Kangaroos — standing up to be counted

One of the recurring areas of controversy surrounding the management of kangaroos in Australia is the question of just how many there are in the country. The answer is not easy to come by. How do you census such a mobile animal over an area of almost 7 million square kilometres?

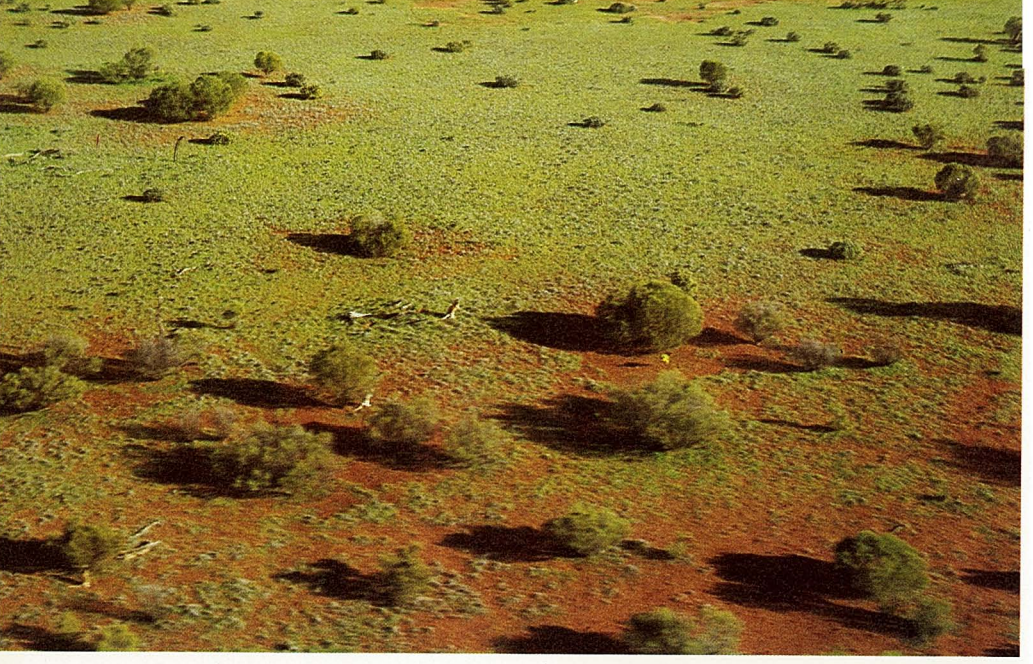
In 1975, researchers from the CSIRO Division of Wildlife and Rangelands Research and the University of Sydney began refining a technique that dates back some 200 years to the earliest days of balloon travel — aerial surveying. Having flown over most of Australia, they have produced what must be the most precise census figures obtained so far: in 1981, some 19 million kangaroos inhabited the country, comprising 8·3 million red kangaroos, 9 million eastern greys, and 1·8 million western greys. These figures, based on data gathered before the recent drought, include an estimate of 4 million eastern greys for the unsurveyed eastern coastal area.

Aerial surveying has come a long way since its first days, when enemy naval vessels were counted from balloons. This century has seen counts made of artillery horses in World War I and of submarines in World War II. In the 1950s, American wildlife authorities began using the technique to count mule-deer and white-tailed deer. This practice spread to Africa for surveying a range of plains animals — elephants, wildebeest, and gazelle; in Canada it has provided estimates of caribou and moose populations.

The kangaroos surveyed in Australia belong to the three largest species, which constitute most of the annual harvest of the animals. The word 'kangaroo' itself is a vernacular term for large macropodid ('big foot') marsupials and, in its broadest sense, includes wallaroos or euros.

Aerial counts of kangaroos started in 1960, followed by a 15-year period of dormancy. In addition, such surveys in Australia have counted rabbit warrens, brolgas, dugongs, and emus. Obviously, animals that are small, nocturnal, or hard to see for some other reason pose problems for those magnificent surveyors in their flying machines, but for suitable animals the method is cheaper and faster than ground methods.

Despite the relatively early start, aerial surveying is still, according to Dr Graeme Caughley of the Division of Wildlife and

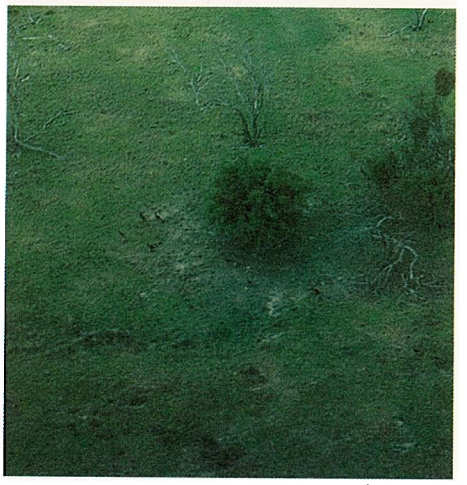


Rangelands Research, a 'baby in the throes of teething trouble'. Dr Caughley's work during the past 8 years has led to improvements in the method. He began by looking at the main 'trouble', intrinsic to all counting techniques, which goes by the formal name of visibility bias. In other words, how many animals are looked at but not seen?

Missing an elephant

When Dr Caughley, a veteran of many aerial surveys in Australia and overseas, tackled the problem, he was able to prove that observers counting from a plane can miss up to one-half, or even more, of the animals in the sample area below the plane.

A number of factors determine an animal's 'sightability'. Size is no guarantee. An observer in a plane passing right over the beast could miss an elephant if it is standing still. Dr Caughley, with Dr Ronald Sinclair and Mr Donald Scott-Kemmis, from Sydney University's School of Biological Sciences, tested a number of variables that they knew contributed to visibility bias, in order to formulate correction factors that would convert an observer's raw tally into a more accurate estimate of the numbers in a sampled area.



An observer in a survey plane typically sees red kangaroos in scrub country (top) and grey kangaroos in open woodland (bottom).

They began by devising a series of field and laboratory experiments that determined the effects of height above ground, speed of the aircraft, and the area scanned by the observer in the available time.

In the field experiments, observers counted red kangaroos at Jerilderie, N.S.W., and sheep on a property at Nyngan, N.S.W., at various heights and speeds, and for various transect widths, to see what effect each of these would have on sightability. