CHAPTER 2

KANGAROO POPULATIONS

POPULATION DISTRIBUTION

2.1 Some of the 48 species of kangaroo are widely distributed while others are only found within a State or region. A few species exist in small pockets. The distribution of each species is documented in the scientific literature.

2.2 The encroachment of human land use and development into much of the range of the kangaroo has changed the pattern of distribution of many species. Some species have adapted to changes in their habitat while others have succumbed to human pressures and have become extinct or almost so. Some species have survived, and even prospered, over part of their range but have disappeared from other parts. The pattern of distribution of kangaroos is dynamic and reflects the effects of continuing human development over their range, including further destruction of the habitat.

POPULATION ESTIMATES

Introduction

2.3 To estimate the population of any species of wildlife is difficult. The task is even more complicated when the animal is small and visibility is restricted by the nature of the terrain. Few species of kangaroo have been surveyed to determine population levels and trends. Most of these surveys have concentrated on the larger kangaroos - the red and grey kangaroos

- in areas where aerial surveys can be conducted. The populations of some smaller species have been estimated by other survey methods. Details of survey methods, their limitations and the population estimates derived from them are discussed below.

2.4 Population estimates of red and grey kangaroos have been widely used and misused in the public debate on kangaroo killing. In the interest of promoting an informed debate, the Committee has tried to put the estimates into perspective.

Survey Methods

2.5 There are various survey techniques which have been used to estimate wildlife populations, including aerial surveys, ground counts, aerial photography, infra-red scanning, faecal pellet counts and kangaroo harvesting data.

Aerial Surveys

2.6 The effectiveness of aerial surveys is limited to open country where kangaroos can be seen by the observers. In heavily timbered or mountainous areas, it is virtually impossible to see kangaroos from the air.

2.7 Aerial surveys are conducted by trained observers in a light aircraft flying transects at a fixed altitude and speed. The observers count red and grey kangaroos within a 200 metre wide transect, one boundary of which is set by a marker on the wing of the aircraft and the other by the aircraft wheel. A correction factor is applied to the raw data to take account of the kangaroos which are missed by the observers. The correction factor takes into account such factors as the vegetation, weather conditions and the time of day. The ANPWS described the design of the survey as follows:

> An aircraft flying at 100 knots for 97 seconds covers a distance of 5 km; since observers scan a strip of width 200m over this distance, the area scanned by each observer is 1 km^2. The sampling intensity (i.e. the percentage of ground that is actually surveyed) can be varied by altering the spacing of the transects. The basic unit of the survey is most commonly a block of 1^o latitude by 1^o longitude (the degree block, approximately 10 000 km^2) or a block of 1^o latitude by $1^o30'$ longitude (a 1:250 000 map sheet). If two lines are flown across such an area (15' South and 45' South), the sampling intensity is about 0.7% (i.e. 0.7% of that block has actually been flown over and counted). In high intensity surveys of smaller areas like Kinchega National Park in New South Wales, or Hattah-Kulkyne National Park in Victoria, the sampling intensity may be as high as 20%, with transects 2 km apart.[1]

2.8 Aerial survey has been the most widely accepted method of assessing kangaroo populations. Regular surveys have been conducted in areas of New South Wales and in South Australia since 1975 and 1978 respectively. Some surveys have also been conducted in all of the other mainland States, mainly between 1980 and 1982 and again in 1984.

2.9 The advantage of the aerial survey is that it can cover a large area in a relatively short time. This makes it more conducive to large-scale surveying than the other methods, which would need considerable man-power to keep pace with aerial surveys.

2.10 The main criticism of aerial surveys is the correction factor applied to the raw data to give an estimated total number of kangaroos within the survey area. The correction factor has been refined with the experience gained by regular surveys but it cannot be relied on to be accurate. The Queensland NPWS, in particular, has been critical of the correction factor used in aerial surveys conducted in that State.

2.11 Professional shooters and fauna dealers expressed concern to CSIRO consultants, Mr G. Morris and Mr M. Young, in their study on the kangaroo industry in New South Wales, about the effectiveness of aerial surveying. Morris and Young commented:

> The fauna dealers interviewed did not consider that the aerial surveying technique gave an accurate estimate of kangaroo numbers at a local level and that more emphasis should be given to information which could be collected from people in the field including fauna dealers, shooters and NPWS personnel. These comments when taken in conjunction with the views expressed by licensed trappers suggest that degree block estimates obtained by the Service may not be sufficiently accurate at a regional level to form the prime basis for day-to-day management decisions.[2]

2.12 In 1984, the NSW NPWS decided to change the structure of the aerial survey from a monitor block to a long line structure. In 1984, 1985 and 1986, both methods were used with disparate results. These results are shown in Table 2.4.

