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WESTERN AUSTRALIA

S.W.A.N.S.

State
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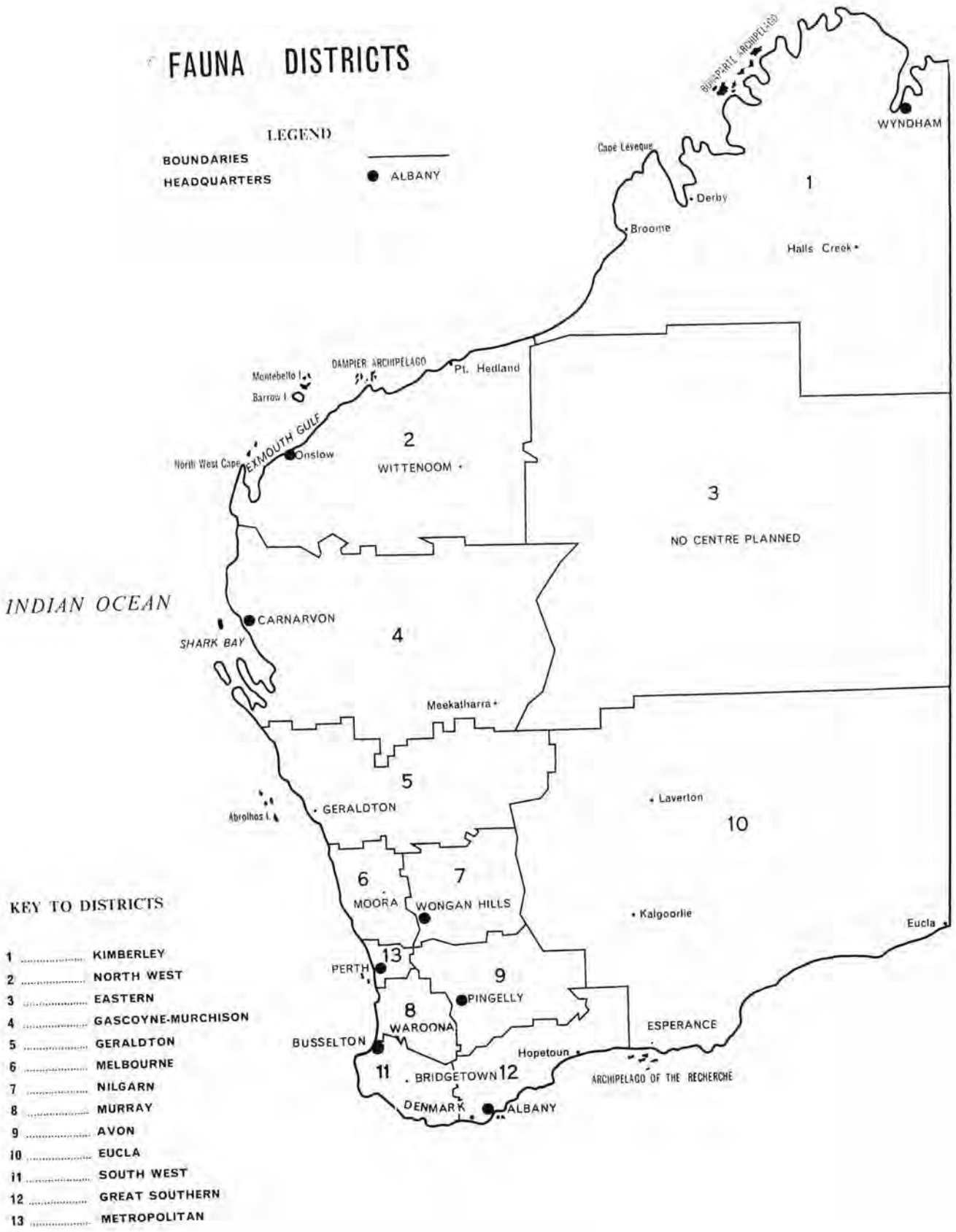
FAUNA DISTRICTS



KEY TO DISTRICTS

1 ..... KIMBERLEY
2 ..... NORTH WEST
3 ..... EASTERN
4 ..... GASCOYNE-MURCHISON
5 ..... GERALDTON
6 ..... MELBOURNE
7 ..... NILGARN
8 ..... MURRAY
9 ..... AVON
10 ..... EUCLA
11 ..... SOUTH WEST
12 ..... GREAT SOUTHERN
13 ..... METROPOLITAN

S.W.A.N.S

Vol. 1 No. 2

SPRING, 1970

Issued by direction of the Hon. G. C. MacKinnon, M.L.C., Minister for Fisheries and Fauna.

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The support of the public is an essential component in any conservation or reserve management programme—but an informed, educated public is needed to ensure its continuing success.

This publication is designed as a medium by which the various organisations, individuals, and wildlife management personnel may be kept informed of the work being carried out by this department; of departmental policies and directions; and for promoting a better understanding and appreciation of Western Australian wildlife and the role it plays in maintaining a suitable environment in which man can live.

Something to think about.....

Pollution in all its forms—the growing accumulation of wastes; the poisoning of the air we breathe; the contamination of rivers, lakes, the sea, and our domestic water supplies; the soil on which we live and depend for agriculture; the cumulative effect of poisons in our food, and the increasing burden of noise in urban communities *—all these things constitute a problem of growing urgency.*

The effect of pollution is so widespread and so enduring that almost every inhabitant of our modern civilised community is conscious of pollution in one form or another. Not only does it affect us as individuals with contaminated food, increased respiratory complaints, and dying gardens—the resultant effect on our fauna, flora and marine life has already reached the point where some species are in danger of extinction and, in some cases have already been eliminated from areas where they were once prolific.

The dangers of pollution are not hypothetical or emotional as some would have us believe. In many parts of the world this has been clearly illustrated—dramatic losses of fishing resources following broad application of pesticides in north-west U.S.A., the massive kills of fish in the Mississippi River in 1963, the total collapse of the Lake Michigan Fishery, the death of 167 Japanese from cadmium and mercury poisoning from industrial effluents, the destruction of marine life from oil spillages. The list is almost endless and will continue to grow unless we heed the warning signs. Or is it already too late?

IN THIS ISSUE....

RE-SHAPING FUTURE MINING DEVELOPMENT

THE WEST AUSTRALIAN SATURDAY JULY 18 1970

WESTERN AUSTRALIA
COMMITTEE OF INQUIRY INTO MINING ACT

Notice is hereby given that the first meeting of the Committee in public session will be held in The Warden's Court, 9th Floor, Mineral House, 66 Adelaide Terrace, Perth, on Thursday 30th July, 1970 at 10.30 am.

Persons and organisations who intend, in due course, to make submissions to the Committee are invited to attend or be represented at that meeting, for the purpose of giving notice of their intention and of submitting to the Committee their views on procedural and other preliminary matters.

Persons or organisations who are unable to attend or be represented on that day are invited to give prompt notice, by mail, to the undersigned, of their intention of making submissions.

The terms of reference of the Committee are as follows:—

(1) To inquire into, and report on, the operation of the Mining Act and, in particular and without limiting the generality of the foregoing, to report whether any and what amendments should be made to the Mining Act in respect of all or any of the following matters:—
- (a) the various classes of mining tenements, rights and licences and whether any should be eliminated;
- (b) whether any new forms of mining tenements, rights and licences are necessary;
- (c) the temporary reservation of Crown land and the grant of rights of occupancy thereover;
- (d) prospecting and mining on reserves;
- (e) mining in relation to conservation, ecology, preservation of the balance of nature and preservation of the environment;
- (f) prospecting and mining on private land;
- (g) the rehabilitation and restoration of land affected by mining activities;

SUBMISSIONS TO THE MINING ACT INQUIRY

Earlier in the year the Government of Western Australia appointed a three-man committee to inquire into the Mining Act.

The appointment of a committee to reshape future mining development comes at a time when the search for minerals and mining operations poses a direct threat to our wildlife and the future of fauna sanctuaries throughout the State.

Although fauna reserves are legally safeguarded from all forms of despoilation, insufficient protection is afforded from the destructive influence of mineral exploration and mining.

At the present time fauna sanctuaries comprise less than 2 per cent. of the total area of Western Australia—surely a far smaller area than could be considered as a satisfactory minimum.

Rather ironically, many of these areas are held under mining tenements and it would seem that some of the most representative fauna habitats also yield the most promising mineral claims.

Looking to the future, the prospect of adding to these areas looks dim as areas which have not already been subjected to agricultural and pastoral use are now being sought by mining interests. Such areas cannot be reserved since reservation is subject to veto by the Minister for Mines under section 268 of the Mining Act.

This Department, fully cognizant of its responsibility to protect and preserve Western Australian fauna has tackled the problem by creating reserves—an internationally accepted scientific procedure. The Department holds as a general tenet of policy that extensive mining and conservation are not compatible and it hopes that this committee will ensure that those areas set aside as fauna sanctuaries are held inviolate against exensive mineral exploitation.

The submissions to the Western Australian Committee of Inquiry into the Mining Act were made by the Director, Department of Fisheries and Fauna, and by Professor A. R. Main, F.A.A., Member of the Western Australian Wild Life Authority and Department of Zoology, University of Western Australia. These are published below.

SUBMISSION TO THE COMMITTEE BY THE DIRECTOR, DEPARTMENT OF FISHERIES AND FAUNA

Item (1) (d)—Prospecting and Mining on Reserves

The Department of Fisheries and Fauna and the Western Australian Wild Life Authority are charged with the responsibility of conserving the native fauna. The main approach to this problem has been by having reserves set aside for this purpose.

The aim is:—

1. To ensure that at least one reserve is set aside for each of the spectacular native species. Where possible, reserves have been replicated.
2. To have large representative reserves set aside so that areas typical or representative of the primitive environment and its fauna and flora are retained.
3. To set aside areas of scientific importance, such as areas where animals occur well outside their normal geographic range.
4. When settlement in a particular region has proceeded for some time to retain a number of smaller reserves to add to the diversity of the environment and retain its unique "Australian" character and permit the persistence of those animals which can to some extent co-exist with European man.

The existing system of Conservation Reserves in Western Australia is not a haphazard one based on a policy of competition with existing industries, but is the result of rational proposals put forward with a full knowledge of the available data on the distribution and ecology of the native flora and fauna. Reserves were usually created in areas unused by agriculture or mining. Now, with a greater utilisation of the State's resources it is inevitable that clashes occur since an adequate system of reserves must contain some land of value to industries as well as to conservation.

At the 30th June, 1970, reserves for the Conservation of Fauna totalled only 5,190,344 acres or approximately 0.8 per cent. of the State, and National Parks covered 3,507,410 acres or approximately 0.6 per cent. of the State.

The Department and the Wild Life Authority have also the responsibility of managing the reserves in their charge. It has appreciated this responsibility and realises the danger that unwise management or uncontrolled use or access may jeopardise the persistence of the fauna as much as active interference. For this reason, the Wild Life Authority and the Department in association with the Department of Zoology, University of W.A. and the W.A. Herbarium have engaged in a long term programme of research at the Tuttanning Wildlife Sanctuary in order to learn why animals live where they do and what they require from the environment. This knowledge can then be used to devise appropriate management procedures. The work at Tuttanning (which commenced in 1959), and paralleled research carried out elsewhere on the W.A. fauna has been founded by the W.A. Government, the University of W.A., the Australian Research Grants Committee and C.S.I.R.O.

From the work at Tuttanning it is clear that the richness of the fauna occurring there is the result of vegetational diversity which in turn is the result of varying topographic relief, soils, different stages of regeneration after burning and the absence of introduced weeds and grasses. The particular importance of these factors is evident in the fact that the concentrations of animals occur at vegetational interfaces provided by gradations of topography, soils and fire history. In other words, the floral diversity is responsible for the faunal diversity. From other studies, it is clear that as soon as diversity is lost, i.e., the environment is simplified, only a few species survive and these tend to fluctuate in numbers. To this end the management at Tuttanning, and indeed management anywhere, should be directed toward maintaining diversity and fauna reserves should be selected to cover areas of maximum topographic, edaphic and vegetational diversity.

The foregoing can be generalised another way. In nature there exists a delicate balance between the various components of the environment—climate, soil, vegetation and animals. It is known that relatively minor changes in one of the components will, because of this interdependence, set off chain reactions of far reaching consequences. It is also known that arid or semi-arid environments are more susceptible to change and slower to recover than areas of higher rainfall.

The types of change which take place are varied and it is not easy to predict either their severity or extent, but the change is usually away from environmental diversity and towards simplicity. Most changes are irreversible. Some radical changes in the vegetation and wildlife of "natural" bushland have already taken place in areas of Western Australia especially those that are surrounded by agricultural land or have been subjected to grazing by exotic animals.

For these reasons any form of activity in fauna sanctuaries which is likely to cause environmental degradation is opposed. This includes a variety of activities, some obvious like taking soil for roads or grazing stock, some not so obvious like the use of chemicals. These activities can be controlled by regulations made under the Fauna Conservation Act. However, the Land Act, which creates and vests reserves, is subject to the Mining Act which allows prospecting and mining on reserves.

The Mining Act covers a wide variety of operations from simple projects such as quarrying for sand or limestone to the complex procedures involved in a major mining venture. However, the common factor to all operations is that they cause the soil to be disturbed and the vegetation destroyed, sometimes over large areas. Unfortunately, the final effect is not limited just to the area mined. This is because:

1. In some cases the exploration techniques cause a large amount of soil disturbance.
2. Soil disturbance leads to the introduction of exotic weeds and grasses which often alter the character of the environment to such an extent that it becomes useless for much of the native fauna. Once weeds become established in an area they can then spread widely, even to relatively undisturbed areas. They compete with the native flora and may lead to the extinction of the species. They increase the fire hazard because of an increased ground cover, and this in turn causes degradation.
3. The increased human usage of the area inevitably has an impact beyond the boundaries of the mined area with detrimental effects on the flora and fauna.
4. Associated with human usage is the increased introduction of exotic predators and pests, such as dogs, cats, rats and mice.

Ideally, mining on reserves, at least in the first three categories listed at the beginning of this submission, should be prohibited as in most cases they are unique and even minor disturbance may have catastrophic consequences. However, I believe at this stage of development of both the reserves system and the mining industry it is unreasonable to prohibit mining on Conservation Reserves out of hand, but a better system than that available at the moment is necessary so that the conflicting values of short term exploitation and long term availability of different resources can be properly weighed up.

I recommend that the following procedure be adopted: A person seeking to mine on a reserve should apply to the Mines Department for a mining tenement as under the present procedure, together with an application for an "Authority to

Mine on a Conservation Reserve". The application should contain particulars of:

(a) the technical qualifications of the applicant and of his employees and the technical advice available to the applicant;

(b) a detailed programme of the proposed prospecting operations. Each such programme shall:

(i) provide for a geological, geophysical, geochemical or other similar survey,

(ii) outline the methods by which the applicant will be able to preserve the ecological balance of the area;

(c) the financial resources available to the applicant and the amounts of money the applicant proposes to expend in fulfilling the above programme;

(d) any other matter relevant to the ability of the applicant to carry out the above programme effectively and with particular reference to his ability to comply with the requirements necessary for the preservation of the ecological balance of the area.

Copies of the applications should also be served within 48 hours on the body controlling the reserve, which shall be as follows:

(a) if the reserve is vested, the body or person who holds the vesting order;

(b) if the reserve is unvested, the Department of Lands and Surveys, except in the case of a Fauna Sanctuary (within the meaning of the Fauna Conservation Act, 1950-1969), in which case it shall be the Department of Fisheries and Fauna.

A copy shall also be served on the proposed Department of Conservation.

The controlling body must consider the application and make a decision on such application no later than six months from the date of service. This period is not sufficient time in which to carry out a detailed biological survey but any further period might be considered to be detrimental to a mining company's interests. However, such a period would enable limited data to be collected and for discussions to take place with the applicant.

If, at the expiration of the period of six months, the controlling body has decided not to approve the application, or if conditions to approval proposed by the controlling body are not acceptable to the applicant, the applicant may then have his application heard by the "Conservation Reserves Tribunal". The Tribunal should consist of the following:—

(a) A chairman—who shall be a District Court Judge and who shall make any recommendations. He shall be assisted by,

(b) an expert on mining matters nominated by the Minister for Mines,

(c) an expert on conservation matters nominated by the Minister for the body controlling the reserve or the Minister for Conservation.

The procedure before the Tribunal shall be similar to that presently applying in the Warden's Court. If an application is to be heard by the Tribunal, it should be advertised and any interested body or person may object for any reason whatsoever and give evidence or be represented.

In any proceedings before the Tribunal, the onus of proof shall at all times be on the applicant to show that it is in the public interest that mining should take place in preference to the purpose for which the reserve was created, taking into consideration the following factors:—

1. The nature of the mining activity in relation to its effects on the remainder of the reserve or on other reserves.
2. The likelihood of restoration of the reserve to its original state after mining is completed.
3. In the case of certain reserves, the effect of mining on the scenic and tourist value of such reserves.

Upon hearing the application and the objections, if any, as well as the evidence and submissions of the body controlling the reserve, the Tribunal shall then make its recommendation to the Governor in Executive Council. Such recommendation would either be to grant, refuse, or grant subject to any conditions and restrictions as it might think fit, or to adjourn, the application. The Tribunal would also have the power to require the applicant to provide a suitable bond and in certain cases sureties thereto to cover the expenses likely to be involved in rehabilitation and restoration wherever possible of the affected area of the reserve.

Item (1) (e)—Mining in Relation to Conservation, Ecology, Preservation of the Balance of Nature and Preservation of the Environment

As stated in the submission on Item (1) (d), the Department's main approach to fauna conservation has been by setting aside reserves for this purpose. However, it also has the responsibility of conserving the fauna and enforcing protection laws on a State-wide basis, and protecting marine and fresh water fisheries. The Department does not seek control of land use in privately owned areas except in isolated cases. However, it is also closely interested in types of Crown Land or water not already included in reserves or which are reserved for other purposes. Also the reserves system for conservation is by no means adequate at this time and must be expanded.

Types of land on which disruption could cause great damage to the conservation of fish and fauna include:

1. **State Forests and Timber Reserves.** These contain many types of animals and plants not found elsewhere and one of the functions of forest country has always been to conserve flora and fauna.
2. **Wetlands**, i.e. lakes, swamps and rivers. These are important as breeding areas for waterfowl (swans, ducks, etc.) or as refuge areas for waterfowl in the summer or in times of drought. Some also contain commercial or sporting fish, e.g., trout and marron as well as native fresh-water fish. Many lakes and swamps are privately owned or are vacant Crown land or reserves for water, etc. Vast areas of wetlands in W.A. have been drained for agriculture or are becoming increasingly saline and it is important that a proportion are protected. The Department is currently working on a survey of wetlands and will request reservation of some of them in the future.
3. **Estuaries and Inlets.** The estuaries and inlets on the south-west coastline are highly productive in terms of both commercial and sport fisheries and wildlife. The Department is opposed to extensive dredging or interference as this usually greatly reduces productivity.
4. **Shallow water marine situations.** Many of the bays on the Western Australian coastline are highly productive in terms of economic fisheries, such as prawns, whiting, scallops, etc., or act as nursery areas for other types of commercial fish. Examples are Geographe Bay, Cockburn Sound, Shark Bay, Exmouth Gulf, Nickol Bay, etc. Extensive dredging, or pollution could easily destroy fisheries worth millions of dollars per annum.

In respect of marine and fresh water situations, the Committee's attention is drawn to Sections 6 (j), 26 and 27 of the Fisheries Act, which appears to prohibit the pollution of water and watercourses by mining operations and also the pegging of hauling grounds.

With regard to the wide context of the preservation of the environment, although this Department has no specific responsibility in this area, it is obviously involved in the problem. The breakdown of the total environment is caused by massive pollution of the atmosphere and water and land masses. This phenomenon is the result of technological advances, especially the burning of fossil fuels, the dumping of industrial effluents and the run-off of agricultural chemicals. The mining industry is obviously only a part of the overall problem but in some limited areas it becomes of prime concern.

Item (1) (f)—Prospecting and Mining on Private Land

The Fauna Conservation Act provides that the owner of land (and this has been interpreted to include the lessee of leasehold land) may enter into an agreement with the Minister for Fisheries and Fauna to have his land or any part of it declared to be a sanctuary for fauna.

Once so declared a sanctuary, it may be classified, managed and controlled in the same manner as land reserved under Section 29 (g) of the Land Act.

