Changes in Species Composition of the Avifauna of Rottnest Island, Western Australia

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Abstract

Rottnest Island (1900 ha) is an A class Reserve and is one of more than 200 islands larger than 10 ha off the coast of Western Australia. The island is gazetted for "Public Recreation" and since 1917 has been a popular tourist resort. The island is unique in that it has a chain of hypersaline lakes which occupy 10% of the surface of the island and attract large numbers of wading birds, including several species of transequatorial migrant.

Over the last 100 years changes in land use and poor management have resulted in extreme degradation of the island's ecosystem with consequent changes to the island's avifauna. There have been 3 recorded extinctions of land bird species breeding on the island and ten land bird species have established themselves on the island since 1904. Of these changes, only 3 of the immigrations were not directly influenced by human activities.

The changes in composition of the island's avifauna we discussed and the need for ecologically based management is pointed out.

INTRODUCTION

There are more than 200 islands larger than 10 ha off the coast of Western Australia. Rottnest Island is one of the medium sized islands (1 900 ha) but is unique for two reasons; one social and the other environmental. The island is an A class Reserve whose gazetted purpose is "Public Recreation". It lies 18 km off the coast of Perth and is a major tourist resort run by a Government utility, the Rottnest Island Authority. The island is one of a chain of three (Fig. 1), the other two being restricted in access. This is because the smallest (Carnac Island, 16 ha) is an A class "Flora and Fauna Reserve" with a thriving colony of the Tiger Snake *Notechis scutatus* and the other island (Garden Island, 1 100 ha and 2 km off the coast) is owned by the Department of Defence and is the site of H.M.A.S. Stirling. Visitors are only allowed ashore during daylight and only if they visit by boat.

Rottnest Island features largely in the Western Australian ethos (Seddon 1983) and is a very popular tourist resort for both day trippers and overnight visitors. As a result, the island is under considerable pressure from humans and over 200 000 visit the island annually. During peak periods (Easter, long weekends, etc.) over 9 500 may be present (i.e. 5 people/ha or 296/km of coast) during the day. The continued existence of the island as a tourist resort has resulted in increasing demands for the development of the island to provide more facilities for holiday makers (Rottnest Island Management Planning Group 1985). This pressure is increasing all the time.

The environmental reason for the island's unique status is the existence of a chain of hypersaline lakes which occupy 10% of the surface of the island and dominate the eastern end (Fig. 2).

Over the past 100 years, changes in land use on the island and poor management of the resources of the island have resulted in extreme degradation of the ecosystems functioning on Rottnest Island. This paper explores the results of this degradation as reflected by the avifauna of the island.

MANAGEMENT HISTORY

The management of the island has had several distinct phases. The island was separated from the mainland about 6 500 years ago (Playford 1983) and since then the sea level has changed several times. During these changes the island consisted of several islands, then assumed its present shape. As far as records can determine, Aborigines did not occupy Rottnest Island after its isolation, referring to it as Wadgemup (= place across the water). The first Europeans to visit the island gave descriptions which indicate that much of the island was covered by *Melaleuca, Callitris* and *Acacia* woodland, essentially similar to that covering Garden Island today (Seddon 1972). After an

