



DEPARTMENT OF
FISHERIES AND WILDLIFE
WESTERN AUSTRALIA

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WILDLIFE MANAGEMENT PROGRAMME No. 1

Published by the Director of Fisheries and Wildlife, Perth,
under the authority of the Hon. Minister for Fisheries and Wildlife

Kangaroo Management in Western Australia 1984

PERTH
WESTERN AUSTRALIA

BY
I. G. CROOK
AND
R. I. T. PRINCE

1984

WESTERN AUSTRALIAN WILDLIFE MANAGEMENT PROGRAMME NO. 1

KANGAROO MANAGEMENT IN WESTERN AUSTRALIA 1984

BY

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1984

ISBN 0 7244 9316 6

ISSN 0813 8869

FOREWORD

In 1980 the Western Australian Department of Fisheries and Wildlife established a publication series entitled "Western Australian Nature Reserve Management Plans". The series consists of authored papers intended to document and facilitate public contribution to management programmes for Nature Reserves in the State. Public interest in this series has encouraged extension of the idea to the documentation of management programmes for wildlife species, the objective being to provide a focus for public contribution to wildlife management policy and practice in the State. "Kangaroo Management in Western Australia 1984" is the first publication in this new series, which has been titled "Western Australian Wildlife Management Programmes".

In the case of the management planning process for Nature Reserves, publication of plans follows a sequence from their draft to their final form, which stand in that form for a period less than or equal to the maximum laid down by Statute, i.e. 10 years. Public comment is invited, formally, as part of the draft stages. For "wildlife management programmes" this format may not always be followed. In the present case, for example, the kangaroo management programmes are ongoing and subject to regular review. Interested parties contribute to the programmes on a regular basis or as required and the programmes are subject to change, in shape and detail, on the same basis. This first publication in the "Western Australian Wildlife Management Programme" series, therefore, documents the existing kangaroo management programmes as at May 1984.

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ACKNOWLEDGEMENTS

The following documentation of kangaroo management in Western Australia is a summary of these particular management programmes to which many people have contributed in the 13 years of their development. These include the Director of the Department, the three Conservators of Wildlife who have served during the period, the Administrative Officer and a number of research officers under the leadership of Dr A. A. Burbidge, the Chief Research Officer.

Outside of departmental officers the list grows. Major contributions have been made by officers of the Department of Agriculture, officers and members of the Agriculture Protection Board, members of the Department's Kangaroo Management Advisory Committee, the Pastoralists and Graziers Association, the Pastoral Section of the Primary Industry Association and representatives of the kangaroo industry. Conservation groups have played their important part; Western Australian, national and international bodies have maintained an active interest in the management programmes, especially in recent years.

All these individuals and groups have contributed to the programmes, which is as it should and should continue to be.

**KANGAROO* MANAGEMENT IN
WESTERN AUSTRALIA
1984**

1. PREAMBLE

The following account is a general statement intended for public information of the basis, objectives and mechanisms of the Western Australian kangaroo management programmes, similar to and updating that of Shugg and Prince (1973). It does not purport to present a rigorous account of kangaroo populations and their distributions or to document in any exhaustive way the evidence accumulated in the 13 years of their operation of the effects of the management programmes on kangaroo populations. These latter purposes are served by two papers by Dr R.I.T. Prince of the Western Australian Wildlife Research Centre, which are currently in preparation (Prince, in prep a & b).

2. RESPONSIBLE ORGANISATION AND STATUTORY BASIS

Kangaroo management in Western Australia is administered by the Department of Fisheries and Wildlife, according to the provisions of the State's Wildlife Conservation Act (1950, as amended) and Regulations.

*In the context of this paper the term "kangaroo" is defined as follows: Members of the macropod family which may be "taken" for the purpose of controlling their populations and rates of natural increase (e.g. in the case of red kangaroos in pastoral rangelands) or to mitigate damage to property, agricultural crops and pastoral rangelands, by virtue of the provisions of Section 14(2)(a) (open seasons) or Section 15(1) and Regulation 5 (damage licenses) of the State's Wildlife Conservation Act and Regulations.

3. SPECIES

The species to which the management programmes refer are those which may be taken by virtue of provisions of the Wildlife Conservation Act for the purposes of controlling their populations and rates of natural increase (in the case of red kangaroos in rangeland areas) or in mitigation of direct damage that they may cause to agricultural or pastoral production.

Three species of kangaroo fall into this category, viz:

Red kangaroo	<i>Macropus rufus</i>
Western grey kangaroo	<i>Macropus fuliginosus</i>
Euro	<i>Macropus robustus</i>

4. ORIGINS AND OBJECTIVES OF THE PRESENT REGIMEN OF KANGAROO MANAGEMENT

4.1 RED KANGAROO AND EURO

The foundation for the present programme of management of the red kangaroo and euro was established in 1970 by the Minister for Fisheries and Wildlife under the provisions of Section 14 of the State Wildlife Conservation Act by notice in the Government Gazette of 17 April of that year.

The notice permits red kangaroos and euros on pastoral leasehold and private lands in the Local Authority areas in the Schedule attached thereto to be taken by the owners or lessees of the land concerned. Where the animals taken are used for commercial purposes, this is subject to the licensing and tagging provisions of the Wildlife Conservation Regulations and such constraints of management as may be applied from time to time.

The management programme was instituted in February 1971. It is based on the principles and guidelines for controlled, commercially-based harvesting principally of red kangaroos on pastoral leasehold lands, set down in the first instance by Arnold (1970) in his unpublished paper "Control of the Kangaroo Industry in Western Australia". The programme was first formally documented by Shugg and Prince (1973) in accordance with recommendations of the Ministerial Working Party on Kangaroos set up by the respective State and Commonwealth Government Ministers at their meeting in Melbourne on 9 March 1973.