2.13 The use of ground counts in conjunction with aerial surveys has been used to try to verify results of aerial surveys but, as Dr G. Caughley of CSIRO told the Committee, it has had varying results. He went on to say that it is impossible to say whether one is right or wrong, or whether both are right or both are wrong.

2.14 Repetition of identical surveys in the same area does, however, provide an estimate of changes in population levels between surveys. In other words, such annual surveys can show whether the population of kangaroos in an area has declined or increased and by the approximate percentage. Even so, caution should be exercised in comparing results because of different conditions experienced by the observers from one survey to the next. For example, there might be more ground cover one year

which makes kangaroos more difficult to see or different weather conditions might influence the counting.

2.15 As mentioned above, few kangaroos in heavily timbered country can be seen from the air which renders aerial surveys of these areas impractical. Other survey methods, principally ground counts, have been substituted to gain a rough estimate of the abundance of kangaroos there.

2.16 Aerial survey observers do not differentiate between eastern and western grey kangaroos because of the difficulty of distinguishing between the two species from the air. Ground counts have been used to calculate a ratio of the two species in the small area where they overlap and this ratio has been applied to the grey kangaroos estimated in aerial surveys in that area.

2.17 Aerial survey techniques are being continuously refined, as exemplified by new correction factors (Short and Bayliss), research on the impact of time of day on the sighting of kangaroos (Wilson) and the introduction of long line surveys instead of monitor block surveys in New South Wales. There is little doubt that the techniques will become more sophisticated as further experience is gained and greater reliance will be able to be placed on the results of aerial surveys in formulating indices of abundance of red and grey kangaroos. The fact that the techniques are changing in the light of this experience suggests that a degree of caution must be exercised in interpreting the results of surveys.

Ground Counts

2.18 Ground counts of kangaroos are normally conducted by observers who walk or are driven along transects and countkangaroos within a specified field of vision. This method is similar to an aerial survey except that it is much slower and requires more manpower to cover a large area. There are several

variations to this method. It is also possible for observers to obtain more detailed information (such as size, sex and condition) about the kangaroos in ground surveys than in aerial surveys.

Aerial Photography and Infra-red Scanning

2.19 Aerial surveys using these methods have been used mainly overseas but with limited success. Dr G. Caughley told the Committee that they were inferior to the unaided eye of an experienced observer.

Faecal Pellet Counts

2.20 Faecal pellet counts have been used to estimate population levels of various species of wildlife. It is not suited, however, to the wide-ranging surveys of kangaroos which are conducted in Australia. Their use is mainly in obtaining population estimates in smaller areas.

2.21 Dr P. Jarman of the University of New England explained the method to the Committee:

> Pellet count usually depends on your subsampling the country that you are working over. You would probably take evenly spaced or randomly spaced quadrates, circles or something like that and count pellets within those, and you can extend it to sample any area that you choose. But I would say that a working area for one person to survey in one day - that is an area in which to count pellets in one day - could probably not easily be more than about two square kilometres. I should be able to tell you the intensity of sampling; it would be a low sampling rate. You would probably be sampling less than 100 points within that two square kilometres, and each point might be two square metres, let us say.[3]

Commercial Harvest Data

2.22 The Queensland NPWS uses statistics compiled from returns submitted by kangaroo shooters and, recently, fauna dealers, to estimate increases or decreases in populations. These statistics may include the number of kangaroos killed by area, species and sex, and the average weight. Any significant variation in the general pattern of commercial harvest data may indicate the existence of a problem, which would then be investigated. For example, a decline in average weight may indicate a decrease in large bucks which may, in turn, point to a decline in the total population in an area.