There is only one such area at the moment but many applications have been received in respect of other properties. They will only be declared if there are sound conservational reasons to do so, but once declared they should be treated as in Item (1) (d).

Item (1) (g)—The Rehabilitation and Restoration of Land affected by Mining Activities.

For the purpose of this submission I take the above two terms to mean different things:

Restoration means the exact duplication of existing conditions.

Rehabilitation means to provide a new set of conditions so that the land can be used to some value.

1. **CONSERVATION RESERVES**

Restoration (in the above sense) of a mined area of primitive bushland is at present impossible except perhaps in isolated cases, e.g., the conditions existing in a salt lake could probably be duplicated after mining, e.g., for gypsum. This is largely because of the extreme complexity of a naturally occurring interdependent system of plants and animals (Ecosystem). While it is possible to raise a variety of plants in nurseries for replanting, difficulties are encountered in some types which do not set seed or require specialised conditions for their survival. However, if topsoil has been removed or its chemical make-up altered, the plants will not re-establish. On the other hand weeds will readily establish in disturbed situations and will compete with the native plants.

It is even more difficult to attempt to re-establish the full range of animals, especially if any species are unique to the mined area. Even if a proportion of the animals were left on unmined land they may still become extinct because the population may fall below its viable limit. Also, many invertebrates, e.g., insects and parasitic worms, are entirely dependent on specific plants and these invertebrates would not survive if the only available specific plants were in botanic gardens or nurseries.

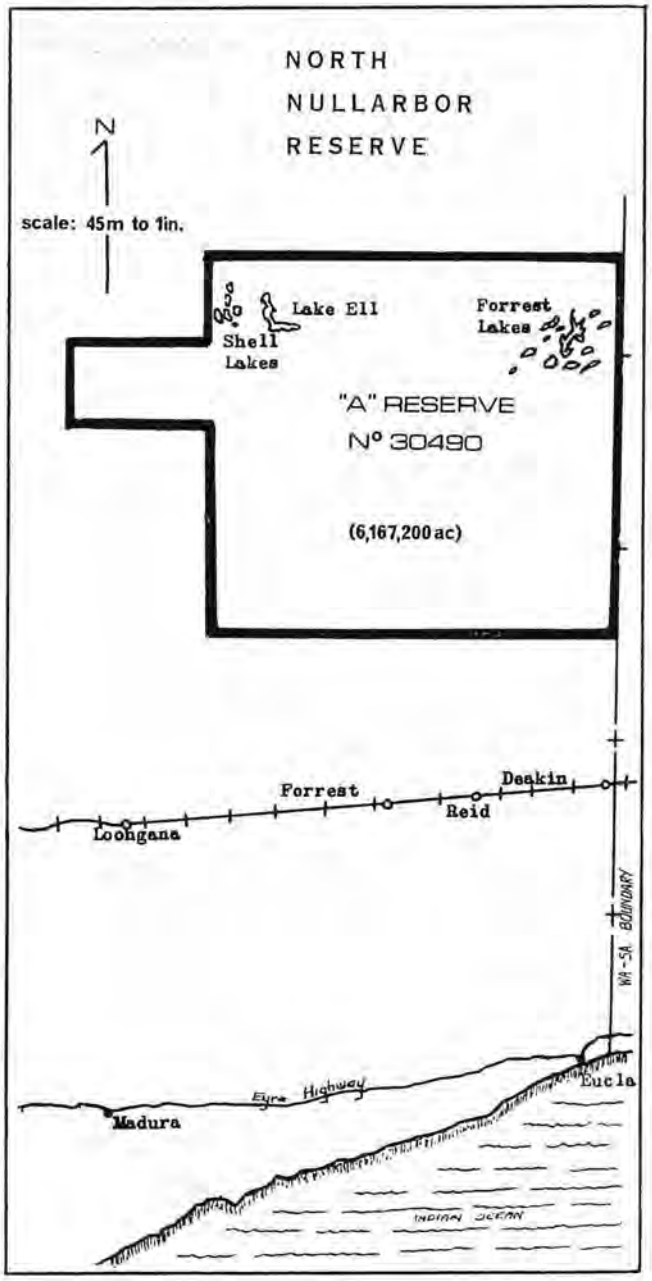
The science of habitat management and wildlife management is in its infancy. Nowhere in the world, to my knowledge, or that of my advisers, has restoration of land to its primitive state been achieved after mining activities have been carried out. In addition, on land used for agricultural purposes where complete clearing has been undertaken, restoration is unlikely to be achieved.

(Continued on Page 19)

W.A.'s FAUNA RESERVE AREA DOUBLED

The creation of a new 6-million acre reserve which has doubled the area for conservation of flora and fauna in Western Australia was announced by the Minister for Fisheries and Fauna, Mr. G. C. MacKinnon, in September.

Now vested in the Western Australian Wild Life Authority, the area is a tract of semi-desert adjoining the South Australian border and is four times as large as the next biggest conservation reserve. A notice setting the area aside was published in the Government Gazette on August 21st. The reserve, known as the Northern Nullarbor Wildlife Sanctuary, contains 6,167,200 acres.



This large area of country was originally recommended for reservation by the Sub-Committee on National Parks of the Australian Academy of Science in 1962.

The area includes regions which are representative of all the geological formations of the northern Nullarbor area and their associated vegetation which ranges from the typical almost treeless, flat-lying marine limestone of the Nullarbor to the Precambrian areas further north.

A transect from the south-west towards the north-eastern corner of the reserve broadly illustrates the regions of the area.

1. The southern edge is the typical, almost flat, limestone country of the Nullarbor. Numerous dongas act as drainage channels. The general vegetation is a grassland of *Stipa* with Sturt Pea and Swainsona. Where thickets occur, the principal trees are *Myoporum, Pittosporum phillyraeoides* and Curara *(Acacia tetragonophylla)*.

2. To the north of the grassland, the limestone country continues, but the vegetation changes to an open woodland of Myall *(Acacia sowdenni)* with an understorey of Bluebush *(Kochia* spp).

Open woodland of Myall with an understorey of Bluebush south of the Shell Lakes

3. Further north the geological nature of the country changes; the dominant rock is micaceous sandstone while the country becomes more undulating with rolling hills and broad valleys in which are poorly defined water-courses.

4. To the north is a rather narrow belt of sands not blown into dunes, and on which occur the first eucalypts *(E. oleosa* and *E. gracilis)*. Beyond these sands are the Shell Lakes, one of a series of large salt pans which extend across the northern limit of the Nullarbor.

Eastward from the Shell Lakes to north of Forrest Lakes, the country is, geologically, a complex of Permian glacial beds, flat-lying well-bedded sandstones, limestones of the Nullarbor complex and Precambrian quartzites. The whole of this area is traversed by innumerable east-west sand dunes which are blown over all of these rock types.

A temporary native catchment in the Shell Lakes System

The vegetation is rich and extremely varied. On the sandhills, spinifex, mallee and acacia are dominant. In the hollows between dunes the vegetation varies with the soil type but eucalypts such as *E. oleosa* together with Mulga *(Acacia aneura)* are common.

Ferruginous sandstone typical of the northern Forrest Lakes area

Around the salt flats are found *Atriplex* spp., *Rhagodia* spp., *Kochia* spp. and *Arthrocnemum.*

The floral diversity of the region is shown by the common genera which are represented as follows: *Eucalyptus* (9 species), *Acacia* (8 species), and *Eremophila* (8 species). Also in the flora are such genera as *Stylidium, Daviesia, Dampiera* and *Templetonia.*

Mygalomorph spiders, frogs, reptiles and birds suggest that this region is, even now, acting as a corridor connecting the faunas of eastern and western Australia. Mammals are not great in variety in the area but the Marsupial mole *(Notoryctes)* is found in the desert sand dunes. The mole is a highly specialised blind creature and is an amazing example of evolutionary processes known as convergence. Although quite unrelated to the true mole of the northern hemisphere, the marsupial mole is very similar in shape, size and habits. At this stage, little is known of its natural history. In its report, the sub-committee of the Australian Academy of Science indicated that the area would yield much significant information on the biogeographic relationships between eastern and western Australia.

QUEEN VICTORIA SPRING RESERVE

In the same issue of the *Government Gazette* another important reserve was set aside. It is known as the Queen Victoria Spring Wildlife Sanctuary.

The area comprises 673,604 acres and is situated some 30 miles north of Zanthus.

Queen Victoria Spring was discovered in 1875 by the explorer Ernest Giles who named it after Her Majesty, Queen Victoria.

The Spring is actually a soak situated in an area of grassland surrounded by small bushes, Eucalypts, Acacias and Spinifex. The soak itself is in sand on a clay bottom and has apparently formed in an old clay pan which has filled with drifting sand. The highest feature in the area is Streich Mound, a sandhill approximately 1,100 ft. high and about nine miles east-south-east from the Spring.

The reserve has numerous sand dunes in it. These dunes overlay gneiss, and are representative

of the environment of the boundary of the interior sandy desert and the metamorphosed Precambrian of the Goldfields.

Looking west from Queen Victoria Spring showing representative flora types—*Acacia, Triodia, Callitris* and *Duboisia*

The flora is interesting in that it is a desert association which includes winter rainfall Mulga. The predominant vegetation in the area is Spinifex *(Triodia)* steppe and the several species of *Triodia* form the dominant vegetation over the greater part of the area. In certain sections these grasses are replaced by *Eriachne, Eragrostis,* and *Aristida.* Goodeniaceae is well represented among the shrubs, while species of the families Malvaceae, Leguminosae, Proteaceae, Compositae and Chenopodiaceae are common. The tree storey consists chiefly of *Eucalyptus,* the principal species being *E. gongylocarpa, E. oleosa* var. *glauca, E. flocktoniae,* and the mallees *E. cylindrocarpa, E. concinna* and *E. leptophylla. Acacia* is well represented, as are *Callitris* and *Eremophila.* Two interesting features are the numerous isolated patches of Mulga and the very large specimens of the grasstree or Blackboy *(Xanthorrhoea thorntoni)* which are common in the area.

A rare species of desert Gecko, *Nephurus laevissimus*

No comprehensive studies have been made of the fauna; however there are various records of reports made by naturalists and surveyors. For example, this is the furthest eastern locality of the frog *Neobatrachus sutor.* The rare desert Gecko *(Nephurus laevissimus)* also occurs in the area together with a new species, *Diplodactylus maini* which was unknown to science before 1962.

The new species of Gecko, *Diplodactylus maini*

NEW FAUNA RESEARCH CENTRE

A new, $110,000 Fauna Research Centre will be built for the Research Branch of the Department of Fisheries and Fauna. This was announced in October by the Hon. G. C. MacKinnon, Minister for Fisheries and Fauna.

The purpose of the centre is to provide facilities for studies of wildlife management problems under laboratory and simulated natural conditions. Steps will be taken to ensure that the centre is aesthetically attractive and that the public will have access to the parklands surrounding it.

Mr. MacKinnon went on to say that negotiations were proceeding between the Shire of Mundaring, the Metropolitan Region Planning Authority and the Lands Department for the use of an area of some 50 acres of suitable land 2 miles south-west of the Glen Forrest Townsite, close to the Helena River and near the C.S.I.R.O. Wildlife Research Station.

At present the fauna research staff of the Department are housed in various temporary premises in the city and suburbs. These are unsuitable and without adequate facilities said Mr. MacKinnon. The new establishment would provide suitable laboratories and equipment for the research scientists, a lake for waterfowl research purposes, animal holding pens, and adequate areas of natural bushland.

Mr. MacKinnon stressed the importance of proper location of the research station—it must be located where there is a minimum of pollution of the waters, air and soil, and not be subject to pressures or development by industry or urban settlement. At the same time the centre had to be close enough to utilise the facilities of the W.A. University, Museum, State Libary, Agriculture Department and the Government Chemical Laboratories.

It was anticipated that building of the new centre would commence in 1971. Messrs. Silver, Goldberg and Associates, Architects, have been invited to undertake its design.

KANGAROOS & WALLABIES FACING EXTINCTION

Recently there has been considerable publicity on the subject of conservation of kangaroos and the threat to their continued existence. Most of this concern has been directed toward the large kangaroos, but what of the other species of kangaroos and wallabies?

At one time in the south-west of the State there were 14 species of the kangaroo and wallaby family. Now, only four or five species are common and the rest are either extinct or very rare.

Among the most common of marsupials in the south-west, and the largest, is the Grey Kangaroo *(Macropus fuliginosus)*, which is found in areas of natural bush and forest. The greatest threat to the "Grey" is the destruction of its habitat by clearing. The Brush Wallaby or Black-Gloved Wallaby *(Macropus irma)*, is also common and is frequently seen on roads and highways at night. Provided the present system of forests and reserves is maintained, these animals should be safe from extinction.

The Tammar *(Macropus eugenii)*, a smaller wallaby about two feet in height, is far less common. However, it still occurs on a number of wildlife sanctuaries and State Forests so its future seems fairly secure. The Tammar is also found on islands off the Western Australian coastline including the Wallabi Islands in the Abrolhos group, Garden Island and islands in the Recherche Archipelago.

The Quokka *(Setonix brachyurus)*, another small wallaby, also occurs on islands, including Rottnest Island near Fremantle and Bald Island, about 30 miles east of Albany. Once abundant on the mainland the Quokka is now rare—occurring only in small populations in swampy areas near Busselton, Albany and in the Darling Range. Many of these areas are in State Forests and therefore the Quokkas' environment is protected to a large extent.

One of the rarest wallabies is the Crescent Nail-Tailed Wallaby or Wurrung *(Onychogalea lunata)*. This animal was common in the drier regions of the south-west, but has rarely been sighted over the past 30 years. The most recent record was at the Warburton Ranges in 1964. Since that time unconfirmed reports have come from the Kalgoorlie area. The two hare wallabies present a similar picture. Relatively frequent sightings of the Western Hare Wallaby or Wurrup *(Lagorchestes hirsutus)* and the Banded Hare Wallaby or Munning *(Lagostrophus faciatus)* were reported in the wheat belt and drier parts of the south-west in the early part of this century. Both species are still found on Bernier and Dorre Islands off Carnarvon, but are now probably extinct on the mainland.

The range of the Brush-tailed Rock Wallaby *(Petrogale penicillata)*, has also been drastically reduced since the early days of the Swan River Colony. It is now found in the Kellerberrin-Bruce Rock area, on Barrow Island and the Recherche Archipelago and in isolated areas in the north-west of the State.

Another uncommon species is the Woylie or Brush-tailed Rat Kangaroo *(Bettongia penicillata)*. This animal was once widely distributed throughout the southern half of Western Australia and the other States but is now very restricted in its range. In Western Australia only two or three localities are known and these are in Wildlife Sanctuaries or State Forests. The biology of this animal is being studied at the Tuttanning Wildlife Sanctuary east of Pingelly. The other species of Rat Kangaroo, the Boodie *(Bettongia lesueur)*, is extinct on the mainland although it was common up to the 1930's.

This animal is unique among wallabies in that it lives in a burrow in the ground. Fortunately, the Boodie is still found on Bernier and Dorre Islands and Barrow Island. The last two species, the Potoroos, are also believed to be extinct. The Long-nosed Potoroo *(Potorous tridactylus)*, still occurs in the Eastern States but the Broad-faced Potoroo *(Potorous platyops)*, was restricted to Western Australia and has not been reported since 1875.

From this summary it is evident that only a few of the fourteen species of kangaroos and wallabies of the south-west are plentiful. The reasons for the disappearance of some species and the increasing rarity of others is unknown—it is probably a combination of factors; the fox and other exotic predators are often blamed, but many of the wallabies became rare before the fox arrived in Western Australia. Disease introduced by man's domestic animals is one possible answer. This is supported by the fact that some wallabies are recovering in numbers, probably having built up resistance to the diseases.

Habitat destruction is another possible cause, but in the case of the wallabies. this does not follow as many became extinct around 1900 when clearing was not very extensive. With so many unanswered questions, perhaps more research could be undertaken to determine the underlying causes of the decline in the smaller species of kangaroos and wallabies—not merely those subject to commercial exploitation.

1970 DUCK SEASON ANNOUNCED

The Hon. Minister for Fisheries and Fauna, Mr. G. C. MacKinnon, announced on the 11th November the dates for the 1970 duck shooting season.

The season will open at 6 p.m., Saturday, December 19, and close at 8 p.m., Sunday, January 10. No license is required to take ducks, but a bag limit of eight ducks per day will be imposed.

In making the announcement Mr. MacKinnon emphasised that the season was earlier than the last two seasons and would be the shortest on record. This was because most of the inland breeding sites were dry or near dry. Some of the areas affected were Toolibin, Taarblin and other lakes of the Arthur River east of Narrogin, Oak Park at Dowerin and Lakes Unicup and Muir in the south-west. A section of Benger Swamp will be closed to shooters to protect broods of the rare freckled duck. Mr. MacKinnon indicated that this area may become a sanctuary for waterfowl as it offered one of the most suitable breeding and nesting sites for large populations of a great variety of water birds.

The Department of Fisheries and Fauna plans to produce a Duck Shooter's Guide prior to the opening of the season, and this will be available, free of charge, from the Department's metropolitan and country offices.

TUTTANNING RESERVE INCREASED IN SIZE

The Department's wildlife sanctuary at Tuttanning, near Pingelly, has been increased in area by the acquisition of 1,600 acres. This brings the total acreage to about 4,900. The amendment of area was brought about by the cancellation of three timber reserves 19125, 19126, 19127 and the purchase of Avon Location 6931, on Lands and Surveys Plan No. 378B/40.

Avon Location 6931, of 160 acres, was purchased from an adjoining land holder for the sum of $4,000. The block is uncleared and contains a good quality bush, the main tree species being Jam *(Acacia acuminata),* She-oak *(Casuarina huegeliana)* and White Gum. Good populations of Tammar *(Macropus eugenii)* and Woylie *(Bettongia penicillata)* are present as well as other sorts of animals. The expenditure of this sum of money to purchase land for inclusion in the Wildlife Sanctuary reflects the importance the Government places in this area.

By notices in the *Government Gazette* of 2nd October, 1970, the purpose of the reserve was changed from "Protection of Fauna" to "Conservation of Flora and Fauna", classified as "Class A" and vested in the Western Australian Wild Life Authority.

RED-TAILED TROPICBIRDS

Tropicbirds, a familiar sight to sailors in tropical regions, are a rare occurrence in the Southern Indian Ocean.

Earlier this year Mr. Norman K. Swarbrick, of Emu Point, Albany, was reconnoitred by five Red-tailed Tropicbirds whilst fishing south of Taylor Inlet, Nanarup.

Unlike storm petrels or albatrosses they do not follow ships but investigate boats which cross their path.

The Red-tailed Tropicbird, *Phaethon rubricauda*

Commenting on the sighting, Dr. Dom Serventy said that a colony was known to exist on Sugar Loaf Rock (near Cape Naturaliste) and that the birds may have been exploring new areas to extend their breeding distribution.

The red-tailed tropicbird is the largest of the three species ranging up to 40 inches in length. The plumage is almost pure white or pink except for the black eye-stripes and the red tail streamers which, incidentally, make up about half the length of the bird.

DISTRIBUTION OF S.W.A.N.S.

This journal is issued free of charge to various organisations and individuals associated with conservation and wildlife management.

If you are not receiving an individual copy and wish to do so, please write and request that your name and address be placed on the mailing list.

See publisher's note, column 1, page 3.

(EDITOR.)

WILDLIFE SHOW 1970

The Annual Wildlife Show conducted by the Western Australian Naturalists Club and the W.A. Gould League took place at the Perth Town Hall from 14th-19th September.

The theme of the Department's display was "Pollution of the Environment". The display unit consisted of 3 panels mounted on metal frames measuring fourteen feet in length. The centre panel focused on the theme indicating how all forms of pollution affect man either directly or indirectly. The adjacent panels outlined the major sources and effects of pollution with photographs of local and interstate examples.

Judging by the favourable comment at the show the display appears to have been a great success.

HONORARY FAUNA WARDENS' REPORTS

Due to pressures on Departmental staff it has not been possible to reproduce Fauna Wardens' reports in this edition of S.W.A.N.S.

The staff who normally process these reports have been engaged in lodging objections against mineral claims on fauna reserves. A great deal of time has also been spent in preparing the new fauna regulations which were gazetted on November 18, 1970. (*Government Gazette* No. 102).