The legal basis of the programme has been modified in some of its details by Government Gazette notice on a number of occasions, most recently on 21 November 1980.

Referring to the red kangaroo, which species is harvested in by far the larger numbers of the two (red kangaroo and euro), the objectives of the programme were stated by Arnold (1970) to be as follows:

- "1. To conserve the red kangaroo so that there is always a substantial population in the State and to keep stocks below pest proportions.
2. To allow the red kangaroo populations to be rationally exploited."

This statement of objectives, with minor changes in wording, has remained current throughout the life of the management programme.

In summary, the programme instituted in 1970-71 arose from the dual need to control populations, so as to limit damage to pastures and crops, and to limit the consequent exploitation of kangaroo populations within biologically sound limits.

During the period 1960-65 the then unregulated kangaroo pet meat and allied dry skins trade in Western Australia may have caused a peak harvesting rate of 100,000 - 150,000 animals of all species, red, euro and western grey kangaroo combined, in any one year.

Exploitation of this kind, of kangaroos of each of the three species now subject to commercialisation, is a long one dating back to the early years of European settlement of Western Australia. Its history is in process of documentation in considerable detail by Prince (in prep. (a)). Based initially on production of skins for export and latterly on a combination of skin and pet meat production, Prince's study suggests that this exploitation has done little to harm the conservation status of the wild populations involved. In this context "conservation status" refers to the long-term stability of distribution and populations.

After 1965, and particularly in the final three years of that decade, however, the pet meat/skin industry expanded and became more heavily dependent on red kangaroos. Hitherto grey kangaroos and a few euros were taken, the take of the latter always being very small because of its hilly and inaccessible habitat. Trade in red kangaroo carcasses and skins by local dealers for the period 1967-1970 was:

1967	175,000
1968	175,000
1969	400,000
1970	275,000

The 1969 take, in particular, was considered too large for the population to sustain. It lead directly to the institution of the 1970/71 controlled management programme.

At the time of formulation of the control programme (April 1970) the population of red kangaroos was estimated to be "... between one and two million animals probably in the lower margin of the range - one to one and a half million" (Arnold 1970). For the initial year of the management programme (1971) a harvest quota of 225,000 was set. A total of 173,000 was taken.

The population of euros was not estimated, nor a quota applied, the management programme for this species being based on two premises:

Firstly, that the inaccessibility of its habitat is, in itself, sufficient protection against excessive harvesting; and

Secondly, that the study of euros by Ealey (1967), which suggested the presence of a population of 400,000 animals in the Pilbara alone, and the presence of substantial populations in extensive highland Nature Reserves and National Parks in the euro's range, assured its security in the face of the minimal harvesting levels pertaining at the time.

This situation continues. Euros are shot only when their incursions into areas of favoured sheep rangelands cause damage. They are rarely taken in significant numbers and then only in response to specific rangeland damage situations.

4.2 WESTERN GREY KANGAROO

The present grey kangaroo* management programme was instituted in 1971 by the Minister for Fisheries and Wildlife under the provisions of Section 14 of the Wildlife Conservation Act by notice published in the Government Gazette of 23 July of that year. The programme was first fully documented by Shugg and Prince (1973) in accordance with the recommendations of the Ministerial Working Party on Kangaroos set up by the respective State and Commonwealth Government Ministers at their meeting in Melbourne on 9 March 1973.

The grey kangaroo management programme, based on the declaration of open seasons on the shooting of grey kangaroos by landowners on private land in certain Local Authority areas, has subsequently been extended to include private lands in Local Authority areas specified in the Schedule to the notice published in the Government Gazette of 21 November 1980. The open season provision supplements a system for issue of "Damage Licenses" permitted under Section 15 of the Act and Regulation 5. The latter continues in Shires not covered by the open season provision.

The difference between the red kangaroo management programme on the one hand and the grey kangaroo management programme on the other is that the latter was designed fundamentally to facilitate damage control, its purpose being to permit landowners to control grey kangaroos which are on their properties and which are perceived to be disadvantaging agricultural production by their grazing of pastures and crops.

In a few areas, notably in recently developed pastoral leasehold land on the Nullarbor Plain, where the ranges of red and grey kangaroos overlap, the latter are taken by licensed, professional kangaroo shooters under the authority of damage licenses. This take is subject to tagging, licensing and quota controls similar to those applying to the red kangaroo and euro. In other areas landowners may also acquire damage licenses and tags, so permitting carcasses of animals to enter the processing trade.

*In all cases "grey kangaroo" refers to the Western Grey Kangaroo, M. fuliginosus.

Approximately 40 percent of the original range of the grey kangaroo lies within that part of the State which has been developed for intensive agricultural production. Much habitat in this area has been affected by clearing. Grey kangaroos persist in bushland "islands" and margins, however, from which their incursions onto farmlands are frequently perceived as damaging to the interests of landowners.

The basic aim of the grey kangaroo management programme is to maintain as high a population of the species as possible, not only in areas where its habitat is secure, such as in extensive areas of State Forests, National Parks and Nature Reserves within its range, but also in uncleared privately-owned land (Shugg and Prince 1973) and on the margins of intensively farmed lands. The philosophy behind this programme is identical to that proposed by the Australian Conservation Foundation (Ratcliffe 1970) in its Occasional Publication No. 4 in which the A.C.F. recommended that "Kangaroos should be allowed to survive at above rarity level, but at a lower density than would cause justifiable anxiety to graziers - *and not as a continually hunted and harried population.*"

By minimising restrictions on the way farmers may manage grey kangaroos on their own land, and at the same time encouraging tolerance of the presence of kangaroos, the programme has aimed to assist the establishment of a stable, lasting relationship between land-use and wildlife-values in the agricultural areas of the State.

5 FORMAL STATEMENT OF THE AIMS OF THE KANGAROO MANAGEMENT PROGRAMS

The objectives of kangaroo management in Australia as recorded in the Australian Government submission to the United States Fisheries and Wildlife Service hearings on entry of kangaroo products are as follows:

"- To maintain kangaroo populations of all species over their natural range;

To contain their harmful effects on sheep and cattle ranching and agricultural production; and

- Where commercial culling is conducted, to avoid unnecessary wastage of

the meat and skins of kangaroos taken in the management programmes."

The Draft National Kangaroo Management Programme (N.K.M.P.) gives the "Aims of Kangaroo Management"* (p. 3) to be:

"...to maintain populations of the designated species of Macropodidae over their natural ranges; and

contain the effects of kangaroos on other land management practices".

For the sake of conformity this wording has been adopted as a formal statement of the objectives of the Western Australian kangaroo management programmes, noting that the sense of the statement is nearly identical to that of the objectives laid down by Arnold (1970) specifically for the present management programme for the red kangaroo in this State.

6. OBJECTIVES OF THIS PAPER

The objectives of this paper are as follows:

1. To re-document the Western Australian kangaroo management programmes according to the guidelines set out in N.K.M.P. to which it is an annex, re-stating and, where necessary, updating the 1973 documentation of the programmes by Shugg and Prince (1973).
2. To demonstrate that the continuing Western Australian Kangaroo Management Programmes (1970/71 as amended) conform to guidelines laid down in the N.K.M.P. and are management programmes suitable for approval by the Commonwealth Minister for Home Affairs and Environment for the purposes of sub-section 10(2) of the Wildlife Protection (Control of Exports and Imports) Act.

*To be modified in the light of any changes to the final wording of the National Kangaroo Management Programme agreed by CONCOM.

The description of the Western Australian kangaroo management programmes below, follows that suggested in Section 3 (Implementation) of PART A of the N.K.M.P., dealing in order, with information under the headings;

- Effects of land-use on kangaroo habitats and populations;
- Assessment of population trends;
- Determination of culling levels; and
- Management procedures.

7. DISTRIBUTION OF KANGAROOS AND THE EFFECTS OF LAND-USE ON KANGAROO HABITAT AND POPULATIONS

7.1 GENERAL CONSIDERATIONS

Unlike the vast majority of medium to larger-sized (i.e. those in the 50 g - 5 kg class and larger) marsupials in Western Australia, many of which are extinct, near-extinct or seriously reduced in range and numbers since European settlement (Burbidge and McKenzie, unpublished data presented at ANZAAS, 1983), the distributions and populations of the kangaroos which are the subject of this paper have suffered little, and in some cases, no reduction in the same period (Prince in prep. (a)). On the contrary it is apparent that, like a few other notable members of the State's fauna, such as the silver gull, some honeyeaters and the brush-tailed possum in urban and near urban areas, the red kangaroo in particular has adapted remarkably well to European styles of rural land use. The impact of European land use on the grey kangaroo and euro populations has been less uniform, but these species too have fared remarkably well.

In this connection it should be noted that, even in areas classified in this programme as "Type e" with respect to their usefulness as natural habitat to kangaroos according to the N.K.M.P. guidelines, i.e. areas where the "...habitat has been altered to the extent that it is no longer suitable...", kangaroo populations frequently persist.

This apparent paradox is best explained by example. The Metropolitan Area of Perth, the capital of Western Australia, can only fairly be described as being "Type e" (i.e. unsuitable habitat) according to the broad classification intended in the N.K.M.P. guidelines. Within this area, however, in Nature Reserves, other local reserves and residual blocks of undeveloped privately owned land, populations of the grey kangaroo persist. The same cannot be said for many other marsupial species native to the area prior to European settlement. Further, it is pleasing to note that, in some areas, these metropolitan populations of grey kangaroos are increasingly coming to the attention and are enjoying the protection of their human neighbours. Whether they will persist remains to be seen, but their continued existence in small reserves attests to their adaptability and their potential as a continuing element of the fauna.

Turning to the agricultural areas, 16,000,000 ha or thereabouts of land in the higher rainfall, south-western part of the State has been cleared for farming, mainly in the last 75 years. This land also has been rendered "Type e" according to the N.K.M.P. guidelines, and represents a large part of the original range of the grey kangaroo. It is the one significant area in the State where land-use has markedly disadvantaged the kangaroo. But even here populations of grey kangaroos persist in bushland remnants and Nature Reserves.

In all other areas of Western Australia, a large State five times the size of Texas and one third the size of the entire United States, the occurrence and abundance of kangaroos have been at least unaffected and in some areas advantaged by human land-use.

What follows is documentation of a management programme which has been in operation in Western Australia for a period of 13 years and which has demonstrated its effectiveness in terms of its objectives in that time. Writing as members of a community whose primary interest is the conservation of wildlife in all its forms, we would add a personal footnote to this introduction: Would that the rest of our fauna in Western Australia and elsewhere could be as well-served by all forms of human attention, from the use of their habitat through the management of their populations to the vigilant oversight of their interest by animal welfare and conservation movements as are the larger kangaroos.

7.2 RED KANGAROO

Red kangaroos occur in varying density over a range which occupies approximately 75 percent of the State, that is, an area of approximately 1,900,000 km². Figure 1 shows the range of red kangaroos in Western Australia in relation to land use. There follows a description of that range in terms laid down in the guidelines of the N.K.M.P.

