biodiversity, such as mammal species, without any consideration of broader biodiversity values and ecosystem services, Royal is important and worth saving. If other matters which are valued by society are considered, then the case for retention of Royal National Park is even stronger.

This is not to deny the undoubted strength of arguments in other components of Flannery's (2003) essay, but the attack on many national parks unnecessarily diminishes the overall message. Conservation must retain the support of a sufficiently large proportion of the human population for it to be sustainable politically. Providing, even if unintentionally, ammunition to those who, for a variety of reasons, are opposed to the concept of conservation, is potentially counter productive. Certainly there are many conservation dogmas which need to be rigorously examined and tested, and unanimity of views is unlikely ever to be achieved. Flannery (2003) provoked a variety of responses (Seddon 2003, Foran 2003, Brown 2003, Christoff 2003, Debus 2003 – with an even wider range of views to be found on the Web), but the argument has since retreated into the background, though it may re-emerge in the future.

Lessons from the past?

The history of the Park since its declaration offers several important lessons.

First it reminds us that conservation policy and management practice are not science, even though they can be, and must be, informed by science. Conservation conducted by government needs to be responsive to the views of the electorate, and the public understanding of the meaning of conservation is complex and changing, and only partly reflects an appreciation of scientific argument.

Policy aims and objectives are likely to change over time (something clearly illustrated at Royal National Park). Scientific knowledge and understanding will increase over time, but we must be mindful that science similarly goes through phases; what is fashionable and, importantly, what types of science attract funding change, sometimes for reasons which are unrelated to need. Biodiversity currently underpins the prevailing conservation paradigms, and it is difficult to think of it as ever not doing so in the future. However, it would be hubris to imagine that we have all the right answers. We need to plan for flexibility. Part of this will require greater commitment to the concept of adaptive management; under such a regime approaches to technical issues and details will inevitably change, but a willingness to embrace change must also extend to the possibility of fundamental changes in paradigms.

The second lesson is that some ecosystems and habitats are more resilient than we might have expected them to be. Despite the various assaults to which the Park has been subjected many of its conservation values have been retained. We cannot extrapolate from Royal to all ecosystems; since the response to disturbance will depend on the ecosystem concerned and the types of disturbance. If, for example, the early management of the nutrient poor sclerophyll vegetation of the Royal had included extensive application of fertiliser as well as selective clearing, the impacts could have been much greater and more long lasting. In assessing the conservation value of areas we should not leap to the conclusion that a history of disturbance since European colonisation will necessarily mean that an area is not worth conserving. Each case will need to be judged on its merits, but while Royal gives cause for optimism this does not give a licence to continue disturbance. Some of the past disturbances at Royal have had continuing impacts. One of the most obvious examples of actions, which seemed like a good idea at the time, but which is now regretted, was the introduction, and the subsequent naturalisation, of deer. Despite the long history of adverse consequences of introductions, there have recently been suggestions for further introductions species regarded as 'game' in NSW.

The third lesson is that despite Royal National Park having a very high visitation rate the conservation values have been retained. In part that can be put down more to good luck then judgement given that the sites of facilities and roads were established by the first Trustees without any appreciation of what would now be termed biodiversity values. However, subsequent management has aimed, with considerable success, at limiting the impact of human activities. As Sydney's population continues to grow, the pressure on recreational resources will intensify and the potential for conflict between conservation and other uses will increase. A balance between uses has been achieved for over a century; there are no grounds for a counsel of despair or for abandoning conservation as the primary objective, but maintaining the conservation values will require continuing community education and probably greater resources.

A centre for research and education.