2.23 The Queensland NPWS combines observations on the general distribution of kangaroos with the above data. Dr T. Kirkpatrick told the Committee:

> I think most biologists, perhaps all biologists, would agree that one of the first signs that an animal population is suffering some damage is when it begins to disappear from its ordinary habitat. When it is not seen there it is an indication that something is going wrong. Again, both from our shooter records and also from our own research observations, and also from the observations of our wildlife rangers, we have a constant record of the distribution of those species that are harvested and whether they are in fact disappearing from their normal ranges. We are not talking about numbers, we are just talking about their presence or absence.[4]

2.24 In its second Supplementary Submission dated May 1986, the ANPWS commented on the use of direct (e.g. surveys) as opposed to indirect (e.g. harvest data) population monitoring techniques:

> There is general agreement amongst wildlife biologists that direct techniques are the most desirable means of monitoring populations. Direct techniques tend to rely on fewer assumptions than indirect techniques, and usually return additional information about the population being monitored that is of use in management (such as distribution and habitat preference). Indirect methods, on the other hand, often rely on assumptions whose validity is uncertain and return little or no additional information that may be of use to management.
>
> Direct methods, however, are not without their own disadvantages. Direct methods are usually very labour intensive, time-consuming and expensive to operate. This is particularly so when the population is to be monitored over a large area. Indirect methods do not suffer from this disadvantage, the necessary data essentially having been collected by the hunter.[5]

2.25 The Queensland harvest data have still to be published and subjected to validation by peer review.

Discussion of Survey Methods

2.26 Each survey method has its advantages and disadvantages. The direct survey methods are more expensive to use over large areas than the indirect methods. Direct methods also depend largely on the correction factors applied to the raw data to compensate for the percentage of kangaroos missed by the observers. These have to take into account many factors including time of day, weather and vegetation. Research is continuing to refine the factors. There are also problems with sampling

methodology as revealed in the change from monitor blocks to long line surveys in New South Wales.

2.27 In a statement prepared for a hearing of the Administrative Appeals Tribunal, Dr C. Southwell of the ANPWS wrote:

> Like direct monitoring, indirect monitoring relies on certain assumptions to be able to effectively follow population trends, and in practice these assumptions are rarely tested. The Applicant has outlined some ways in which a number of assumptions of the "catch per unit effort" (CPUE) method generally and the Nance-Kirkpatrick population simulation model specifically could be violated for kangaroo populations. At present there is little data available to test whether the assumptions are in fact violated, and if so, how sensitive the techniques are to assumption violation. Assumption violation does not necessarily invalidate a method; violation may be insignificant and/or the method may be robust (or insensitive) to violations. Field validation of the Nance-Kirkpatrick population model, which is currently occurring, should provide a test of assumptions. Similarly the alternative model advanced by Dr de la Mare requires field validation. The advantage of indirect techniques is that monitoring can occur almost continuously and does not require the large commitment of resources that is necessary for broad-scale monitoring.
>
> Until the assumptions of both approaches are further investigated in the field, it is not possible to conclude with certainty that one approach is better than the other. A monitoring system that utilises both is likely to be more effective than a system using only one, as this would allow for both periodic abundance estimation and continuous assessment of the take, and would provide a cross-check between methods.[6]

2.28 The large-scale surveys are more accurate in calculating indices of abundance than absolute populations of particular species. Population estimates derived from survey data can only be indicative rather than actual and should be treated accordingly. It should be remembered that the survey intensity is designed for large areas and there are problems in the extrapolation of estimates to small areas. Local factors might have resulted in an increase or decrease of kangaroo populations against the trend for the region. This has obvious ramifications for management programmes.

Aerial Surveys Conducted in Australia

2.29 Aerial surveys commenced in New South Wales in 1975-76, and in South Australia in 1978, and have been conducted annually in those two States since then. Few surveys have been conducted in the other States. Table 2.1 shows all the surveys that have been performed and the organisations that conducted them.

2.30 From the results of a series of surveys in which 1981 was the median year, it was estimated that there were about 19 million red and grey kangaroos in Australia. Further surveys in New South Wales, South Australia and Queensland in 1982-83 indicated a decline in the population of these species of about 40 per cent owing to the prolonged drought in much of eastern Australia, reaching up to a line drawn through Quilpie, Charleville and Roma.[7]

2.31 The annual winter survey in New South Wales in 1984 showed a further decline in population numbers of red and grey kangaroos resulting in action being taken by the NSW NPWS to ban the commercial killing of kangaroos in specific areas where the

population density had declined to below one kangaroo per square kilometre. This ban remained in force until population levels rose to at least one kangaroo per square kilometre in those areas.