- a. Area where habitat is relatively unaltered and the species' populations have been largely unaffected:

Nearly half of the range of the red kangaroo (900,000 km²) is too arid to support any pastoral and agricultural activities. Consequently, it has been relatively unchanged by European man. The occurrence of red kangaroos in this area is widespread and the population naturally sparse for the most part.

- b. Area where it is expected that (a) will continue:

There is no likelihood of the status of the above part of the range of the red kangaroo changing in the foreseeable future.

- c. Area where future major habitat changes are likely to occur.

No major changes can be anticipated in the foreseeable future over most of the range of the red kangaroo. Minor changes in land use on the south western and southern limits of the range are possible.

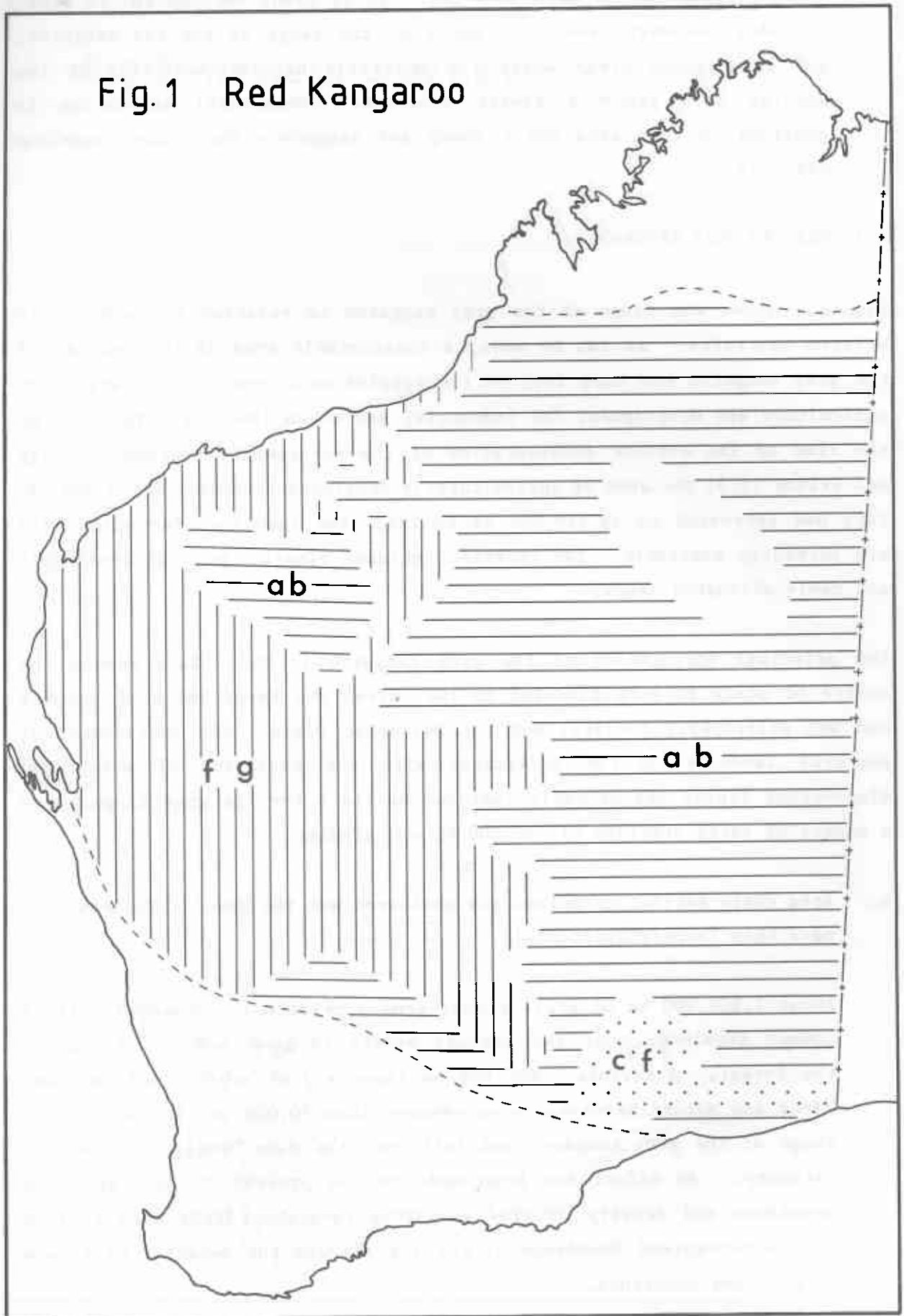
- d. and e. Area where habitat has been altered and species populations have been significantly reduced; and area where habitat has been altered to the extent that it is no longer suitable.

No significant area.

- f. and g. Area where current land use has improved the habitat and where land uses are adversely affected by the designated species.

This area largely corresponds to the shrubland pastoral areas in the southern half of the State (Jennings et al. 1979, Fig. 4) where

Fig.1 Red Kangaroo



sheep-grazing is the main land-use. It is about 600,000 km² in area, includes the most favourable parts of the range of the red kangaroo, and encompasses areas where the naturally highest densities of the species have probably always occurred. Commercial harvesting is confined to this area where sheep and kangaroos share the rangeland pastures.