When the Park was established, Sydney University was already two decades old and a focus for scholarly activity. The Royal Society of New South Wales had been providing a forum for discussion and publication of new findings across a range of disciplines for a comparable period, and the forerunner of ANZAAS, the Australasian Society for the Advancement of Science, was soon to provide a national stage for scientists to report and debate their endeavours. The Linnean Society of New South Wales was to provide for a narrower range of disciplines, not as a rival, but more as a sibling to the Royal Society. A glance at the journals of the time shows the wide range of investigations being pursued. The structure and organisation of science differed from that of today; there were no PhD students (the PhD was not awarded by Australian Universities until after the Second World War), there were no competitive grant schemes, and enthusiastic and skilful amateurs were still able to make significant contributions to the literature. Travel to remote areas was difficult and conditions for fieldwork onerous. In these circumstances it might have been expected that the National Park with ease of access would have become a centre for research activity. It is not clear that it did. The early official guidebook and by-laws do not make explicit mention of research, although archaeological digs were conducted (Attenbrow, these proceedings), the Zoological Society maintained a cottage as a field laboratory in the Park, and the Park was a regular venue for collecting expeditions by groups interested in particular taxa (Carter 1933). Given that collecting without permission of the Trustees would, under the by-laws, have been forbidden, there was presumably a mechanism for obtaining approval to collect or conduct research. The by-laws do not make mention of the criteria for obtaining permission, or whether there was a requirement for reporting findings. It would be an interesting research project to explore the Trust archives for information about early research activity.

With the advent of NPWS there was a formal process for applying for research licenses, although the relationship between potential researchers and the Service was not always a smooth one. Royal National Park is accessible relatively easily from all the Sydney universities and from the University of Wollongong. The number of research projects, on research grants, by the NPWS staff itself and for honours and postgraduate theses probably increased, although tracking data on approved projects is not easy and much information has possibly been lost. There is no register, of which that I am aware, of publications referring to research in the Park; not all relevant papers have Royal National Park in the title, and many are not available in digital format and so escape electronic searches. Most of the research was conducted on an independent basis, and while Park Superintendents may have had wish lists there was no co-ordinated long-term research programme.

Around the world there are many sites which are associated with long-term research by particular institutions, in a number of cases research finding have been synthesised in major publications - for examples see Savill et al. (2010) for Wytham Wood in Oxfordshire UK, possibly the most studied ecological site with the most research theses per hectare of any location; Friday (1997) for Wicken Fen, one of the oldest nature reserves in Britain, and Pomeroy and Weigert (1981) for Sapelo Island Georgia USA, a major centre for research on saltmarshes. We are not yet in such a position that a work on Royal National Park could be prepared, but these Proceedings are an important step along the way.

Research provides the necessary underpinning for education, but the nature, and strength and specificity/generalisation of the research – education nexus varies with context. At one extreme, teaching and learning about global environmental issues does not require detailed knowledge or understanding of individual sites nor of natural history. Nevertheless, thinking on such matters can be enhanced in the context of a particular location. The National Park throughout its existence has provided for the raising of 'environmental consciousness' (albeit that if that expression had been used in 1879 it would probably have been met with a blank look). Even if, for many of the vast number of visitors to the Park, it is primarily at place of recreation, simply by it being a national park conveys a message. Throughout its existence as a park, messages about the importance of natural areas have been given to visitors, although the messages have changed and developed over the years. Community education has always been a function of the park, even if not always explicitly, and over many years a range of guide books have been available, as well as interpretive programmes. Some of this material has been prepared by government agencies, some by volunteer groups (Daniels, these proceedings) and some by commercial publishers (for example, Fairley 1976).

When it comes to formal education there is again a long and diverse history. Organised field excursions from schools were not a feature of the early years of the Park, but at that time opportunities for nature rambles were available to many suburban schools, without the need for organising transport. For a long period,

however, there have been school groups engaged in field trips to study ecology, environmental studies, geography and geology. In periods immediately before, and for a long time after the Second World War, natural history studies were given a degree of prominence in the New South Wales curriculum. To an extent that continues, although prohibition, or strict regulation, of collecting (necessary as the constraints are), decline in natural history skills, and occupational health and safety concerns over the conduct of excursions limit the scope of activities.

At senior high school and tertiary level the potential scope for using the Royal National Park is vast. However, for project-based studies, research permits would normally be required, and this might be a constraint. The diversity of habitats within the park (from rocky shore to rainforest) is a great attraction, although most excursions tend to be limited (through time constraints) to only a few at any one time, and some are frequently ignored (for example the saltmarshes of Cabbage Tree Creek, although historically subject of two detailed studies (Collins 1921, Kratochvil et al. 1973) are rarely investigated).