Table 2.1: Aerial Surveys of Kangaroo Populations

	AREA	YEAR	FREQUENCY	ORGANISATION
NSW	Sheep zone	1975-76	Annual	CSIRO initially then NSW NPWS
	Commercial harvest zones	August 1984	-	NSW NPWS
SA	Sheep zone	1978	Annual	CSIRO initially then SA NPWS and Sydney University
	Beyond sheep and arable zone	1981 and 1982	-	CSIRO and Sydney University
	Areas of significant grey kangaroo habitat not covered earlier in 1984	September 1984	-	ANPWS
	Pastoral area	October 1984	-	Sydney University
QLD	South of sheep zone	1979	-	Queensland University
	Sheep zone	1980	-	CSIRO and Sydney University
	Beyond sheep and arable zone	1981 and 1982	-	CSIRO and Sydney University
	Southern part of sheep zone	1983	-	CSIRO and Sydney University
	Pastoral zone	May 1984	-	CSIRO
	West and north QLD, areas of red kangaroo habitat not covered in May 1984	July 1984	-	ANPWS
	Areas of significant grey kangaroo habitat not covered in May/July 1984	September 1984	-	ANPWS

WA	Sheep and arable zone, 61% of WA	1981	-	CSIRO
	Deserts	1982	-	Sydney University
	Red kangaroo habitat	May/June 1984	-	ANPWS
	Areas of significant grey kangaroo habitat not covered in May/June 1984	September 1984	-	ANPWS
NT	Most of NT	1981 and 1982	-	CSIRO and Sydney University
VIC	Western Victoria	1980	-	Sydney University
	National Parks in Western Victoria	1981	Annual	Sydney University

Source: Evidence p. 1070, 1898, 1916, 2061, ANPWS letter 13/9/84 and ANPWS Submission 324 - Appendix K14, p. 5.

2.32 The results of the national aerial surveys of red and grey kangaroos in 1980-82 and 1984 are shown in Tables 2.2 and 2.3. Although the 1984 surveys only covered about 55 per cent of the area surveyed during 1980-82, the areas not surveyed were areas in which there was a low density of kangaroos.

2.33 The correction factor which was applied to eastern grey kangaroo data in the 1984 surveys was the same as that applied to the 1980-82 data for that species, even though between the two sets of surveys research had shown that the correction factor for eastern grey kangaroos was too low. The 1980-82 correction factor was used again to enable a direct comparison of the relative abundance of that species. The use of that correction factor meant that the total population of eastern grey kangaroos was actually higher than that estimated.

2.34 An estimate of 4 000 000 eastern grey kangaroos in the eastern highlands was included in the total population for 1980-82 and an estimate of 2 300 000 for 1984 (Table 2.3).

Table 2.2 Trend in Indices of Kangaroo Abundance between 1980-82 and 1984 within the Areas Covered by both Surveys

Species	Red		Western Grey		Eastern Grey	
	1980-82	1984	1980-82	1984	1980-82	1984
Queensland	2 156 000	1 760 000	104 000	55 000	3 028 000	2 317 000
New South Wales	3 836 000	1 663 000	876 000	241 000	1 936 000	887 000
South Australia	1 085 000	710 000	256 000	126 000	-	-
Western Australia	1 010 000	2 001 000	426 000	666 000	-	-
	8 087 000	6 134 000	1 662 000	1 088 000	4 964 000	3 204 000

Table 2.3 Comparable Estimates for the Total Populations of Red, Western Grey and Eastern Grey Kangaroos in 1980-82 and 1984

	Red	Western	Eastern	Total
Total Population 1980-82	8 351 000	1 774 000	8 978 000	19 103 000
Total Population 1984	6 330 000	1 162 000	5 791 000	13 283 000
Percentage change, 1980-82 to 1984	-24.2%	-34.5%	-35.5%	-30.5%

Source: G.C. Grigg, L.A. Beard, G. Caughley, D. Grice, J.A. Caughley, N. Shepherd, M. Fletcher and C. Southwell: 'The Australian Kangaroo Populations, 1984', 'Search', Vol. 16 No. 9-12, Oct/Dec 1985, p. 278, with a few modifications.

2.35 Despite the considerable limitations inherent in aerial surveys of kangaroos, as mentioned earlier in this chapter, they are regarded by Federal and most State authorities as the best survey method currently available for measuring population trends.