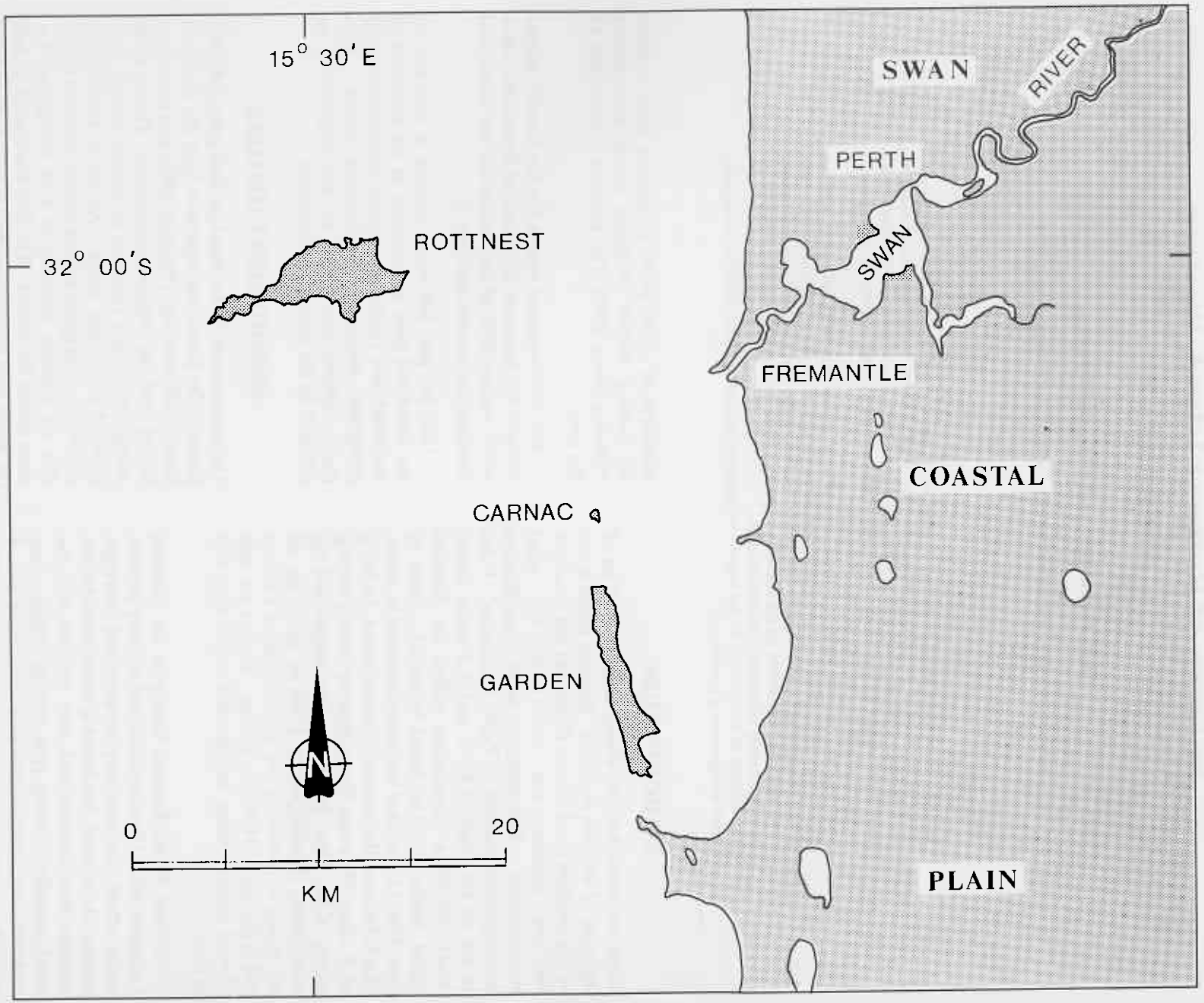

Figure 1.
Map of Swan Coastal Plain and adjacent sea showing position of Rottnest, Carnac and Garden Islands