The Royal National Park Environmental Education Centre is heavily used by schools, from kindergarten to Year 12. It is a facility within the Park of the New South Wales Department of Education and Training. Its website proclaims that it is 'enabling environmental citizenship' and its mission statement is 'to foster in students an appreciation of the environment, their responsibility for its future', important goals but not immediately linked to the study of natural history. The use made of Royal by tertiary institutions is harder to assess, but there is a long tradition of excursions and use by honours and research students.

I suspect that use for excursions is less than it used to be. From my own institution, the University of New South Wales, large botany classes were held in the 1960s and 70s, organised and directed with almost military precision by Dr. Nola Hannon – indeed these excursions remain, for alumni, notable events in their undergraduate careers. Difficulties of logistics, costs and timetabling led to the demise of these excursions. When I joined the university in the late 1970s there were still a number of half day excursions, but these were rapidly becoming impractical. Increasing traffic and congestion has bitten into the time available in the field, indeed the risk of spending most of the timetabled slot stuck in a traffic jam on General Holmes Drive or The Grand Parade is high.

Lessons from the more distant past

Royal National Park is botanically extremely species rich. A long-standing interest of Australian plant ecologists has been to explain why so many species can coexist on what are, for the most part, very infertile soils. Beadle, in a series of papers (1953, 1954, 1962, and 1966) demonstrated a relationship between species richness and community distribution with soil phosphorus. Adam et al. (1989a) confirmed the very high species richness of heathland on soils with very low phosphorus – many of the data for this paper were from quadrats within Royal National Park. This association between low nutrient availability and high species richness conforms to the general model advanced by Grime (1979, 2001) which explains that under conditions of high resource availability species richness declines as a result of the vigorous growth of highly competitive species. While Adam et al. (1989a) concentrated on phosphorus, and there is little doubt that phosphorus status in itself is a major determinant of species richness, concentrations of other soil constituents are likely to be correlated with phosphorus, so that the relationship might be more generally expressed as a relationship between soil fertility and species richness. However, the availability of particular ions is likely to vary with stage of soil development – young soils being more likely to be deficient in nitrogen, while older soils have low phosphorus (Lambers et al. 2008).

Plants are only one component of biodiversity. Are other taxonomic groups likely to show similar patterns? Each species of plant provides a range of potential habitats, flowers, stems, leaves, roots, for other species, particularly invertebrates. High plant species richness is thus likely to be associated with high levels of diversity of insects, and the activities of collectors such as Carter (1933), suggest that this is so for Royal National Park. Plants growing on low nutrient soils are nevertheless able to produce (relatively) large amounts of carbon rich, nutrient poor nectar so that pollination by birds is common, with a diversity of species adapted to different flowers. The low nutrient status of the vegetation is, however, likely to limit its use by 'bulk' feeders. To obtain sufficient nutrients, mammalian herbivores would need to consume large amount of foliage. This will affect population size of large herbivores which will be present at low densities, hence maintenance of viable populations will require large areas of habitat. Similarly, large top carnivores require extensive areas of habitat (Colinvaux 1978). Designing reserves large enough to support viable populations of such a species within park boundaries is difficult, but while an overall conservation strategy may require at least some large reserves, smaller areas, lacking large – area – requiring species, may nevertheless sustain functioning ecosystems.

Demonstration of the inverse correlation between species richness and phosphorus does not prove a causal relationship. Nevertheless it does suggest that we should be cautious about increasing nutrient status. Nutrient status, at least close to roads and tracks, is likely to increase, as a result of runoff of dust from road metal, and material from vehicles and tyres, and because of the accidental or deliberate depositing of rubbish (in which biodegradable rubbish, generally thought by the general public to be benign, may be more harmful than visually offensive, but inert, material). Park managers will need to be careful in managing both existing and new tracks, to minimise potential for runoff penetrating the bush through appropriate choice of road materials and the design of the drainage system to capture and remove as much runoff as possible.