> Other factors taken into consideration in setting quotas include seasonal conditions, previous harvest levels, land use trends and known distribution of species.[8]

2.36 In an address to a public meeting at Charleville, Queensland, on 18 June 1985, the Minister for Arts, Heritage and Environment commented on the request of the Queensland Government for an increase in the commercial quota for 1985:

> The only way the Government will increase the quotas is when it is provided with the scientifically supported evidence that the kangaroo population has increased by such numbers that it is posing a threat to our rural properties ...
>
> It (scientific evidence) means that proper aerial and ground surveys conducted by authoritative bodies such as the Kangaroo Monitoring Unit, the CSIRO etc, provides evidence of significant increase warranting additional culling.

Later in his speech the Minister said:

> ... I can tell you that in the arenas in which we have to defend and justify kangaroo harvesting estimates of population numbers are absolutely critical.

2.37 Because of the important role played by population estimates in kangaroo management and the controversial and emotional nature of kangaroo killing as a topic of public debate, government spokesmen, representatives of animal welfare organisations and other interested groups have a responsibility to provide accurate population estimates in public pronouncements in so far as population estimates can be accurate. This includes

giving the year to which the estimates refer because of the wide fluctuations in population levels in recent years.

2.38 Regrettably, too often attention has not been paid to the need for accuracy. This point is illustrated by the conflicting estimates quoted by government spokesmen as set out in a list presented to the Committee in a public hearing and reproduced at Appendix 3. Government spokesmen have not been alone in this regard. Representatives of other organisations have also been inaccurate in some of their public utterances.

Population Estimates

New South Wales

2.39 Aerial surveys were conducted in New South Wales in 1975 and have been repeated annually since 1977. The results of those surveys are shown in Table 2.4.

Table 2.4 Populations of Red Kangaroos and Grey Kangaroos in NSW 1975-1985

Estimates from Monitor Block Aerial Surveys

Year	Estimated Populations		Total
	Reds	Greys	
1975	2 073 000	1 580 000	3 653 000
1976	No estimate	No estimate	No estimate
1977	2 669 000	2 030 000	4 699 000
1978	2 069 000	2 314 000	4 383 000
1979	2 355 000	1 933 000	4 288 000
1980	3 377 000	2 797 000	6 174 000
1981	4 626 000	2 420 000	7 046 000
1982	5 700 000	3 700 000	9 400 000
1983	3 400 000	2 100 000	5 500 000
1984	2 690 000	1 540 000	4 230 000
1985	2 280 000	2 430 000	4 710 000

2.40 In 1984, the NSW NPWS decided to change the structure of the aerial survey from monitor blocks to a long line method. Dr J. Giles of the NSW NPWS explained:

> ... although they (the monitor blocks) were selected at random, they were clumped. We used them for a number of years and became progressively concerned that, because the blocks were clumped - they tended to occur in two blocks, if you like, broadly in the western division - they could be giving us misleading results. Therefore, we decided to change the survey design to one whereby we flew lines across the full length of the commercial harvesting area and compared those, as is stated here, with the monitor blocks surveyed at a slightly reduced intensity.[9]

A comparison of the results of both aerial survey methods conducted in 1984 and 1985 are shown in Table 2.5.

Table 2.5 Comparison of Population Estimates of Red and Grey Kangaroos in NSW between Monitor Block (MB) and Long Line (LL) Surveys

	Year	Estimated Populations		Total
		Reds	Greys	
MB	1984	2 690 000	1 540 000	4 230 000
LL	1984	1 650 000	1 088 000	2 738 000
MB	1985	2 280 000	2 430 000	4 710 000
LL	1985	2 377 000	1 899 000	4 276 000

2.41 Dr Giles told the Committee:

> I would suggest, and bear in mind we are conducting experimentation, that the long line figure gives the more accurate figure - accurate meaning most closely approximating to the real value. The other figure, I believe, has a fair likelihood of being biased because the position of the points of survey is by its nature biased.[10]

2.42 The NSW NPWS conducted aerial surveys in 1986 again using both methods. In 1987, only the long line method was used to estimate kangaroo populations.

2.43 Dr Giles said that the quotas for 1985 and 1986 prepared by the NSW NPWS for submission to the ANPWS were based on the lower figures of the long line surveys.

Queensland

2.44 The Qeensland NPWS has not placed the same reliance on aerial surveys for estimating Queensland's populations of red and grey kangaroos as have the fauna authorities of the Commonwealth and of the other mainland States in which there is a commercial kangaroo industry. It has steadfastly maintained that the aerial survey results of surveys done in Queensland grossly under-estimate the number of these species of kangaroo.