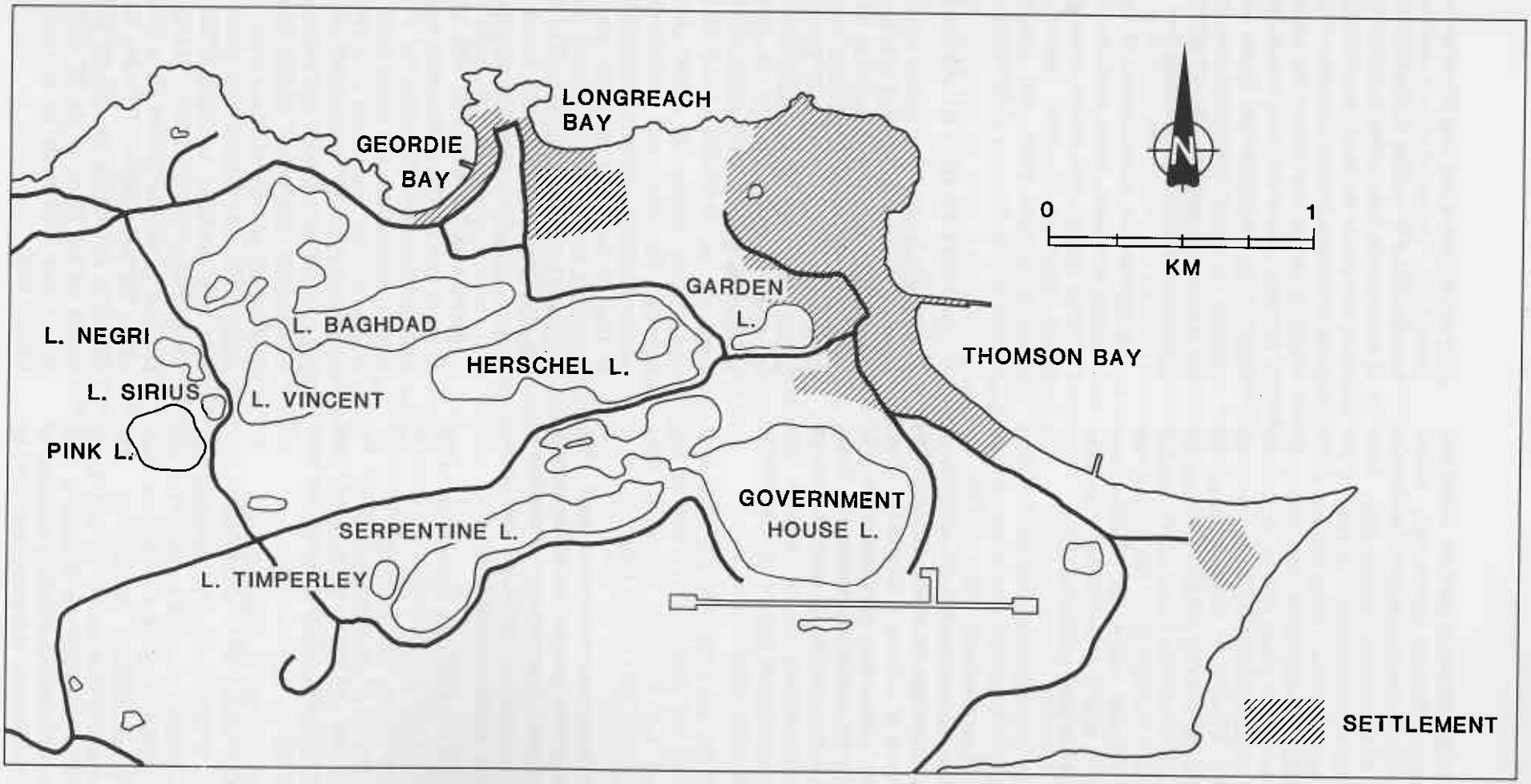

Figure 2.
Map of the eastern half of Rottnest Island showing the salt-lake complex.

unsuccessful farming venture, in 1838 the island was designated as an Aboriginal prison with various prison superintendents erecting limestone buildings at the eastern end of the island (Thomson Bay). Most of these buildings form the historic precinct of the present day main settlement. During this era, which lasted until 1903 the vegetation was extensively modified as clearing took place; first for agricultural venturers, then to improve visibility for the governor of the Swan River Colony. He visited the island for holidays and took out shooting parties. These parties hunted the quokka *Setonix brachyurus* and the banded stilt *Cladorhynchus leucocephalus*. This species was known as the "Rottnest Snipe" and prisoners were used as beaters to drive the birds towards the guns lurking in brushwood hides besides the lakes.

In 1903, a far-sighted governor declared the island an A-class Reserve for public recreation, and the second stage of management began. This has continued until the present day with the exception of two discrete periods when the island was controlled by the Department of Defence. During the Great War, there were 1 300 German prisoners of war held on the island for 15 months and during the World War there was a large garrison of troops housed on the island. The remains of the barracks, gun emplacements and dugouts may be seen at various points over most of the island.

During the 1960s and 1970s there was a period of development with the settlement at Thomson Bay being expanded and a second settlement being established at Geordie and Longreach Bays.

At no stage during the development, until 1983, was there any apparent plan for the management of the island as a whole. This oversight has resulted in the present degradation of the island and several managerial acts of ecological vandalism.

Basically, since April 1917 the management of the island has been the direct responsibility of a Board of Control (now called the Rottnest Island Authority) which has its own set of by-laws which include the protection of all flora and fauna and the island's land surfaces. Apparently this particular charter has been consistently ignored.