OBITUARY

On the 11th August, Mr. Archer Rose Whitworth of Dorothy Street, Geraldton, passed away in the Geraldton Regional Hospital after a long illness.

The late Mr. Whitworth was for many years an active Honorary Warden of fauna and in his capacity of Clerk of Courts at Geraldton he was most helpful to all members of this Department who have been stationed in the Geraldton District.

Archie, as the late Mr. Whitworth was known to his friends, was a very pleasant and popular figure at Geraldton, Broome and Carnarvon where he served as Clerk of Courts.

He was keenly interested in civic affairs and sporting activities and was well respected for his work of Senior Vice-President with the Police and Citizens' Youth Club in Geraldton.

The late Mr. Whitworth is survived by his widow Mrs. N. Whitworth and four children.

FAUNA WARDEN—APPOINTMENTS

HARMAN, Jayden David.

FAIRBANKS, Horace Asa.

Gazetted 31st July, 1970.

DECLARATION AND AMENDMENT OF RESERVES

CHANGE OF PURPOSE :

Class	Reserve No.	Locality	Plan	Area	Previous purpose	New purpose	Vesting	Gazettal
A	20338	12 miles northeast of Kondinin	345/80	Abt 12,650a.	Conservation of Flora	Conservation of Flora and Fauna	W.A.W.L.A.	7/8/70
B	4990	Eastern shore of Peel Inlet	380 A & D/40	Abt 344a.	Public Utility	Conservation of Flora and Fauna	....	7/8/70
B	24036	Eastern shore of Peel Inlet	380 D/40	848a. 2r. 35p.	Flora and Fauna	Conservation of Flora and Fauna	....	7/8/70
C	17746	6 miles northeast of Kununoppin	34/80	5,102a.	Catchment Area	Catchment Area and Conservation of Flora and Fauna	....	24/7/70
A	4458	7 miles northeast of Wagin	409 B/40	240a.	Recreation and Conservation of Flora	Conservation of Flora and Fauna	W.A.W.L.A.	21/8/70
A	26763	15 miles east of Lake Grace	387/80	3,207a 12p.	Conservation of Flora	Conservation of Flora and Fauna	W.A.W.L.A.	18/9/70
C	30267	10 miles south of Karlgarin	376/80	996a. 1r. 1p.	Conservation of Flora	Conservation of Flora and Fauna	W.A.W.L.A.	18/9/70
C	21981	7 miles west of York	2 A, B, C/40	513a. 2r. 32p.	Timber (Settler's Requirements)	Conservation of Flora and Fauna	W.A.W.L.A.	18/9/70
A	27979	Jitarning	377/80	Abt 110a.	Government Requirements	Conservation of Flora and Fauna	W.A.W.L.A.	4/9/70

NEW RESERVES :

Class	Reserve No.	Locality	Plan	Area	Previous Use	Purpose	Vesting	Gazettal
A	30191	Avon Valley, 12 miles west of Toodyay	Toodyay 40, Sht. 1	Abt 4,928a.	Freehold Commonwealth Land	Conservation of Flora and Fauna	W.A.W.L.A.	7/8/70

CONTROL OF BIRDLIFE AT AUSTRALIAN AIRFIELDS

The presence of birdlife at airports has been a constant source of danger—particularly since the introduction of jet aircraft.

A series of papers on gulls and other birds inhabiting airfields was prepared by CSIRO wildlife Research Officers and appeared in the "CSIRO Wildlife Research", Vol. 14, No. 2, in December, 1969.

Two of these papers were reprinted in *S.W.A.N.S.*, Vol 1, No. 1. The third paper is published below.

PAPER 3—ORANGE RUNWAY LIGHTS REDUCE BIRD-STRIKE DAMAGE

By G. F. Van Tets, W. J. M. Vestjens and E. Slater

SUMMARY

Insects and spiders which congregate at night around runway lights on airfields form an attractive food source, and thus draw a wide variety of birds and bats into the flight paths of aircraft. Aircraft can be severely damaged when they strike birds or bats. If the number of insects and spiders which are concentrated by runway lighting could be substantially reduced, presumably the frequency of this type of damage to aircraft would also be reduced.

It was found that orange light which excluded wavelengths shorter that 530 m_{μ} attracted fewer insects and spiders by weight than white light of equal visibility to humans with normal vision. A reduction of 92 per cent. was achieved with a Pyrex orange runway light lens, formerly in general use in Australia but now replaced by a variety of white lenses to conform to specifications of the International Civil Aviation Organization.

There are strong indications that these specifications should be amended in the interest of aviation safety to ensure that as many of the short wavelengths as possible are excluded from signal lights, and that orange should be the colour for the main runway lights.

I. INTRODUCTION

From time to time aircraft are severely damaged when they strike birds and bats at high speeds. Birds and bats picked up from the runways of airfields throughout Australia, after they were either struck by an aircraft or shot when attempts were made to disperse flocks, were forwarded to the CSIRO Division of Wildlife Research for examination. Two-thirds of over 200 full stomachs were found to contain mainly insects and spiders.

There are two methods in general use commercially to overcome problems caused by concentrations of insects around lights. One is to attract insects to an ultraviolet light near an electric grid which destroys them by burning. Another method is to use orange instead of white lights and thus concentrate fewer insects.

During November and December 1967, at Tindal R.A.A.F. Base near Katherine, N.T., amounts of insects and spiders concentrated by white and by orange runway lights were compared. During March and April 1968, amounts of insects and spiders concentrated by light screened by three different orange filters and by white and by ultraviolet lights were compared at the Gungahlin Research Station of the CSIRO Division of Wildlife Research, Canberra. The results and their practical implications for aviation safety are presented below.

II. METHODS

(a) *Experiment at Tindal*

The airfield at Tindal had a single sealed runway with 79 white runway lights 200 feet apart down both sides and 4 green lights at each end. The edges of aircraft parking areas were indicated by orange lights. Blue taxi-way lights were not present at the time of the experiment. A wind-sock was illuminated by four white lights above it. The white runway lights and the green end-of-runway lights were connected to the same circuit. The wind-sock lights and the orange parking lights were on other circuits. The airfield area around the runway and taxi-ways consisted of red and black soils with a limestone substrate. The surface had been graded bare. Around the airfield was flat wooded country with some irregular clearings to accommodate airfield buildings and installations.

The experiment started at dusk on November 30 and ended during the morning of December 20, 1967. The 20 nights involved are referred to as nights 1-20. On the uneven-numbered nights the runway lights were all white and on the even-numbered nights they were all orange.

The orange colour was achieved by inserting an orange filter, Strand Electric Cinemoid No. 5, between a white airfield-type light bulb (12V, 48W) and the outer glass cover of each runway light. The current of the runway light circuit was adjusted to 5.8 A for white and 6.6 A for orange light so they would be equally visible to humans with normal vision.

The green end-of-runway lights, being on the same circuit as the runway lights, were brighter and bluer on orange nights than on white nights. The two conditions of the green lights are referred to as high and low green. The orange parking lights and the wind-sock lights were at the same intensity on all 20 nights. The lights were

kept burning continuously from before dusk to after dawn. The orange parking lights failed and were off on the seventh night.

Around four runway lights (a-d) (nights 1-20) and two end-of-runway lights (e, f) (nights 7-20) insects and spiders were trapped in white Ilford developing trays (11 x 9 x 1½ in.) filled with a weak Shell Teepol 630 detergent solution. Four trays were placed in a square around the light. The insect catch of a light was filtered out of the solution with cheesecloth which was wrapped into a bag, closed with a piece of string, and stored in alcohol. The catches were removed from the trays between 11 p.m. and midnight, and again shortly after sunrise.

A sample of insects and spiders was also obtained each night with a white light trap placed on the ground under the trees beyond the airfield boundary. The trap consisted of a 150-W white light bulb above a funnel that led into a container filled with tetrachloro-ethane gas. This light burnt at the same intensity on all 20 nights.

The catches were shipped by air in alcohol to Canberra, where they were dried, weighed, and sorted into recognizable taxa.

Around each of eight runway lights, two green end-of-runway lights, and two orange parking lights, a 4½-ft. square of white cheese-cloth was pegged down with roofing nails. Each night between 11 p.m. and midnight, the taxa of insects and spiders visible on the cheese-cloth square and the light were recorded in a notebook. The taxa of insects and spiders present on and around the wind-sock were recorded each night between 7.30 and 8.30 p.m.

With the aid of binoculars and a telescope, observations were made from a temporary control tower of the numbers and kinds of birds visible on the airfield. These observations were made from about 8 to 11 a.m. During the collection of insects and spiders from the trays and the changing of the orange runway light filters at about 7 a.m., notes were also kept of birds seen on the runway. In order to examine what they were eating, several birds were collected with mist nets and by shooting.

(b) *Experiment at Gungahlin*

The research station at Gungahlin consists of a central group of buildings surrounded by animal enclosures and open paddocks which are separated by substantial wind-breaks of many native and introduced species of evergreen and deciduous trees. Near the buildings are two duck ponds, and on a slight slope overlooking these ponds four lights were placed 60 feet apart and in line. The lights consisted of light bulbs inside biscuit tins placed on the ground. On the side facing the ponds light was let out through the following four combinations of filters, each 4 in. square:

(1) White light from a 60-W bulb through one 1.5-mm sheet of frosted perspex.

(2) Orange light from a 100-W bulb through Cinemoid No. 5, and two 1.5-mm sheets of clear perspex.

(3) Orange light from a 100-W bulb through Kodak No. 22 and four 1.5-mm sheets of clear perspex.

(4) Orange light from a 150-W bulb through a Pyrex runway light lens and three 1.5-mm sheets of frosted perspex.

With the aid of transformers and different thicknesses of perspex and frosting the combinations were matched to be equally visible to humans with normal vision. Frosting helped to disperse the light from the Pyrex lens and make it more comparable with the other lights.

The lights were kept burning from before dusk to after dawn: March 25-29 and April 1-5, 8-12, 16-20, 1968. The 16 nights involved are referred to as nights 1-16. During the first eight nights the lights were one white, two Cinemoid No. 5, and one Kodak No. 22. During the last eight nights they were one white, one Cinemoid No. 5, one Kodak No. 22, and one Pyrex. The lights were moved daily in rotation around the four positions to eliminate position effects.