2.45 In an open letter that was circulated to all members of the United States Congress in support of the delisting of kangaroos from the United States Endangered Species List, Dr G. W. Saunders, Director of the Queensland NPWS, stated:

> Professional culling of the most populous species is seen as a vital Service management tool. Populations of these species in Queensland are estimated from 15 to 30 million, depending mainly on natural factors.

2.46 In response to a question about the derivation of these figures, Dr Saunders told the Committee:

> I am basing mine (my estimate) on the experience which I have had with the industry - managing the legislation, conserving kangaroos, living in the bush, working with my officers, et cetera. I do not think there is any doubt about that. I was probably being very conservative in saying that.[11]

2.47 Subsequently, Dr Saunders mentioned that aerial survey data from the 1984 survey had been analysed within the Queensland NPWS and a figure of 17 million arrived at. He went on to say:

> ... because our estimate based on those aerial counts is, say, 17 million, and then it has to be at least double that; it has got to be double.[12]

2.48 The Queensland NPWS has eschewed using population estimates obtained from aerial surveys as a basis for its kangaroo management programme. Although it has done some studies to try to validate the results of aerial surveys, it has preferred to rely on commercial data in drawing up its management programmes. The Queensland NPWS population model has not yet been published and subjected to independent verification.

2.49 The ANPWS provided the Committee with a feasibility study of broad-scale monitoring of whiptail wallaby populations in Queensland, which had been prepared by the National Kangaroo Monitoring Unit for the Queensland NPWS. In the report of the study, Southwell and Fletcher recommended:

> that an initial broad-scale survey be undertaken with the aim of obtaining an accurate and precise estimate of whiptail abundance over a broad portion of the species' range where harvesting occurs.
>
> ... The monitoring strategy thereafter would depend on the magnitude of the broad-scale estimate in relation to the current and expected harvest level in the area.

2.50 The broader study is currently being done and should be completed early in 1988.

South Australia

2.51 Since 1978 The University of Sydney has been contracted to carry out aerial surveys of kangaroos in South Australia. The annual survey figures shown in Table 2.6 are the results of surveys for 207 000 square kilometres of pastoral country whereas

the total quota is obtained from estimates for the total 282 300 square kilometres of the Commercial Utilization Area.

Table 2.6 Population Estimates for Surveyed Area of South Australia

Year	Number of Kangaroos*
1978	1 202 600
1979	1 216 700
1980	1 236 900
1981	2 275 600
1982	1 496 300
1983	907 300
1984	836 000

* There is no breakdown between red kangaroos and western grey kangaroos.

Sources: (1) Information extracted from Appendix 6 of 'The Macropod Conservation Programme in South Australia Part A (To Apply from 1 January 1986)'.

(2) G. C. Grigg, L. A. Bear, G. Caughley, D. Grice, J.A. Caughley, N. Shepherd, M. Fletcher, C.Southwell 'The Australian Kangaroo Populations 1984', "Search" Vol. 16, No. 9-12, Oct/Dec 1985, pp. 277-279.

2.52 The Committee noted the 84 per cent increase in the population between 1980 and 1981 and questioned Professor Grigg on this extraordinary increase; one which is biologically impossible. He advanced three contributing factors:

(a) that in 1980 there were many advanced pouch young which were visible in 1981 along with the next group just out of the pouch;

(b) a migration of kangaroos into the surveyed areas between the two surveys; and

(c) a higher ratio of females in the population.

2.53 If the explanation for the extraordinary increase in 1981 given by Professor Grigg is correct, it raises questions about the interpretation of results of aerial surveys with potentially significant ramifications for the State's kangaroo management programme and quota.

Western Australia

2.54 In Western Australia, the red kangaroos mainly inhabit the rangelands while the western grey kangaroos are concentrated in the south-western agricultural areas.