CHANGES IN VEGETATION

The changes in the vegetation of the island have been well documented by several authors. Pen and Green (1983) provide a detailed account of these together with a comprehensive reference list. The extent of the change is illustrated by the fact that in 1919 about 66% of the island was believed to have been covered by *Melaleuca* and *Callitris* woodland or *Acacia* scrub. By 1941 this was reduced to 23%, by 1956 to 18% and is less than 8% at present (Pen and Green 1983). The extent of the former woodland can be appreciated by walking through most of the areas of heath on the eastern two-thirds of the island and seeing the size of the dead trees still littered on the ground. *Melaleuca* now dominates the remnant woodland and the few *Callitris* that remain are dying. In fact, this species may soon become extinct on the island. *Acacia rostellifera* still occurs in patches the length of the island. Both *Melaleuca* and *Callitris* are fire-sensitive species and this is the cause of the elimination of most of the woodland.

At present the island consists of small areas of *Melaleuca* woodland, *Acacia* scrub, heath (dominated by exotic species) and various areas of plantation mostly consisting of exotic species like *Tuart, Eucalyptus gomphocephala* and coastal Moort *E. platypus* with smaller areas of *Melaleuca* and *Callitris*.

SURVEYS OF THE AVIFAUNA

Rottnest Island is the best studied island around the coast of Western Australia and is, in fact, one of the best surveyed islands in the world as far as birds are concerned. The first documented account of the avifauna was given by Lawson (1905) who spent several weeks collecting specimens in 1904 and most of these are lodged in the Western Australian Museum. In 1929 Glauert published an annotated list based on his observations and those of other ornithologists visiting the island, including D.L. Serventy. The most well documented list was published by Storr (1964, 1965a and 1965b) who made 62 trips to the island over nine years until 1962, spending a total of 275 days there. Storr's records included those of his colleagues and he had a copy of Glauert's 1929 paper in which Glauert had noted records made after he published the paper.

Between 19 December 1981 and September 1984 we made over 30 trips to the island at approximately monthly intervals in 1982, 1983 and the first half of 1984. Since then we have visited the island irregularly. Our visits lasted from two to five days and during each visit we identified and counted the birds around the salt-lakes and swamps, around the coast, visited each of the habitats and caught and banded birds in some woodland areas, the heath and among caves and buildings. The results of this work have been published in Saunders and de Rebeira (1983, 1985a, 1985b, 1986). In addition Storr provided us with the species cards forming the data set for his three papers of 1964/65 and these data allowed us to compare the changes in abundance of waders on the island in the 22 years between his surveys and those made by us (Saunders and de Rebeira 1986).

CHANGES IN THE AVIFAUNA

MacArthur and Wilson's (1964, 1967) theory of island biogeography proposed that the number of species existing on an island is in dynamic equilibrium between immigrations and extinctions and that this process results in the turnover of the species existing on the island. The rate of this change is dependent on the rate of immigration and the rate of extinction. There has been a great deal of discussion about turnover rates and methods of evaluating these rates. We have discussed this subject elsewhere (Saunders and de Rebeira 1985a) so we will not dwell on it here except to note that between 1904 and present there have been three recorded extinctions and 10 immigrations of land bird species on or to Rottnest Island. None of the extinctions and only three of the immigrations could be regarded as valid for calculating natural turnover rates. In other words, all of the extinctions and seven of the immigrations have been directly or indirectly attributable to human influence. Basically, for the 80-odd years since 1904, the avifauna extinction rate (for non-marine species) for the island was zero; the immigration rate for non-marine species of bird was 0.04%/year and the relative turnover rate was 0.12% of species/year. That is, immigrations and extinctions are infrequent and turnover of breeding species is also infrequent, especially when compared with figures obtained from other areas (e.g. Diamond 1971).

It is worth examining the extinctions and immigrations to see the effect of mismanagement on the change in species composition.

The first recorded extinction occurred sometime in the 1920s when the brush bronzewing *Phaps elegans* disappeared from the island. Although this species has never been seen on the island by any ornithologist, it undoubtedly occurred there (Storr 1965b) and there are records of pigeons being trapped and sold for food to the crews of visiting ships. A combination of trapping and habitat destruction almost certainly removed this species.