7.3 WESTERN GREY KANGAROO

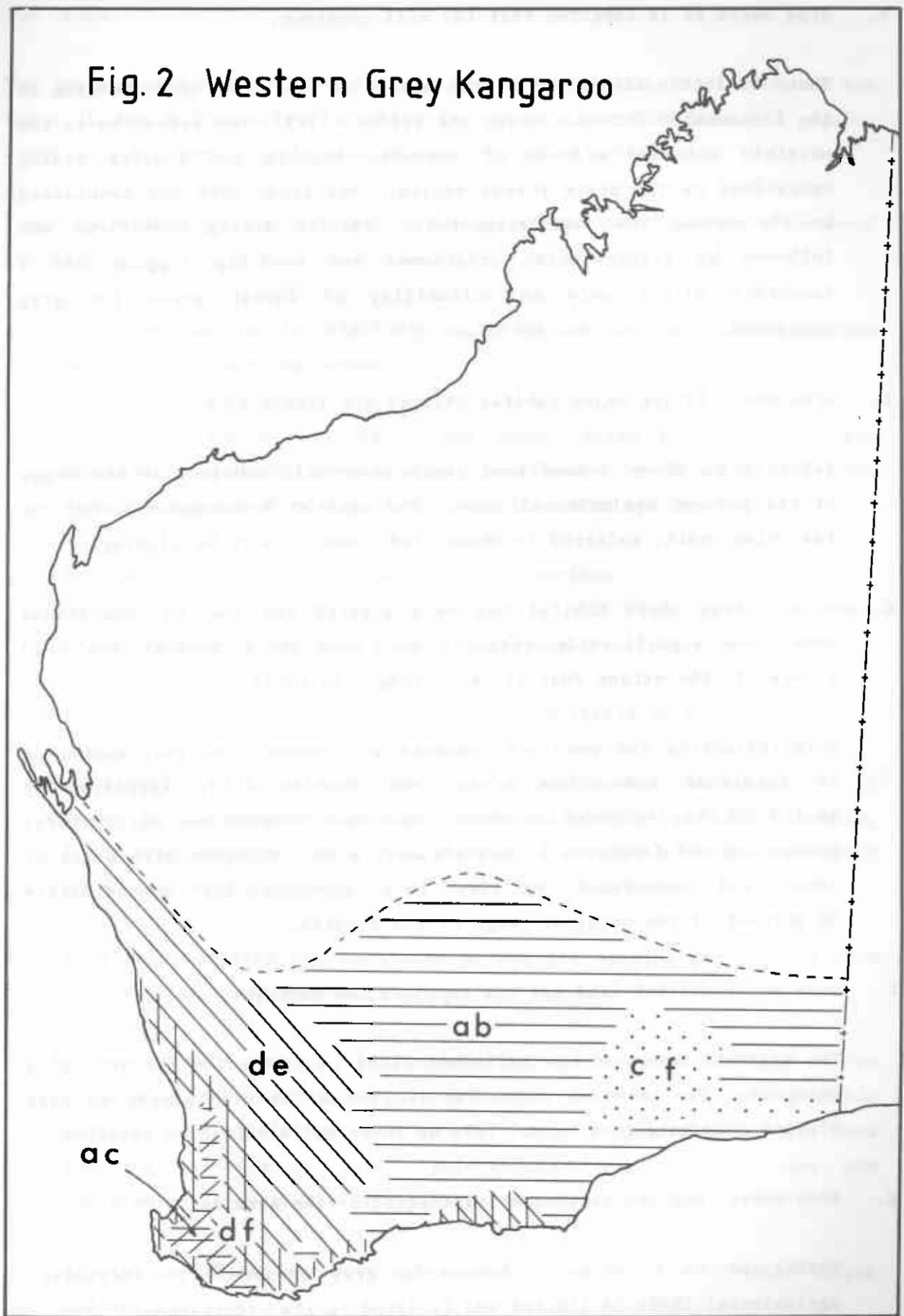
Figure 2 shows the range of the grey kangaroo in relation to land use in Western Australia. As can be seen, a considerable area of the habitat of the grey kangaroo has been lost to the species as a result of clearing for agriculture and development for industrial and urban land use purposes. At the time of the earlier documentation of the management programmes (Shugg and Prince 1973) the area of agriculturally developed land was 13,740,000 ha. This had increased to 16,120,000 ha in 1982, the last year for which data are currently available. The increase includes clearing both of previously and newly alienated lands.

The principal strongholds of the grey kangaroo in this State remain the series of State Forests situated in the jarrah and karri belts of the dry and wet sclerophyll forests, and the Nullarbor Plain. The development of pastoral land-use on the Nullarbor, with the provision of water and dingo-proof fences has probably improved habitats for the grey kangaroo on a number of large stations of 400,000 ha and greater.

- a. Area where habitat is relatively unaltered and the species' populations have been largely unaffected.

About 1,800,000 ha of State Forest remain relatively unchanged. It is common knowledge that the species occurs in good numbers throughout the forest. A further 5,600,000 ha (approx.) of substantial National Parks and Nature Reserves (area greater than 20,000 ha) lie within the range of the grey kangaroo and fall into the same "unaltered" habitat category. No effort has been made to the present to determine the abundance and density of grey kangaroos throughout this area because of the recognised abundance of the species and the security of tenure of the land concerned.

Fig. 2 Western Grey Kangaroo



- b. Area where it is expected that (a) will continue.

There is little likelihood of the status of the above area changing in the foreseeable future. Shugg and Prince (1973) drew attention to the possible untoward effects of woodchip logging and bauxite mining operations on the State Forest habitat, but these have not eventuated to the extent that was suggested. Bauxite mining operations are followed by reforestation programmes and woodchip logging has a temporary effect only on suitability of forest areas for grey kangaroos.

- c. Area where future major habitat changes are likely to occur.

Refer to b. above. Some land development will continue at the edges of the present agricultural zone. The rate of development during the last nine years, referred to above, indicates this to be slowing.

- d. and e. Area where habitat has been altered and species populations have been significantly reduced; and area where habitat has been altered to the extent that it is no longer suitable.

Notwithstanding the previous comments with respect to grey kangaroos in farmlands and urban areas (see Section 7.1), approximately 16,120,000 ha, referred to above, have been cleared for agricultural production and farmlands in Western Australia. Together with areas of urban and industrial activity this accounts for approximately 40 percent of the original range of the species.