Insects and spiders were trapped in white Kodak developing trays (13 x 11 x 2 in.) filled with a weak Shell Teepol 630 detergent solution and placed one in front of each light. Triangular roofs 1½ ft. above the ground shielded the trays and lights from rain and dew. During the same 16 nights, insects and spiders were also trapped by an Oliphant Germicidal ultraviolet lamp (1000 V. 0.040 A) placed in a laboratory window 5 ft. above the ground. The spiders and insects attracted to the ultraviolet lamp were funnelled into two glass containers and killed by tetrachloro-ethane gas. The catches were collected about 9 a.m. and were weighed and sorted into taxa.

(c) *Special Characteristics of Runway Light Filters*

The visual appearance of the colour of the light transmitted through various regular and experimental runway light colour filters is not a criterion on which to base experiments like those cited above. Hence all the filters used during the course of this study were examined with a Zeiss hand spectroscope and checked for any ultraviolet transmission with a fluorescent powder, after excluding all visible light with a Kodak Wratten 18a filter. In this way, filters with known absorption characteristics could be chosen for the experiments.

III. RESULTS

(a) *Quantities of Insects and Spiders Attracted to Lights*

Insects and spiders tended to be more abundant around white and green lights than around orange lights. The weights of the catches around lights of constant colour intensity and location, however, varied greatly, presumably due to humidity,

temperature, wind, and other climatic factors. To compare the data for the catches of the various lights they were grouped for each night as follows:

(1) four runway lights (a-d) and the light trap at Tindal;

(2) two end-of-runway lights (e, f) and the light trap at Tindal;

(3) one white and three orange lights at Gungahlin; and

(4) one white and one ultraviolet light at Gungahlin.

Within each group the weights of the catches were converted by angular transformation to arcsin $\sqrt{}$ percentage of the total catch for the group. Comparisons of these conversions and conversion of the means back to percentages gave the following information:—

(1) Orange (Cinemoid No. 5) runway lights attracted 27-43 per cent. less insects and spiders than white runway lights at Tindal. This difference is significant at the 99 per cent. level according to Student's t-test.

(2) The catches of the light trap, the white runway lights, and the high- and low-intensity green end-of-runway lights at Tindal were not significantly different, although high green did catch more than low green.

(3) Orange (Cinemoid No. 5 and Kodak No. 22) lights attracted 48-81 per cent. less insects and spiders than white light at Gungahlin. These differences are significant at the 99 per cent. level. There were no significant differences in the attractiveness to insects and spiders of light filtered by Cinemoid No. 5 and Kodak No. 22.

(4) Orange (Pyrex) light attracted 92 per cent. less insects and spiders than white light, 60 per cent. fewer than orange (Kodak No. 22), and 61 per cent. less than orange (Cinemoid No. 5). These differences are significant at the 99 per cent. level and may be due to the relatively high intensity of the yellow band at about 590 m_μ in the emission spectrum of Pyrex orange.

(5) Ultraviolet light attracted 38 per cent. more insects and spiders than white light but this difference is only significant at the 90 per cent. level.

(b) *Kinds of Spiders and Insects Concentrated by Lights at Night*

There were no major qualitative differences in the occurrence of spiders and insects attracted by lights of different colour and green lights of different intensity.

(c) *Kinds of Insectivorous Birds and Bats that Frequent Australian Airfields*

Seed-eating birds, pigeons, parrots, and finches were present in large numbers around the airfield at Tindal, but spent little time on it because of the scarcity of vegetation and, consequently, of food for them. Nevertheless, it was visited at times by a wide variety and large numbers of insect-eating birds. Sometimes these birds came to feed on back-swimmers, Notonectidae, which landed at night on wet pavements including those of the runway, taxi-ways, and parking areas. Occasionally the birds came onto the airfield to feed on insects knocked out of the sky by a sudden tropical downpour. Usually they appeared to be feeding on insects and spiders concentrated by the airfield lighting at night and still present in the morning. Oriental dotterels and Australian pratincoles were seen feeding around the runway lighting at night. In the morning when the orange runway light filters were being changed and the insect and spider catches were being collected, these bird species were seen feeding on the runway; black kite, whistling kite, brown falcon, Oriental dotterel, Mongolian dotterel, greenshank, Australian pratincole, and black-faced woodswallow.

The average total daily weight (6 lb.) of all birds seen feeding on the runway at that time of day is of the same order of magnitude as the estimated weight (4 lb.) of the nightly average of insects and spiders concentrated around the runway and end-of-runway lights. This is more than ample food for these birds provided it is still accessible to them at that time. Not included in the weight of birds were the thousands of Oriental pratincoles which roosted at night on the airfield. These short-legged birds normally feed like swifts on the wing on flying insects at the edges of tropical cyclones. At night they roosted on areas devoid of vegetation, e.g., large clay pans and airfields. A few, not more than 20 Oriental pratincoles were seen during the morning feeding on the runway together with Australian pratincoles and Oriental dotterels. They appeared clumsy at foraging on the ground in comparison with the other two species which have much longer legs. The other insectivorous birds seen during the morning on the airfield probably also obtained most of their food elsewhere, but they were present in the area and could take advantage of any temporary source available to them on the airfield.

At Darwin, Townsville, Cairns, and Mackay aircraft have struck southern stone-curlews (av. wt. 1½ lb.) at night. The presence of these nocturnal and mainly insectivorous birds among those struck by aircraft and sent to Canberra for identification and autopsy provided the first clue that the airfield lighting might be providing food for at least some of the birds that are damaging aircraft.

It should be realized that some of the larger birds, besides feeding directly on spiders and insects around the lights, may also feed on some of the smaller insectivorous animals including frogs, lizards, snakes, and small birds which forage around the lights. For example, at Cairns, Townsville, and Mackay the introduced cane toad, *Bufo marinus*, is a major link in this food chain. Even large birds which are struck by aircraft can provide food for other birds. While the mantids and ants feed on other insects around the lights, they also provide, directly and indirectly, food for birds.

At night hundreds of little red flying foxes, *Pteropus scapulatus,* fly in long columns over the airfield at Tindal, but they do not stop because of the lack of fruit trees and flowering trees to feed in. Similar numbers of bats were heard hawking after insects over the runway lighting. Gould's wattled bat, *Chalinolobus gouldii,* has been struck by aircraft at Perth and at Alice Springs. It is also known to feed on flying insects around street lights at Canberra and elsewhere. At Tindal, the unpouched sheath-tailed bat, *Taphozous georgianus,* was found breeding in a cave on the airfield perimeter. This species also feeds on flying insects at night.

A wide variety of insectivorous birds is known to have been struck by aircraft in Australia. Each species eats only a selection of the varieties of insects and spiders that are attracted by airfield lighting. Collectively, however, they eat at least two-thirds of all these insects and spiders. There is a slight positive correlation between the occurrence of spiders and various taxa of insects found in airfield birds and bats and their occurrence in the catches around the airfield lights at Tindal.

IV. DISCUSSION

The experiments at Tindal were to explore on an airfield scale whether runway lights concentrate significant amounts of insects and spiders to be a major food source for birds and bats, and whether orange instead of white runway lights would be a practical means of reducing this food source. Birds and bats did seek to find food around the runway lights at Tindal, and presumably they also do so at other airfields when the weather is suitable.

Because Tindal airfield was still under construction it was the only airfield in Australia for the experiments and was available for only 20 days. Ideally there should have been white and orange lights only on the alternate nights; however, this could be done only with runway lights because the other airfield lights had to remain white, orange, or green as signal lights to permit aircraft to use the airfield in an emergency. There were also building lights near the airfield. In addition, on a completed airfield there would have been blue taxi-way lights and red warning lights. It was assumed that owing to the distances of these other lights from the runway lights, their effect on the amounts of insects and spiders concentrated around the runway lights was slight to negligible.

The siting of the white light trap at Tindal was not ideal, but it was the only location available with electricity as far away as possible from other lights. It was assumed that although it was in a different microclimate its catches were mainly affected by the same macroclimate as the airfield. Although the white light trap differed in design and location from the white runway lights its catches did not differ significantly in kind and quantity from those at the white runway lights. It thus provided a reference for comparing the catches of the airfield lights.

The experiments at Gungahlin were to select an orange filter which would concentrate the smallest number of spiders and insects. Ironically it was found to be the Pyrex orange runway light lens, which was in general use in Australia until about a decade ago when it was gradually replaced by a variety of white lenses in order to conform with recommendations of the International Civil Aviation Organization, which require that runway lighting must be white (I.C.A.O. 1964).

V. CONCLUSIONS

The insects and spiders which concentrate at night around white runway lights attract birds and bats into the flight path of aircraft and thus increase the risk of aircraft being damaged through striking these animals.

Orange lights concentrate fewer insects and spiders by weight than white lights of equal visibility to man. Therefore there are strong indications that, in the interest of aviation safety, the rationale behind the requirements for white runway lights should be re-examined and that there should be a further examination of the possibility of using orange runway lights which exclude wavelengths shorter than 530 m_{μ}.

Ultra violet and as much as possible of the short wavelength emissions of the spectrum should be excluded from white and coloured airfield lights.

DO PEOPLE CARE ABOUT CONSERVATION ?

A recent Gallup survey conducted for the National Wildlife Federation in the U.S. showed that most Americans *do care* about conservation.

The survey revealed that:

51 Per Cent of Americans are deeply concerned about deterioration of environment, 35 per cent somewhat concerned and 12 per cent not very concerned.

73 Per Cent are willing to pay additional taxes to improve natural surroundings, 51 per cent would pay $10 or more, 18 per cent around $50 and 4 per cent $100 or more.

75 Per Cent are in favour of setting aside more public land for conservation purposes; 19 per cent not in favour.

The survey also revealed that rural areas and small cities are considered the most pleasant places in which to live; air and water pollution were cited as the most pressing of conservation problems, and opinion seemed evenly divided on the possible necessity of limiting human population.

It would be most interesting to see a similar study conducted in Australia—perhaps sponsored by a National Conservation Body.

A.C.F. CASE STUDY OF COCKBURN SOUND

The Australian Conservation Foundation has produced a special publication titled "Conservation of Cockburn Sound", edited by an eminent marine biologist, Dr. R. G. Chittleborough, of Perth.

The publication concerns itself with the staggering problem of conservation of the Sound in a wide context. It deals separately with the competing demands on the area—industry, recreation, education and science—and is completely open in discussing the conflict which has developed.