Both the rufous whistler *Pachycephala rufiventris* and the golden whistler *P. pectoralis* have occurred on the island but the rufous whistler was last seen in 1925 (Storr 1965b). Storr believes that its extinction was connected with the decline of *Callitris preissii* which is now nearly extinct. This is due to increased frequency of fires and direct cutting for various purposes. The golden whistler is still a conspicuous resident of the remnant woodland but habitat degradation and destruction has made this species vulnerable and its total populations is probably small (Saunders and de Rebeira 1985b).

The only other known extinction of land birds was a pair of the Australian magpie *Gymnorhina tibicen* which bred on the island in 1922 (Storr 1965b), and disappeared soon afterwards. The fact that there was only one pair involved, and they only remained for one breeding season indicate they were vagrants which found the island unsuitable.

As mentioned earlier, there have been 10 immigrations of land bird species since 1904. The pied oystercatcher *Haematopus ostralegus* was a rare visitor to the island before the 1930s yet it was resident on the adjacent mainland (Alexander 1921). By the late 1950s it had become a breeding resident as a result of a natural immigration into suitable available habitat. The banded plover *Vanellus tricolor* underwent a major expansion onto the Swan Coastal Plain in the late 1920s as a result of clearing of native vegetation for agriculture (Seventy and Whittell 1976). Prior to the changes wrought by Europeans, Rottnest Island would not have had any suitable habitat for this species. Initially, clearing for agriculture and, latterly, grazing by horses (since removed) and mowing (runways and golf course) have maintained habitat suitable for the banded plover. This species colonized the island in 1934 as a result of the range expansion, due almost entirely to human influence. The red-necked avocet *Recurvirostra novaeholandiae* became established as a breeding resident (in small numbers) in the late 1970s or early 1980s, having been a rare visitor. The areas it frequents do not appear to have been modified in any way and there is no apparent human influence in this immigration. The two turtle doves (laughing *Streptopelia senegalensis* and spotted *S. chinensis* both colonized the island in the 1930s (Sedgwick 1958), and both were a direct result of deliberate introductions of exotic species into the Perth metropolitan area. The sacred kingfisher *Halcyon sancta* is an interesting species because of its choice of nesting site. Up until the 1960s this species was of uncertain status (Storr 1965b) and it did not appear to breed on the island. By the 1980s this species had become a breeding resident and it nests in the exotic palm trees scattered around the settlements. There are caves around the coast of the island and some of these may be suitable nest sites but there is no evidence of the birds breeding there. It appears that the establishment of this species on the island is due to the provision of suitable nest sites by humans. The rainbow bee-eater *Merops ornatus* is another species which has established itself comparatively recently, almost certainly as a result of the effects of human disturbance. This species was first recorded on the island in December 1977 (Abbott *et al.* 1978) and is now a breeding migrant. It digs its nesting burrows in areas like road cuttings, sand-pits and the golf course;

all sites which would not have been available before European settlement. The tree martin, *Cecropis nigricans* was an uncommon visitor until the 1970s when it started visiting the island in hundreds during the summer. In 1983 a small colony established itself in the roof of a wooden tower. This species normally nests in holes in trees but there are few, if any, such sites on the island and it was only the provision of an artificial nest site which allowed this species to establish itself. In 1950 the western warbler *Gerygone fusca* colonized the island and spread quickly to all suitable woodland habitat (Storr 1965b). At that period about 18% of the island was clothed in woodland and this colonization represents a natural immigration into unmodified habitat suitable for this species. The tenth immigration was the pair of the Australian magpie mentioned earlier which made on attempt to breed before disappearing from the island.

Turnover rates of breeding birds on islands are calculated from changes in composition of species of land birds and marine species are not taken into account. Nevertheless, marine species may be affected by changes in habitat as these may affect the suitability of the island as a breeding platform. There have been two recorded extinctions of marine birds on the island and both are believed to be the direct result of human interference. The little shearwater *Puffinus assimilis* was recorded as breeding on a small islet off the main island between 1922 and 1928 (Robinson 1935). Storr (1976) believes that its disappearance was a result of human interference with the small breeding colony. The red-tailed tropic bird *Phaethon rubricauda* made several unsuccessful attempts to breed on the island in the late 1950s (Storr 1964). Although their immigration was probably a natural event, their extinction was not. Unfortunately they chose to breed on the island's airport and the aeroplanes interfered with these attempts. It has not been recorded from the island since then.

While two marine species have become extinct on the island, two have established themselves as breeding species since 1904. The little pied cormorant *Phalacrocorax melanoleucos* was an uncommon visitor to the island until comparatively recently, despite the fact that it was common on adjacent mainland. In 1983 a small breeding colony was established on an offshore islet and small numbers are resident all year; the result of a natural immigration. (Natural is used in the sense of Lynch and Johnson 1974; i.e. human influence has not been responsible for the event). The Caspian tern *Hydroprogne caspia* was not recorded by early ornithologists (Glauert 1929) yet it was a resident on the adjacent mainland (Alexander 1921). Sometime prior to Storr's survey it had become a breeding resident and it retains this status today.

There have been two deliberate introductions of birds to Rottnest Island; ring-necked pheasant *Phasianus colchicus* and peafowl *Pavo cristatus*. Both species appear to be maintaining breeding populations and have done so for the last 50 years.

The changes in species breeding on the island are summarized in Table 1 and of 20 such changes only 6 (30%) are due to natural changes. All of the remaining 14 cases result from changes created by management or failure to manage in such a way to prevent the change.

IMPORTANCE OF ROTTNEST ISLAND AS A CONSERVATION AREA

The fact that the island has 10% of its area taken up with a series of super saline lakes and brackish swamps has considerable influence on the avifauna of the island. Of course, Rottnest Island should not be considered in isolation from the rest of the Swan Coastal Plain. The Swan Coastal Plain has long been regarded as prime habitat for urban development and extensive agricultural practices. As a result many changes have been carried out and by 1966 nearly 50% of the wetlands between Yanchep and Rockingham had been drained (Riggert in Seddon 1972) and since then the loss of wetlands has continued, e.g. the causeway area on the Swan River (Tarburton 1974). This loss of habitat for wading species has made the island increasingly more important as a conservation area because many of the non-breeding migrants visiting the island are transequatorial migrants breeding in the Northern Hemisphere. The importance of the island to these species is indicated by the ruddy turnstone *Arenaria interpres*. The fact that there are extensive areas of suitable feeding habitat around the lakes, and that there is no tidal influence, means that these areas are available throughout the day and night. The island is visited by mobs of turnstones and during the summer there may be more than 400 present. During 1983 a survey of waders around Australia estimated there were 5 347 turnstones in the country (Minton and Lane 1984) and during February 1983 the island held about 9% of that figure (Saunders and de Rebeira 1986).

Similarly the island is an important feeding area for the red-necked stint *Calidris ruficollis* and curlew sandpiper *C. ferruginea*, both transequatorial migrants and the banded stilt, a local migrant which breeds on the seasonal lakes of the arid and semi-arid zones of the mainland. The conservation value of Rottnest Island is maintained by considerable productivity of

Table 1.
Extinctions and immigrations of bird species breeding on Rottnest Island (1904-1984)

Species	Change	Probable reason for change in status
a) Marine birds		
Little shearwater	Extinction	Direct human interference with breeding colony
Little pied cormorant	Immigration	Natural expansion into suitable habitat
Red-tailed tropic bird	Immigration	Natural expansion
Red-tailed tropic bird	Extinction	Direct human interference with breeding colony
Caspian tern	Immigration	Natural expansion
b) Land birds		
Pied oystercatcher	Immigration	Natural expansion
Banded plover	Immigration	Range expansion as a result of human activity
Red-necked avocet	Immigration	Natural expansion
Laughing turtledove	Immigration	Feral colonizer
Spotted turtledove	Immigration	Feral colonizer
Brush bronzewing	Extinction	Trapping and habitat destruction
Sacred kingfisher	Immigration	Range expansion using human alteration of habitat
Rainbow bee-eater	Immigration	Range expansion using human alteration of habitat
Rufous whistler	Extinction	Habitat destruction
Tree martin	Immigration	Range expansion using human alteration of habitat
Western warbler	Immigration	Natural expansion
Australian magpie	Immigration	Range expansion using human alteration of habitat
Australian mapgie	Extinction	Human interference
c) Deliberate introductions		
Peafowl)		Deliberate release of caged animals brought to the
Ring-necked pheasant)		island for that purpose

these salt-lakes which support a varied avifauna; on occasions, well over 5 500 birds may be feeding in or around the lakes. Of interest here, from a management perspective is that peak numbers of birds are present on the island between December and February and this is the peak period of human occupation.