- f. Area where current land use has improved the habitat.

The pastoral areas of the Nullarbor Plain in particular fit into this category. Provision of water and dingo-proof fencing appear to have allowed grey kangaroos to multiply on these Nullarbor sheep stations.

- g. Area where land use is adversely affected by the species.

Correspond to f. above. Damage by grey kangaroos to intensive, agricultural lands is limited and isolated in its occurrence.

7.4 EURO

The Euro occurs over a wide area in the State but major populations are found in the Pilbara district where it can conflict with domestic grazing stock. It has been closely studied there by Ealey (1967).

Figure 3 shows the range of the species in relation to land-use throughout its range.

- a. Area where habitat is relatively unaltered and the species' populations have been largely unaffected.

The far inland arid areas of the range, which are unsuitable for pastoral production, remain largely unaffected by European man. The distribution and abundance of euros in this area are unaltered.

- b. Area where it is expected that (a) will continue.

No development of the area above is foreseen.

- c. Area where future major habitat changes are likely to occur.

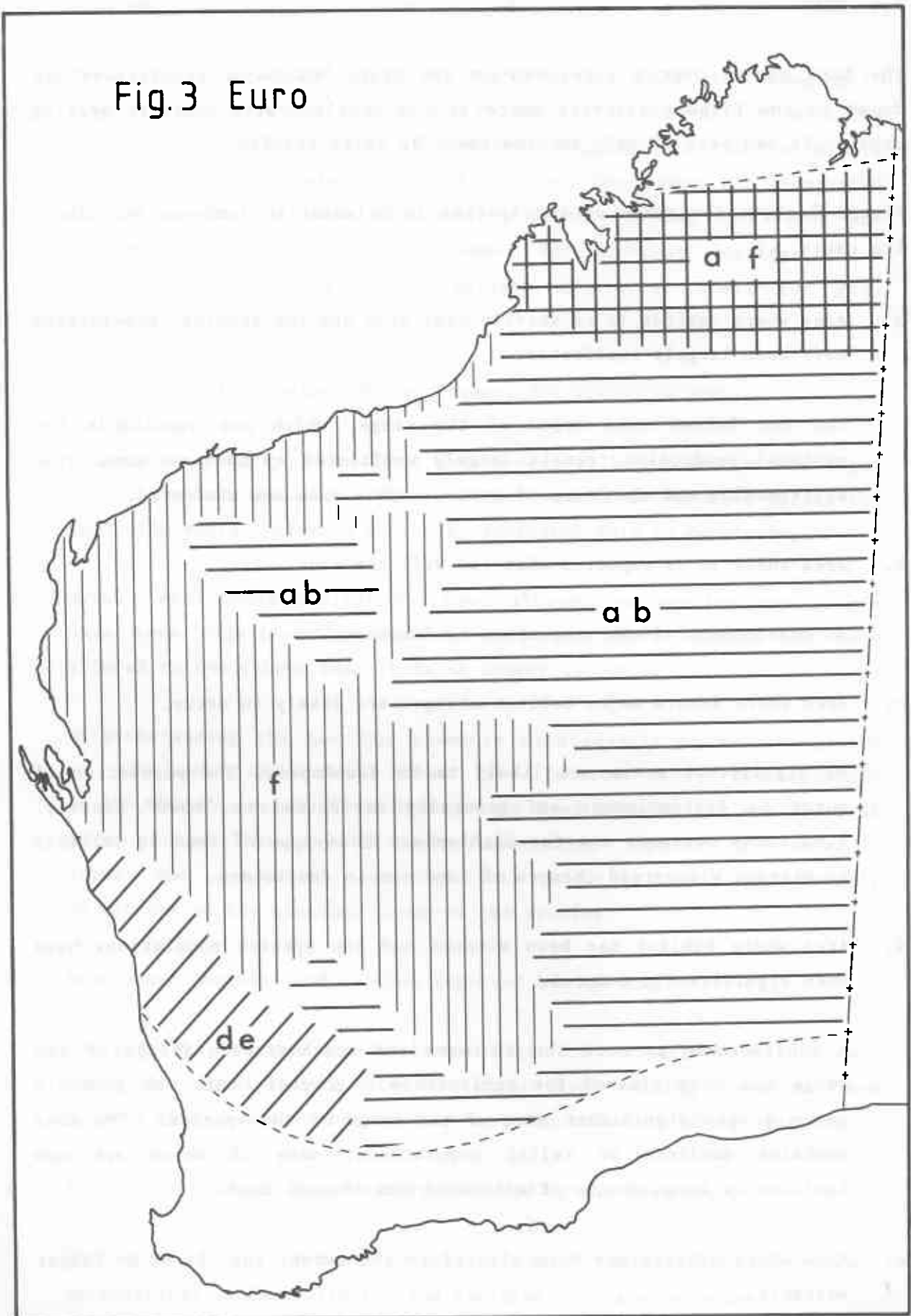
No significant areas are likely to be developed. The population of euros is discontinuous and generally restricted to "hard" country, i.e. rocky outcrops and the highlands. This type of land is unlikely to attract widespread changes of land use in the future.

- d. Area where habitat has been altered and the species populations have been significantly reduced.

A considerable part of the southern and south-western fringe of the range has been cleared for agriculture. However, this was probably never a very significant part of the range of the species. The area contains outliers or relict populations, many of which are now isolated by large tracts of alienated and cleared land.

- e. Area where habitat has been altered to the extent that it is no longer suitable.

Fig.3 Euro



Virtually none. In the main, the natural habitat of the euro is neither amenable to nor suitable for agricultural and pastoral development.