While low nutrient status of the soil is correlated with the floristic species richness of communities such as heathland and sclerophyll woodland it does not immediately explain the diversity within communities. Adam et al. (1989b) analysed quadrat data from cliff top and headland sites along the New South Wales coast. A number of the quadrats were from Royal National Park, within the Coastal Heathland recognised by Connolly et al. (these proceedings). There was sufficient commonality for some geographically widespread, floristically-defined communities to be recognised. However, within the broad communities, particular stretches of cliff, or individual headlands, could be identified as having their own characteristic suite of species, while at individual sites, within large areas of structurally and physiognomically uniform contiguous vegetation individual quadrats, while sharing many species in common, nevertheless had their own unique combination of species.

Cliff and headland vegetation is not continuous along the whole New South Wales coast. Occurrences are separated by extensive area of dunes, or by estuaries. These features have been present for a considerable period of time, and while the position of the coastline has moved with changes in sealevel, cliff habitat will always have been discontinuous, essentially existing as habitat islands (and at certain stages of sea level and coastal evolution – 'real' islands). Differences between sites may reflect stochastic processes of local extinction and uncertain success of recolonisation. For example, the coastal heathlands of the northern headland of Botany Bay, the Kurnell Peninsula and Royal National Park, although obviously similar in appearance have their own species assemblages, with the biggest difference being across the entrance to Botany Bay. Hamilton (1917) described the vegetation on coastal headlands and sand dunes between the northern beaches and Port Hacking, documenting many local occurrences of species.

What, however, might explain the differences within localities? At the community level, the patterns of distribution shown by vegetation mapping (Connolly et al., these proceedings) can be correlated with ecological factors which have been recognized for decades – underlying geology, soil type, topography, aspect, drainage etc. It is striking for example that the inland boundary of the coastal heath at Royal National Park is roughly coincident with the distance from the cliff edge where annual input of sodium in aerosolic salt drops below 10,000 mg m^{-2} (Adam , unpublished data). Aerosolic salt, minute crystals of salt produced by the rapid evaporation of droplets of spray, is blown inland. Although it can be detected kilometres inland, particularly during storms. Deposition drops very rapidly at Royal National Park from in excess of 40,000 mg m^{-2} yr^{-1} Na^{+} close to the cliff edge to 10,000 mg between 150 – 200m inland and then declines slowly further inland. Deposition of aerosolic salt is not uniform throughout the year, but is highest during periods of north easterly winds in summer. The high acquisition during summer could mean that if coastal heath were to burn, and burning right to the cliff edge is rare, immediate regeneration, either from seedlings or resprouting would be particularly affected by salt.

The impact of aerosolic salt is primarily on the foliage of plants. Species in Coastal Heathland generally possess either very thick cuticles or are invested with trichomes, both adaptations which will limit abrasion and consequent cell damage from salt ingress. Soils are generally well drained so that salt entering the soil is rapidly leached and roots are not exposed to high salinity. Where pockets of poor drainage occur saline soils develop and patches of vegetation floristically identical to intertidal saltmarsh occur on seacliffs.

Aerosolic salt is not just sodium, it also contains chloride and sulphate, and amongst the cations, high levels of magnesium. Does it also provide a source of nitrogen, and more particularly phosphorus, for what would otherwise be nutrient deficient soil? In some parts of the world's oceans upwelling creates nutrient rich surface waters, so that aerosolic salt would contain relatively high nutrient levels. In addition, the fertility of the seawater, and the consequent abundance of plankton and fish could support large numbers of seabirds, providing an even more effective means of providing nutrient input into coastal vegetation. To a visitor from the northern hemisphere it is striking that the cliffs in Royal are not the seabird cities common

on high latitude northern hemisphere shores, but are largely barren of nesting birds.

The distribution of upwelling zones is determined by global patterns of oceanic currents and the location of continents. Over very long geological time scales tectonic movement of the continent will have changed the patterns of currents and upwelling, but the nutrient status of the waters off what is now Royal National Park is likely to have prevailed for tens of millions of years. Despite the efforts of humans discharging increasing amounts of nutrients into the sea at a global scale, changes in nutrient inputs would not be anticipated in the remotely foreseeable future.