In addition to the wading birds there is a small population of osprey *Pandion haliaetus*. Over the last 25 years there have been from two to four pairs breeding around the coast and these spectacular birds attract a great deal of attention. On occasion more than 20 birds have been present on the island and there are at least 12 known nest sites (Saunders and de Rebeira 1985b). In fact the island probably has the largest concentration of osprey around Cockburn Sound.

As Rottnest Island has been isolated for about 6 500, years does it possess any endemic species? The red-capped robin *Petroica goodenovii* has an isolated population on the island and this species is not present on any of the other islands in Cockburn Sound, nor is it present on the adjacent mainland. This population has probably been isolated since the island separated from the mainland but at present not enough is known of the animal to determine if it is an endemic race. The red-capped robin depends on woodland for its survival and its population is most dense in the remnant woodland areas where it forages on the ground. This species is territorial and the reduction of woodland areas would almost certainly have led to a reduction in total population on the island. This species must be regarded as vulnerable because of this fact.

The only known endemic race of bird on the island is the singing honeyeater *Meliphaga virescens*. Widely distributed on mainland Australia and present on many offshore islands including Barrow Island, the singing honeyeater throughout its range is a striking example of Bergmann's rule when mainland populations are examined (Wooller *et al.* 1985) with regard to body mass. The singing honeyeater is not as vagile as is widely believed as it shows a remarkable degree of endemism in body mass; the birds on Rottnest Island are 21% heavier than the birds from Perth, only 18 km away, and an extensive banding campaign has shown no evidence of movement over Cockburn Sound. In fact the birds on Rottnest Island

are so much larger than the birds at Perth that they take a size 4 leg band instead of a 3 over the rest of mainland Australia. Interestingly the birds on Barrow Island are 18% heavier than the populations in the adjacent Pilbara. The fact that Rottnest Island has an endemic race of the singing honeyeater makes an assessment of the future management of the island's resources imperative.

The rock parrot *Neophema petrophila* is the only other isolated population on the island; in that it is not present on surrounding islands, nor on the adjacent coast of metropolitan Perth. This species is present in small numbers having been subject to pressure from residents of the island who were illegally harvesting the young. By the 1960s this species had almost become extinct on the island but has started to increase and small flocks are often seen. Protection from illegal trading has probably had most to do with the increase in this population. This management has been "de facto" as there has never been any active protection of the flora and fauna of the island by any of the successive Rottnest Island Boards. While management plans have been produced (one in 1972 and one in 1984) they were for the future development of the island and not for management of the existing ecosystems (R.I.P.M.G. 1985).

MANAGEMENT OR MISMANAGEMENT?

Rottnest Island has been managed since 1917 by a Board of Control which resembles a small town council. It manages the settled areas which constitute the tourist areas and has degraded the remainder of the island, an area which constitutes a national park with a residential complex. Their rape of this area has resulted in the loss of many of the values visitors hold of the island. There is absolutely no reason why the island can not be managed as a holiday resort and retain the wildlife values which enhance the area's tourist image. To do that requires a complete change of management policy - radical if necessary. The easiest method would be to change the legislation, retain the A-class reservation and the proposed "Public recreation" but placing the island firmly under the control of a competent management authority who is capable of treating the island as an entity.

The logical authority is the Department of Conservation and Land Management. There is an enormous amount of information published about the ecology of the island as it has been a study centre for generations of students. Unfortunately much of this study has had no direction other than esoteric scientific interest. With planning, much of this work could have had management implications which could have been incorporated in a management plan by a competent authority, which could have upgraded the plan as new information became available. Such an authority could highlight areas of research necessary for filling gaps in the knowledge of the island's ecosystems if it was a clearing house for projects to be undertaken on the island. The island is far too valuable a recreational, educational and scientific resource to be squandered as it is now by a Board of Control which is incapable of understanding ecological theory and using it to manage the island.

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