- f. Area where current land-use has improved the habitat.

Ealey (1967) records that changes in the environment caused by sheep farming favoured the euro population in the Pilbara district (cited by Ealey p.10 as 50,000 km²). Ealey's hypothesis that the sheep induced spread of spinifex and the provision of watering points benefitted euros and allowed a marked increase in their numbers and effective habitat has been widely accepted. This phenomenon, however, appears to be limited to the Pilbara. Recent observations suggest that the drought of the latter part of the 1970s may have substantially reduced this population.

- g. Areas where land-use is adversely affected by the species.

Negligible.

8. ASSESSMENTS OF KANGAROO POPULATION TRENDS

Until the aerial survey of kangaroo populations carried out independently of the Department in the winter of 1981, there had been no history of regular census of kangaroo populations in Western Australia or of direct comparisons of Western Australian populations with those of other States. This aerial census work, reported by Caughley et al. (1983) and Short et al. (1983), therefore, is a most important benchmark against which to judge development of the Western Australian kangaroo management programmes.

8.1 RED KANGAROO

As has been noted (Part 4, above) the present red kangaroo management programme was instituted in 1970/71 following an upsurge in harvesting believed by the Department to be excessive in relation to prevailing conditions and the estimated population at that time. Two different estimates of the adult red kangaroo population were derived at that time. Both gave similar results. The first was based on extrapolation to Western

Australia of ratios of domestic livestock units to red kangaroo populations for western New South Wales and the Northern Territory. Domestic livestock numbers in the pastoral areas of Western Australia were known and the overlap of the areas of kangaroo distribution and pastoral use was clear.

The second estimate was based on knowledge of the abundance of red kangaroos around artificial watering points and the distribution of these water points. For management purposes the kangaroo stock was assumed as a result of these estimates in 1970/71 to be about 1,250,000 animals.

Since that time red kangaroo harvest rates have continued to be set assuming an underlying stable population or one affected, as in the latter years of the 1970s, by prolonged and severe drought.

The actual harvest rates for red kangaroos subject to the programme since its inception are as follows:

1971	173,000
1972	198,000
1973	119,000
1974	129,000
1975	110,000
1976	144,000
1977	151,000
1978	131,000
1979	151,000
1980	100,000
1981	136,000
1982	138,000
1983	162,000

If it is assumed that the population was steady at (say) 1.2 million animals (+30%), harvest rates may have varied between extremes of 1:4 and 1:17 during this period, around a mean of 1:8.5 which equates to (approximately) 12% of the assumed population/annum.

This description is an oversimplification, of course. The extent to which the 1970s decade of drought affected the population is by no means certain, but documented experience of the 1980-82 drought in eastern Australia

suggests that mortalities as great as 40-60% of abundant stocks can occur in some situations.

Although no further attempt was made to actually estimate the population in the 1970s, extensive statistics on harvest rates/unit effort and on sex ratios and carcass weights of harvested animals were collected and progressively analysed as time series over this period. The detailed analysis of these data is the subject of the paper by Prince (in prep. (b)).

Many of these data suggest progressive downward trends in average carcass weights, proportions of males in the total harvest and, in some areas, associated rates of take of animals. For example, in the Murchison Management Area average male carcass weights have declined from approximately 22.5 kg in 1971 to 21 kg in 1982 while those of females have declined from 14 to 13 kg in the same period. The proportion of males in the harvest trended from 55 to 45% and the total number of animals taken per month fell from an average of 3,200 at the beginning to 1,600 at the end of the period.

The significance of figures such as these, which are given as examples only, is difficult to judge.

The population counts reported by Caughley et al. (1983) and Short et al. (1983) are an important benchmark in the Western Australian management programme for two reasons:

- The resultant population estimate for red kangaroos of 1,027,000 is somewhat less than the estimate on which the present management programme was based. This is especially so considering that the latter estimate was for the population in pastoral leasehold areas, i.e. that available for active management, while that of Caughley et al. was for the whole State.

- Continuing harvesting of red kangaroos at a median rate of 140,000 carcasses per year corresponds to a harvest rate of 1:6.5 on the new total population estimate.

The only additional factor that needs to be mentioned in this discussion of population assessment and trends during the period of the red kangaroo

management programme is that the 1981 census figure is acknowledged by its authors as being likely to be an underestimate. The extent of the possible underestimation is not known. From these data together we are left with the conclusion that, during the period of the management programme, the red kangaroo population subject to harvesting may have remained stable or may have declined somewhat. Whichever conclusion is adopted is dependent on the degree of confidence placed on the 1970 and 1981 population estimates.

If there has been an overall decline, it may have been as great as 10 to 20 percent. Such a decline would be consistent with the combined effects of prolonged drought and continued harvesting during the latter years of the 1970s but is less than the mortality levels suffered by Eastern States kangaroo populations during their 1980-82 drought period.

Since 1980 however, the Western Australian rangelands have enjoyed a succession of climatically average-to-good seasons. These should have been accompanied by an increase in the kangaroo population. The 1984 aerial census will establish whether this has been so.

While the aerial census technique probably underestimates actual populations, two such censuses repeated using the same methods should give figures which can be compared to reveal trends in the population in the intervening period.

8.2 WESTERN GREY KANGAROO

The only data indicating the likely population of grey kangaroos in Western Australia are those obtained in the 1981 aerial kangaroo survey which suggested a population in excess of 436,000.

8.3 EURO

No data additional to those provided by Ealey (1967) on numbers of euros are available. The euro's habitat is not amenable to aerial survey. Recent observations in the same area, however, suggest that the drought of the 1970s may have made inroads into the population and an estimate of the present total population of 100,000 to 200,000 would be a safe one.

9. DETERMINATION OF CULLING LEVELS

Culling of populations for the purpose of limiting their rates of natural increase is, in this sense of the term, carried out only in the case of the red kangaroo in Western Australia. While some grey kangaroos and euros are taken this is done only in response to specific occurrences of concentrations of animals which are perceived to be affecting pastoral and agricultural production. The average numbers taken in any one year (ca 30,000 grey and 5,000 euros against quotas of 50,000 and 10,000 respectively), in relation to the total known or estimated populations reflect the damage control nature of these programmes.

Red kangaroos, also, are taken in response to specific damage situations and a proportion of the royalty tags available in any one year (ca 20%) is reserved for this purpose. The remaining larger proportion of the total shooting activity is a culling operation; its objective is to reduce the rate of natural increase of the population which, experience has shown, will result in numbers unacceptable to pastoralists if it is not so controlled. Numbers of each of the three species that may be taken during any one year (January-December) are set by the State Minister for Fisheries and Wildlife following consultation with the Kangaroo Management Advisory Committee. This management advisory committee is chaired by the Director of Fisheries and Wildlife and comprises members of the administration and research branches of the Department, the Rangeland Management Section of the Department of Agriculture, the Agriculture Protection Board, representatives of local authorities, pastoralist and farmer organisations, and kangaroo shooter and kangaroo processor interests.

Insofar as products from kangaroos taken in the course of this programme may enter the export trade, quotas agreed by the State Minister are referred to the Commonwealth Minister for Home Affairs and Environment in conformity with requirements of the Commonwealth Act.

9.1 DETERMINATION OF CULLING QUOTAS FOR THE RED KANGAROO

The objective of culling of red kangaroos may be stated as being to maintain the aerial census estimated population in a stable condition about

an average of one million animals : a population of size possibly somewhat less than that estimated at the beginning of the programme. A continuing culling rate of about 140,000 animals, the quota approved by the Commonwealth for 1984 is consistent with these objectives and other factors, including the following:

a. Current population trends.

The total population is assumed to be stable at ca 1,000,000 or to have increased somewhat since 1981 (Short et al. 1983). This assumption will be checked by aerial survey in 1984.

b. Seasonal conditions.

After a prolonged drought during the latter years of the 1970s most of the red kangaroo range has experienced a series of average-to-good seasons. These culminated in heavy general rains during February, March and May 1984.

c. Previous annual harvests.

Harvest rates have varied from 100,000 to 198,000 per annum around a mean of 142,000 in the last thirteen years. The present culling level is consistent with this history and knowledge of the population.

d. Proportion of the habitat and population not subject to culling.

As previously discussed, while much of the potential habitat of the red kangaroo lies outside the area developed for pastoral production, and in which harvesting may occur, the great bulk of the population lies within it.

e. Land-use practices and trends in land-use.

No changes significant to the discussion.

f. Significance of the take outside the commercial quota.

Illegal harvesting of red kangaroos for commercial purposes inside or

outside the declared open season areas is well nigh impossible, because:

(i) all kangaroo carcasses in chillers or transported by any means or in processing works, must have a lawful tag attached;

(ii) patrolling by District Wildlife Officers presents a continuous hazard to would-be illegal operators;

iii) unlicensed hunters operating illegally would receive no support from pastoral lessees or from licensed shooters. The same deterrents apply within the open season areas to make illegal harvesting there virtually impossible. The inaccessibility and lack of support systems of any kind in the desert and very arid areas, together with the sparseness of the kangaroos and the uneconomic transport costs involved all help to ensure that the legal protection has practical effect.

Any skins or carcasses found without tags are liable to confiscation. Any person found in possession of skins or carcasses or who consigns or transports them is also liable to prosecution. Royalties are charged at the rate of 20 cents for each kangaroo tag. If the carcass and skin are consigned separately a tag must be fixed to each. The proceeds are credited to revenue.

Activities such as sport shooting, use for food purposes by Aboriginal people, and use of kangaroos for farm dog-food are also likely to have minimal effect on kangaroo populations. The number of people and dogs which could be the subject of such activities are very small compared with the area and number of kangaroos involved.

The same considerations apply to grey kangaroos and euros. The greater amount of illegal activity (31 prosecutions in the last 3 years) involved offences relating to the illegal taking of grey kangaroos. Almost without exception these involved cases of illegal amateur shooting, mainly in the forested and bushland areas in the near-Perth region.

9.2 CULLING QUOTAS FOR 1984

In accordance with the provisions of this programme the following culling quotas have been set by the Minister for Fisheries and Wildlife and approved by the Commonwealth Minister for Home Affairs and Environment. Quotas are given together with estimated minimum population of each of the three species, viz:

	Culling Quota	Estimated Minimum Population
Red Kangaroo	140,000	1,000,000
Grey Kangaroo	50,000	400,000
Euro	10,000	100-200,000

10. MANAGEMENT PROCEDURES

The procedures whereby it can be fairly asserted that the number of kangaroos taken illegally is a negligible one and whereby legal "taking" is controlled are laid down in the Wildlife Conservation Act and Regulations. The enforcement of these provisions is the whole or part time responsibility of twenty two Wildlife Officers appointed under the provisions of the same Act. Thirty five prosecutions against alleged offenders have been taken during the last three years. Where commercial operations are involved relating to kangaroos the provisions include the licensing of shooters, registration of chillers and processing works, the mandatory tagging of kangaroo carcasses, the regular inspection of processing and shooting operations and provision for weekly and monthly reporting by processors and shooters respectively.

For full details the reader is advised to study the Wildlife Conservation Regulations, in particular, which cover all aspects of licensing, forms of reporting and rules regarding the transport, marking and movement of fauna in the process of "taking" both for commercial purposes and otherwise.

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