In his foreword to the report, Sir Garfield Barwick, President of the A.C.F., raises some of the most significant points concerning the future of Cockburn Sound: "Cockburn Sound is of national conservation significance, not only because it is the only embayment of its kind along more than 700 nautical miles of our western coastline between Shark Bay and King George Sound, but because it is in close proximity to large and growing population centres." Elsewhere he goes on to say, ". . . an example of the complex problems, common overseas, but only now beginning to arise in this country . . ."

Sir Garfield concludes by expressing the hope that a solution to the problem of how best to achieve long term multiple uses of the area will be found after thorough investigation and consideration.

The main text of the publication reports on the physiography of the Sound, outlines what is known of its ecology and discusses present utilization and some of the problems to be faced.

Part 5 of the publication headed "Problems and Responsibilities" draws particular attention to those bodies responsible for the development of the Sound, for their failure to come to grips with the real problems—that is, of finding an acceptable solution to the competing demands on the area. The opening paragraph reads: "One striking aspect in the industrial exploitation of Cockburn Sound has been the failure of the State and Commonwealth Governments to seek advice upon the biological consequences of proposed devlopments."

A second point refers to negotiations between various companies and the Department of Industrial Development (made without reference to other Departments concerned), relating to the discharge of effluent into the Sound. An example is cited here ". . . the 'Industrial Lands (Kwinana) Agreement' allowing C.S.B.P. and Farmers Ltd. to pump up to 350 tons of calcium sulphate sludge per day into Cockburn Sound."

It is also pointed out that the planned causeway to Garden Island could increase the pollution problems within the area.

Another illustration of the problem in determining the Sound's future is found in the Cockburn Sound Conservation Committee, which consists mainly of a number of Shire and City Councils adjacent to the area.

The Terms of Reference of this Committee contain the following passage: "The Committee has no intention of exerting pressure to negate future development or to nullify Parliament's or the Department of Industrial Development's efforts to further industrial, commercial or other types of expansion."

Examples of tainted fish, high turbidity of water and other interesting revelations are also cited.

In its conclusions the Foundation's report recommended the setting up of a Planning Committee to be responsible for planning the overall development of Cockburn Sound and adjacent areas.

The report also recommends an ecological survey of the area and suggests rigid controls to prevent any deterioration in the Sound.

Copies of the publication are available at 50 cents each from the Director, Australia Conservation Foundation, 191 Royal Parade, Parkerville, Victoria, 3052, and from the University Bookshop, University of Western Australia, Crawley.

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(EDITOR.)

Continued from Page 7

Rehabilitation of conservation reserves is possible under some circumstances although the extent to which this could be done would vary with each case and would also depend on the amount of money and time available. However, rehabilitation of an area, which before alteration was for the purpose of preserving primitive bushland, would be of limited value. It must be emphasised that any attempt at restoration or rehabilitation would be a long term process. In my opinion and that of my advisers the minimum time for results to be assessed would be 20 years and a time of 6 or 7 decades would be more likely. For a mining venture of limited life or uncertain future such restoration work would be difficult to guarantee.

2. OTHER LAND

The principles outlined above would also apply to other types of land where natural bushland is desirable. Where the aim is to grow a standing crop, e.g., cereals, pasture or timber, rehabilitation only may be desired; complete restoration would not be necessary. This rehabilitation will be possible only if the mined material is not the actual substrata on which the plants depend, i.e., if the overburden is put back.

3. GENERAL

If a decision is made to mine a conservation area, rehabilitation of the area should be included as a condition of each mining tenement granted. This rehabilitation process should be a cost against the holder of the mining tenement and be under the supervision either of the body controlling the reserve or any other person nominated by that body. Included in the rehabilitation costs would be those of the person or persons supervising the rehabilitation work. As stated in the Department's submission in relation to Item (1) (d), the expenses likely to be involved in the rehabilitation process should be guaranteed by the provision of a suitable bond and surety.

Item (1) (h)—Compensation

It is not possible to place an accurate figure on the value of conservation reserves as a resource. The basic reason is that these reserves are areas set aside to ensure adequate space for future generations of tourists and scientists. Our knowledge of living things is extremely limited at this time and we cannot assess now what possible values may be discovered in the future, e.g., insects may be used for biological control of agricultural pests or chemicals may be found in plants which are of great medical or industrial value. Thus the cost of destroying such a resource will compound in time.

If a decision is made to mine a conservation area, a bond should be determined guaranteeing rehabilitation of the area at the conclusion of, or during the process of, the mining project. In addition, compensation to the State should be considered, taking into account the following:—

1. The nature of the scientific research being undertaken, and the value of the area as a research site.
2. Fish and wildlife production values; commercial, sporting and tourist.
3. Recreation value and loss of revenue as a tourist area.
4. Management practices—fencing, firebreaks, roads, wildlife management and habitat management, and policing of conservation laws.

Item (1) (i)—The manner in which applications for mining tenements, rights and licenses are dealt with and whether and if so what improvements are considered necessary.

The need for a change in the manner of dealing with applications to mine conservation reserves has been dealt with to some extent in my submissions on Items (1) (b) [see page 23], and (1) (d).

In order that a proper decision can be made, either by the body controlling the reserve or the proposed tribunal, further information is necessary. It is submitted that the applicant should provide information with his application as outlined in the submission on Item (1) (d). In addition the applicant should provide information on steps he proposes to take to rehabilitate the mined land and an estimate of the cost of this work.

At the moment the Department of Fisheries and Fauna can only obtain information on the pegging of reserves in time to lodge an objection by checking newspaper advertisements. Often the advertisement is published in a newspaper which is not readily available in Perth or the details of the location of the claim are too vague for it to be plotted. In order to overcome this, the Department believes that the applicant should serve a copy of his application for an Authority to Mine on the authority controlling the reserve, within 48 hours of lodging with the Mines Department.

The submission on Item (1) (d) outlines the manner in which detailed information and expert advice should be made available to the proposed Tribunal considering applications relating to reserves. This requirement is made in light of the present situation whereby a Warden receives one serves. The requirement is made in light of the question whether mining might cause injury or obstruction to the enjoyment of the reserved land. While such a person may be competent to judge this from a mining point of view, it is doubtful whether he has the ability to judge this value of the reserve or the possible damage from a conservation point of view. The Department submits therefore that when a conservation reserve is being examined the tribunal (or warden) should

also instruct some other competent person to evaluate the area with respect to its purpose and report on the possible effects of mining from a conservational aspect.

SUBMISSION TO THE COMMITTEE BY A. R. MAIN

Item (1) (d)—Prospecting and Mining on Reserves

There are numerous sorts of reserves in Western Australia which have been set aside for public purposes under the Land Act. These include temporary reserves, native reserves and reserves for water, recreation, camping, cemeteries, landing grounds, etc. But because the need for national parks and fauna and flora reserves was appreciated most recently, there has not been a prolonged development of reservation for these purposes. Even now [September 30th, 1970] National Parks and Fauna Reserves only total about 3.5 and 12.0 million acres respectively of the 80 million acres of reserves.

In 1959-60-61, the Australian Academy of Science, realising that reservations for fauna and flora and national parks were lagging behind the need of the Australian community for such reserves, set up in each State a subcommittee which was to plan components for a series of reservations on a national (i.e. Australia-wide) scale. The report on the Western Australian subcommittee, of which I was a member, was issued in 1961. It can be seen in its Australia-wide context in the report of the National Academy of Science Committee which was published in 1968.

The aim of the Western Australian subcommittee (and the national committee) was to put forward a proposal for a system of reserves which was to be (i) representative and (ii) adequate and (iii) secure. The concepts underlying these criteria are set out as follows:—

(i) (a) A system of reserves may be said to be biologically representative, when all the different sorts of country, different plant associations and different animal assemblages characteristic of the different rainfall and other regimes of the country are represented. The Western Australian subcommittee of the Australian Academy of Science attempted to select just such a representative set of reserves which, if preserved in perpetuity, would provide conditions which would ensure the preservation of representatives of all the principal kinds of native biota in W.A.; that is the communities of plants and animals which occur naturally in the country. But, since the wider public need for the utilisation of such areas was also taken into account (i.e., where possible their use as National Parks was planned for) scenic attractions typical of the various landforms were also included.

In making the proposals for the reserve system the Committee incorporated as many existing reserves as possible but, in some cases, other areas of vacant crown land were proposed for reservation; and in many cases recommendations were made for an up-grading of the degree of security of existing reserves to Class A with the intention that these were to remain inviolate for that public purpose except by decision through an Act of Parliament.

In recent years the reserves proposed by the Academy subcommittee have been reviewed by the government appointed Reserves Advisory Council, of which I was also a member. Recommendations concerning most reserves made by the Academy subcommittee have now gone forward to the Minister for Lands to have them created Class A and registered in one or other of the two principal authorities charged with the management of reserves in W.A. (i.e., The National Parks Board and the W.A. Wild Life Authority).

(b) In addition to the general pattern of current animal and plant distributions which is catered for by a system of reserves set up under the above criteria, there is another class of natural distributions which must also be included if the reserve system is to be fully representative. These are the unique assemblages of plants or animals which occur in small pockets beyond their normal ranges. These are the greatest scientific interest for genetic studies and for the clarification of evolutionary problems. Such populations are often genetically unique. Examples of them in W.A. are those species associated with granite outcrops, or those occurring on soils different from the heavily leached soils commonly in W.A. because of a content of heavy metals which are usually toxic, or those occurring on small isolated mountains along the south coast, or in deep gorges in desert ranges.

When reviewing the report of the Academy subcommittee it must be remembered that eight years have elapsed since its proposals were made. Knowledge of the distribution of these unique assemblages was much less complete then than it is today

and, while the general system of reserves proposed in it to be representative of the principal natural distributions was very complete, our knowledge of the scientifically unique distributions was much less complete then than it is today. As a consequence, numbers of such small areas, not contained within the Academy report, would be regarded as worthy of inclusion.

The small size of these unique assemblages renders them extremely susceptible to disturbance, and management procedures to preserve them must be critical.

(ii) The adequacy of a reserve system refers not only to the extent which it is representative but to the capacity of individual reserves to retain the biotas which they are set up to preserve. It must be recognised that the separate Australian faunas and floras are part of a wider continental fauna which, because of its vast size provides a buffer against local fluctuations and catastrophies. Once a reserve is set up and the country about it developed for some other purpose the biota within it is liable to become downgraded in its composition by the loss of various elements unless it is big enough and it is managed properly.