How are we to explain the small scale (10s -100s metres) variation in floristics within communities? Not all species in any community are equally common; in most patches of vegetation there will be more species which are uncommon (or locally rare) than common, but nevertheless there are sufficient common species to define communities. Therefore one quadrat may have a very different species composition than that of another nearby quadrat (perhaps only metres away) within the same contiguous stand of vegetation. In such examples, is the composition of each quadrat essentially a random selection of the locally available pool of species (so that species are effectively sprinkled like confetti across the area), or is there a mechanistic explanation?

Local variation of this type is more frequent within species rich communities in areas which, at the regional scale, are characterised by both high species richness and high levels of endemism. Hopper (2009) has recently focussed attention on highly species rich regions by developing the OCBIL theory (very Old Climatically Buffered Infertile Landscapes, which are to be contrasted with YODFELs – Young, Often Disturbed, Fertile Landscapes).

OCBILs as recognized by Hopper (2009) are rare, and he concentrates discussion on just three areas – the Southwest Australian Floristic Region, the Greater Cape in South Africa and the Pantepui (the 'Lost World' of Conan Doyle, the summits of the tepui, in a region mainly in Venezuela but extending into Guyana and Brazil). All of these are Gondwanan, two are well studied floristically, but the Pantepui is very difficult to access and is relatively unexplored, although sufficient is known to indicate that it has a rich and distinctive flora, but in an environment differing from the other two regions in experiencing exceptionally high rainfall.

YODFELs on the other hand are extensive across the vast areas of the northern hemisphere subject to recent glaciations, but even within areas recognised as OCBILs, YODFEL landscape components occur immediately adjacent to ancient land surfaces. YODFELs are not always clothed with vegetation made up of widespread species. Within YODFELs can be localities with high species richness and significant numbers of endemics. Lord Howe Island and Hawaii provide examples of this.

OCBILs are not restricted to the three regions identified above, and Hopper (2009) acknowledges that there are more to be identified. He indicates that there are OCBIL features in the Blue Mountains, but does not include the coastal lowlands around Sydney within the OCBIL compass. The proximity to the sea and the changes which were consequent on recent sea level fluctuations would rule out classification of Royal National Park as being a very old landscape, for all that it is clearly infertile.

Mucina and Wardell-Johnson (2011) have provided a critique of Hopper (2009), in which they recognize the value of adopting aspects of the theory but suggest that many features regarded by Hopper (2009) as hallmarks of OCBILs (as he defined them) are, in fact, characteristic of a much wider range of locations which they refer to as OSLs – old stable landscapes. They also recast Hooper's (2009) predictions in forms which potentially provide testable hypotheses. Mucina and Wardell-Johnson (2011) also place much greater emphasis than Hooper (2009) on the role of fire in the development of the flora and vegetation of OSLs. Hopper (2009), while recognizing the importance of fire in contemporary landscapes suggested that many features regarded as fire adaptations were exaptations, features which while conferring abilities to survive fire had originally evolved under different selection pressures. Exaptation is a term coined by Gould and Vrba (1982) which has not been widely adopted by other biologists. Fire has been recognized as an important feature in the management and conservation of Australian ecosystems; Orians and Milewski (2007) developed a Nutrient-Poverty/Intensive-Fire theory which integrates many aspects of Australian ecology; intense fire may exacerbate the low availability of nutrients in the landscape, but Orians and Milewski (2007) extend this beyond the availability of nutrients for plants, which botanists had long identified, and point out how much of the fauna will also be influenced by nutrient availability. Similar ideas had been advanced earlier by Wisheu et al. (2000).

The issue of whether biota exhibit fire adaptations, or whether the features claimed to be adaptation are really exaptations, has provoked vigorous debate (Bradshaw et al. 2011a,b, Keeley et al. 2011), a debate which is partly semantic, and which involves suggestions which will be difficult

to test unambiguously. However, both sides of the argument agree on the importance of considering fire regime, and that imposing 'artificial' fire regimes to manage fuel load could have adverse consequences from a conservation perspective. This is obviously an important issue to be addressed in the context of Royal National Park, where decision making for fuel management has to take into account both the sensitivity of the ecosystems and the close proximity of suburban development.