Rangelands

2.55 In 1981, an aerial survey was conducted by CSIRO over 61 per cent of the State. Another was done by the ANPWS in 1984 covering 47 per cent of the State. Comparing the results of the 101 common blocks, there was an increase of 93 per cent in the number of red kangaroos over the three years, from 954,774 in 1981 to 1,845,934 in 1984. This 'represents a yearly finite rate of increase of 24.5%'.[13] After extrapolation to obtain total populations for the whole State, the figures were increased to 1,027,000 in 1981 and 2,018,000 in 1984, which represented a 98 per cent increase.[14]

2.56 Fletcher and Southwell of ANPWS reported that:

> The 1981 survey occurred at the end of a drought and was followed by three years of good to average seasons. The estimated yearly finite rate of increase is in accord with observed rates of increase in NSW red kangaroo populations (Bayliss 1980) and with J. Caughley's (pers. comm.) model for NSW red kangaroo populations (this model predicts an increase in excess of 25% per annum in good to average seasons, even when subject to culling pressures of 5-15% of the previous year's population).[15]

2.57 The 1987 Management Program recorded that Western Australia continued to have average to good seasons in 1985 and 1986.

2.58 Apart from periodic aerial surveys the Department of Conservation and Land Management has used other methods to monitor population trends, such as analysis of harvest data, ground surveys and patrols, transect dung sampling and consultations with landholders.[16]

South-western Agricultural Areas

2.59 From the results of the aerial survey conducted by the CSIRO in 1981 it was estimated that there were in excess of 436,000 western grey kangaroos in Western Australia. The 1984 aerial survey resulted in an estimate in excess of 683,000 western grey kangaroos.

2.60 Apart from the two aerial surveys, the Department of Conservation and Land Management has used other methods to monitor population trends of western grey kangaroos, similar to those mentioned above for red kangaroos.

Tasmania

2.61 In the Tasmanian kangaroo management plan for 1986, it is stated:

> No accurate estimate of wallaby abundance in Tasmania is currently available. However, an approximate figure can be derived from available information on population density and areas of potential habitat.
>
> Thus, transect counts conducted by the Service in general areas in the Midlands and north-east of the State give wallaby densities of 0.5/ha to over 5.0/ha, with both species being represented in approximately equal numbers. Given that approximately 75% of Tasmania is suitable as wallaby habitat and taking an average density of 1.5 wallaby/ha, gives what is considered to be a conservative estimate of over 6 million wallabies of both species combined.[17]

Conclusions

2.62 The Committee believes that, despite its limitations, the aerial survey method is the most appropriate method for estimating indices of abundance of red and grey kangaroos on a state or national basis. Such surveys should be conducted at least annually in Queensland, New South Wales, South Australia and Western Australia. In the opinion of the Committee, surveys conducted at intervals of three or more years do not provide enough information on trends in the population levels of those species. It is also more difficult to determine whether a significant variation between two widely-spaced surveys is the result of a significant increase or decline in populations or due to some other reason, such as climatic variations or differences in the conduct of the survey or in the analysis of the data.

2.63 Because of the limitations in the aerial survey method, it should be used in conjuction with other forms of survey, such

as harvest data or ground counts of one form or another. Significant variations between the results of two different methods should be investigated.

2.64 The Committee is satisfied that, on the basis of the results of population surveys and on the other evidence given to the Committee, red and grey kangaroos are not presently threatened with extinction. The evidence before the Committee does not support the suggestion that populations of those species are nearing a critical point after which they would crash and become endangered. If, however, there is a significant change in the habitat or the pattern or extent of killing of these species, further consideration will have to be given to their long-term viability.

2.65 Although the Committee does not find that total populations of red and grey kangaroos are presently in danger, some areas may become denuded of kangaroos through the destruction of habitat for agriculture or other human land uses.

2.66 The Committee **RECOMMENDS** that aerial surveys of red and grey kangaroos be conducted in New South Wales, Queensland, South Australia and Western Australia at least annually but preferably twice a year.

2.67 The Committee also **RECOMMENDS** that the ANPWS undertake or commission more research into either the further refinement of the aerial survey method or into alternative survey methods or combinations of survey methods to arrive at more reliable indices of abundance and estimates of total population size of kangaroo species.

2.68 There is also a need to obtain information in smaller areas where a population of a species has declined. These population variations might run counter to broad trends as determined by aerial surveys. Ground or faecal counts could be

employed to survey the species, not only to establish numbers but also to gather more detailed information about the species in those areas.

2.69 Few surveys have been carried out on populations of species of kangaroos other than the red and grey kangaroos. Further surveys and research should be undertaken to provide a more accurate picture of the population size and other population characteristics of these species.

2.70 The Committee **RECOMMENDS** that the ANPWS commission or conduct regular surveys by appropriate methods of all species other than red and grey kangaroos which are subject to legal killing.