There is no theoretical knowledge anywhere in Australia, or elsewhere in the world for that matter, which gives an easy guide as to how the size of a reserve may be determined when it is selected. In order to overcome this deficiency in W.A., Main has studied the composition of the fauna (and in particular the faunas containing species of the kangaroo family) on islands around Western Australia, treating them as naturally isolated populations which might be regarded as natural reserves which have stood the test of time. A relationship was established between the sizes of islands and the diversity of the faunas contained within them (Main 1961) and subsequent studies have been made of various islands including Barrow Island (one of the largest offshore islands of the Western Australian coast). These studies have been supplemented by intensive research at the Tuttanning Reserve, east of Pingelly, W.A.

When we look at the information derived from the islands, it is clear that adequacy must be measured in terms of whether the environment provides shelter and food for the species which it contains. The general conclusions on this study have been presented in a paper sent to the journal "Biological Conservation" and now in press.

Briefly the findings show:

1. Different species of plants require different conditions. These may be:
   (a) different soils and climate;
   (d) different history of burning;
   (c) protection from burning.
2. The needs of animals may be thought of in terms of both food and shelter; these may or may not be found in the same plant association, most commonly they are not and shelter may often be found years after a burn or in unburnt country while food is in recently burnt areas (say within 2-3 years). Animals tend to be in higher density along contact zones of areas of different soils or fire histories.

Under natural conditions regeneration occurs following infrequent wildfires. These are destructive but without them at the appropriate interval plant and animal diversity is lost. From management studies at Tuttanning Reserve near Pingelly it appears that naturally the complete diversity of plants and animals cannot be retained within a reserve unless it contains areas of both burnt and unburnt country. Moreover, the burnt areas should range in age from recently burnt to those burnt up to 20 years previously. A further finding from this work is that not only are some animals restricted to plant stands of specific ages but many also occur in low densities, e.g., from 1 per 50-70 acres to 3 or 4 per square mile. A final complication is that the minimal population for survival of some macropods appears to be between 200-300 animals. Consequently should they prefer plant stands of a specific age after fire and occur in low densities it follows that extensive areas are required in order even to retain the minimum population.

The nectar-eating birds also require extensive areas, for not only is the mallee burnt by fire but flowering of unburnt stands depends on seasonal rainfall which in marginal areas can be quite erratic.

(iii) Brief mention of the action of the Academy of Science sub-committee with respect to security has been made under item (i) (a) [p. 20] and of the subsequent review and recommendations by the Government-appointed Reserves Advisory Council.

The reason for this is self-evident because if there is any justification in setting aside a representative system of reserves to conserve fauna and flora as a public purpose in the public interest then there must be some means of securing these reserves against alienation unless it can be judged by the public to be in the greater public interest that they should be converted to some other purpose. Under the Land Act the securing of this public purpose is achieved through classification of the land as being of Class A and making it subject to alienation *only* by Act of Parliament. Under the Mining Act the public purpose is secured under Section 267A which does not confer the same degree of security. We would recommend that alienation from the public purpose under the Mining Act should also require an Act of Parliament.

During the course of 1969-70 the International Biological Programme (I.B.P.) has initiated a study of national parks and reserve systems throughout the world. This has been a result of the world-wide appreciation of the need for representative, adequate and secure parks and one section of the I.B.P. programme (Section C.T.) has been devoted to selecting and documenting such a system at the international level. In Western Australia the system of parks and reserves recommended by the Australian Academy of Science sub-committee is judged to meet the stringent standards of the I.B.P. together with certain other areas containing specialized and unique faunas and floras which have been discovered and evaluated since that time. The international recognition of the importance of these areas is a significant step in increasing awareness of the need for added security because they are not only set aside in the interests of the people of W.A. but fulfil a much wider need. It should be noted that at the time that the Western Australian system of representative reserves was selected, geological exploration and mining activity had proceeded on the Western Australian shield for at least 60 years. Moreover, the pastoral industry had been in existence for almost 100 years and the agricultural industry on the western boundaries of the arid part of the shield had been extending rapidly in the last 30 years. The foregoing conditions meant that when selecting for an adequate and representative park system the Australian Academy sub-committee was precluded from selecting those areas where agriculture, mining or pastoral activities had already changed the natural state of things. The sub-committee decided that these considerations would not lead to an unrepresentative reserve system if the reserves selected were designed to take into account transition areas, e.g., between agricultural and pastoral situations or between moister and more arid areas. Thus a series of reserves was finally chosen, each reserve being an integral part of a whole system and each reserve representing a unique association of transition zones. In doing this the Committee was conscious of the fact that its choice was a most economical one in terms of areas involved and least disturbing to the already established industries. However, with additional knowledge and experience it is clear that the above desire left the proposed system of reservations with an under-representation of certain types of area notably the riverine plains, e.g., of the Fitzroy in the Kimberleys and others such as the Ashburton and DeGrey in the Pilbara.

The Committee was one which included not only some of the leading biologists in the State but also senior foresters, geologists and administrators of land; its findings have been endorsed by the Government-appointed Reserves Advisory Council which includes the administrative and professional heads of Government departments involved in the use of land as well as representatives of the Shires. Accordingly it can be seen from the description which is given in this submission of the procedures under which the land was selected, and the rigorous examination of the allocation of land for public purpose which the reserves of the system have subsequently had, that the areas selected, and the land involved, were not chosen frivolously. It must follow that the public purpose must not be lightly set aside by a single sectional interest.

Subsequent to the formulation of the proposal for the system, mining

has undergone a great expansion and now involves minerals which were not formerly considered economic in Western Australia. Nevertheless, most of the recent discoveries have been in the already known mining region, e.g., the area broadly including Norseman, Kalgoorlie and Laverton. No extensive reserves have been proposed in these areas. However, to the west of these areas proposed reservations crossing climatic and floral transition zones have been involved in hearings in the Wardens' Courts. It is perhaps unwise to extrapolate from the gold mining industry but it should be noted that the western areas have never produced extensive and lasting ore bodies as has the Kalgoorlie region.

(1) (e)—Mining in Relation to Conservation, Ecology, Preservation of the Balance of Nature and Preservation of the Environment.

In this regard mining can be at two levels, (A) the exploratory phase and (B) actual mining operations. (A) Depending on the nature of the exploration, i.e., whether extensive exposures are necessary, exploration need not be damaging. However, once money has been spent on exploration it is very difficult to justify depriving the explorers of an opportunity of recouping their money by actual mining. However, the dilemma that the administrator must face is that if the public interest is to be continually evaluated so that Parliament may, from time to time, make appropriate decisions it should be possible for mining, or any other sectional interest, to make a case to the Parliament for a re-evaluation of the use of land in reserves.

In connection with the iron mining industry it should be noted that the Hamersley National Park actually included some of the iron mining areas of the Pilbara. However, the conservational aspects of this region have been included in the Barlee Range Nature Reserve.

(B) Once mining commences it can be looked at in two ways: (1) that mining which is **intensive,** e.g., deep shafts, oil wells and so forth, where the only disturbance is localised and along access ways, or (2) that mining, e.g., open cut, quarrying or beach sand mining which is **extensive** and highly destructive and which will tend to increase its effects over a great number of years. Extensive mining in the sense used above is not compatible with any conservation which requires the retention of the natural relation between soil, plant and animals. Extensive mining not only affects the balance of nature but it can also affect the environment by changing water tables, altering drainage patterns or damming and polluting rivers. The by-products of mining activity might also be included here, for example, what might be expected adjacent to nickel or iron processing plants is illustrated in a series of papers by Gorham and Gordon in the Canadian Journal of Botany (references below).

Gorham, E., and A. C. Gordon (1960). Some effects of smelter pollution north-east of Falconbridge, Ontario. Canadian Journal of Botany 38: 307-312.

Gorham, E., and A. C. Gordon (1960). The influence of smelter fumes upon the chemical composition of lake waters near Sudbury, Ontario, and upon the surrounding vegetation. Canadian Journal of Botany 38: 477-487.

Gorham, E., and A. C. Gordon (1963). Some effects of smelter pollution upon aquatic vegetation near Sudbury, Ontario. Canadian Journal of Botany 41: 371-378.

Gordon, A. C., and E. Gorham (1963). Ecological aspects of air pollution from an iron-sintering plant at Wawa, Ontario. Canadian Journal of Botany 4: 1063-1078.

The foregoing really affects the preservation of the environment as well as conservation in the strict sense.

Submission by Dept. - Should be Directors' submissions on P4

Item (1) (b)—Whether any new forms of Mining Tenements, Rights and Licenses are necessary.

There are many types of reserves in Western Australia, such as reserves for water, camping, recreation, cemeteries, landing grounds, natives, stock routes, public utility and various conservation purposes. Of these the need for reserves for national parks and conservation of flora and fauna was appreciated most recently, and the problems of mining such areas raises most controversy. At the moment there is one method of dealing with applications for all reserves irrespective of the complexity of the situation.

I submit, therefore, that there should be a special license and manner of dealing with applications to mine conservations reserves. The application could be called an "Application for Authority to Mine a Conservation Reserve"

The reasons for the need of such a special system and the manner of dealing with such a system—is given in the submissions on Items (1) (d) and (1) (i).

Item (1) (g)—Rehabilitation and Restoration of Land affected by Mining Activities

Rehabilitation after extensive mining, e.g., open cast coal mining, bauxite mining, beach sand mining, is to be looked upon as a horticultural exercise. Country can be made to look less scarred than if nothing were done. However, one cannot view rehabilitation as in any way replacing the complex biotic factors which existed before the advent of mining. The reason for this is that plants require long successional stages to be passed through before the full assemblage (so-called climax phase) is reached and it is always the climax phase which is destroyed at the start of extensive mining operations. To use an analogy, one can talk about rehabilitating the victim of a road accident; nevertheless if an accident makes a man a paraplegic no amount of rehabilitation will allow him to use his legs; rehabilitation will not restore the whole man.

The Director,
Chief Warden of Fauna
and Staff of the

Department of Fisheries and Fauna

extend Best Wishes for Christmas
and the New Year.

Special thanks are expressed to all Honorary Fauna Wardens and other helpers who, throughout 1970, have assisted and contributed towards a better understanding and appreciation of wildlife and conservation.

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