In the last few decades Royal National Park has experienced several major fires. It is interesting that fire does not feature as an issue in the early guides of the Park (Anon 1902). Was the late nineteenth century a period of low fire incidence, or did fires occur but were regarded as so unremarkable as not to be recorded? The use of extensive areas of the Park for military training might have been expected to increase the likelihood of ignition, while on the other hand the extensive clearing of understory in parts of the Park by the Trustees in the name of improvement would have reduced fuel load in those areas. The fire history in the early years of the Park would be an interesting topic for archival research.

Low nutrient status of old soils is associated with plant strategies to increase nutrient uptake and retention. These include the occurrence of a large number of species with symbioses to permit nitrogen fixation (not just the well known *Rhizobium* – legume system but also other relationships involving actinomycetes or cyanobacteria), although there are few studies which have measured fixation in the field; a diversity of carnivorous plants; large numbers of mycorrhizal species, and the presence of species with various forms of cluster roots (Lambers et al. 2008, Hopper 2009, Mucina and Wardell-Johnson 2011). These features are apparent in the flora of Royal National Park (and in the Sydney sandstone more generally), although quantification of their occurrence in different communities in the Park is lacking. In extremely phosphorus deficient soils, ectomycorrhizal roots are less common than on more fertile soils, while various forms of cluster roots are more common (Shane and Lambers 2005, Denton et al. 2007, Lambers and Shane 2007, Lambers et al. 2008). Soil samples from Royal National Park had the lowest levels of phosphorus recorded by Adam et al (1989a) in their survey; on the basis of studies elsewhere in Australia it would be predicted that there would be a high incidence of cluster roots in Coastal Heathland in Royal and it would be of interest to test this hypothesis.

One of the consequences of the low fertility and low incidence of disturbance which affects the soil of OCBILs, and probably more broadly OSLs, is that restoration following damage may be difficult, and for practical purposes impossible. Hopper (2009) was cautiously optimistic that restoration following, for example, mining, would be possible. Standish and Hobbs (2010) presented a contrary view, which they characterised as realistic rather than pessimistic. They suggested the need for further research in the hope that better methods could be found. In YODFELs (particularly in the areas where much restoration has occurred, the recently glaciated landscapes of North America and Europe), regeneration on fertile soils with a relatively species poor flora, while not a trivial undertaking, has produced acceptable results reasonably quickly. This success can be attributed to the flora displaying the traits that made colonisation of deglaciated landscapes possible.

Royal National Park, by virtue of being a conservation reserve, is unlikely to suffer broadscale disturbance, but on a smaller scale there will be areas of closed tracks, road batters and the like where restoration of vegetation is required. This will not necessarily always be easy to achieve.

In terms of the consequences for management of conservation reserves arising from OCBIL (and/or OSL) theory, there are several which relate to the β diversity within communities (the high total species richness and level of endemism within OCBIL and OSL sites is justification for these being a priority for establishing reserves).

Sander and Wardell-Johnson (2011) have suggested that much of the turnover of β diversity in south- western Australia reflected the fine scale occurrence of edaphic microhabitats. If the assemblages of species are favoured by, or adapted to, these locally restricted habitats then there should be selection pressure for reduced dispersability – if propagules are spread beyond the immediate neighbourhood of their parents they are likely to encounter less favourable conditions. Hopper (2009) shows that in south-western Australia the majority of native plant species have no obvious means of seed dispersal. There are exceptional circumstances (fierce winds, extensive flooding) which could result in occasional long distance dispersal, and this could permit colonisation events (for an example in *Banksia*, see He et al. 2004) but, in general, species will stay put. Myrmecochory, which is a common feature in Australian sclerophyll communities (and also in the Greater Cape – Bond et al. 1991), is a mechanism for achieving very local dispersal, but is unlikely to facilitate medium and long distance dispersal.

If limited dispersability of most of the flora in low nutrient stable landscapes where there is fine

scale habitat differentiation is indeed the rule, then it has both positive and negative consequences for conservation planning. On the positive side it may mean that small areas of habitat can be viable in the long term (Hopper 2009). This is not an argument against seeking to establish large reserves, but rather an argument against writing off small areas as lost causes without careful consideration on a site by site basis. Small areas obviously cannot support large populations of large mammals, for which other conservation strategies are required, but maintenance of flora and associated pollinator systems in small areas could be possible (see Cowling and Bond 1991).

On the negative side, if the high β diversity shown by the Park's flora reflects underlying fine scale patterning of the environment then there may be implications for the possible response of the biota to climate change, and also the way we view the landscape.

If we look at the landscape in terms of a fairly coarse delineation of 'communities' we might conclude that, for example, there is a series of patches of heathland along the coast, and that these are, in general terms, the same or very similar. Given the likelihood of future environmental change, then our long term conservation strategy might be couched in terms of facilitating exchange between the separate areas, through, for example, provision of corridors. (In the case of Royal National Park, given the proximity to Sydney this strategy would be problematic in a north-south direction, but more feasible east-west). However, if we need to define communities at a much finer scale, then the utility of linkages may be questionable (Hopper 2009). If, as suggested by Sander and Wardell-Johnston (2011) in Western Australia, there is fine scale patterning in the soil environment, and individual plant species require particular soil conditions, then the niche for individual species may be defined both in terms of a climatic envelope and soil conditions, and both sets of conditions would need to be present for the species to survive. Even if species could move in response to climate change (and the low dispersability of many species suggests that this would be unlikely) they would still require the same or similar soil conditions, which are unlikely to be present in the newly climatically suitable sites.

Hopper (2009) has suggested that provisions of links between patches of habitat within OCBILs is unlikely to promote successful natural relocation of species, and may even be undesirable in permitting the spread of generalist species. This view of linkages is from a botanist's perspective, but for some elements of the fauna, corridors might provide advantages. It is clear that provision of linkages will not be the universal panacea for addressing climate change. This could justify re-prioritisation of management aims and objectives, but equally it means that some species and communities maybe doomed to local or even total extinction. However, even what Hopper (2009) regards as stable and climatically buffered sites would have been exposed to some elements of past climate change and yet today support diverse floras, so that may be the chance rare dispersal event, such as postulated by He et al. 2004, will be sufficient to allow the survival of many species.

OCBIL or OSL theory, although still preliminary, suggests that planning for climate change will need to be even more complex than it currently is, and that we will need sophisticated approaches to determining what can be done in individual circumstances. Gaining acceptance of the need for a landscape approach for addressing conservation issues has been a major advance, but now there is a need to incorporate within that big picture a much finer grained view of what the landscape means for individual species.

The Park as a place of visitation into the future

Royal National Park is one of the most visited parks in New South Wales. We can take comfort from the survival of so many of the biodiversity values in the face of such pressures, but in the future visitor pressure may increase as the population in the greater Sydney region continues to grow.

As new parks have been created in the more distant parts of the State, a frequent justification invoked to sell the concept to the local population is that they will become tourist attractions and be the saviour of the local economy. Undoubtedly these parks do attract some visitors, but rarely sufficient to meet the promises. As Sydney gets larger, and, in all probability, fuel and travel becomes increasingly expensive, I doubt that visitation to parks in the western parts of the State will increase. Indeed, I expect that on a decadal time scale it will decline. To satisfy the demands of the population there will be greater use of parks (including Royal National Park) in, and near, Sydney (Adam 2007). It is possible that visitation to Royal National Park will return to its original 1879 pattern, with much greater use of a revived public transport system. For many of the visitors their needs will be for 'green lungs' and they will have little appreciation of, or need for, the ecological values. The challenge for the future will be to manage increased human visitation to provide maximum enjoyment while at the same time effectively conserving biodiversity and the landscape.

The lesson from the past is that this is not an impossible dream; it has been achieved for over 130 years, even if for much of the time there was not direct attention given to biodiversity. With increased population pressure and with different climatic conditions the task will not be easy, and there will inevitably be changes to components of biodiversity. Nevertheless ecological processes which permit retention of a substantial part of the biodiversity of the Park can be maintained with appropriate management and resources. The Park as we see it today is the legacy of its geological history as influenced by human activity. If, to quote Mrs. Thatcher, our tenure of Royal National Park is on the basis of a full repairing lease our obligation is to ensure that it is handed on to future generations as a fully functioning assemblage of ecosystems.

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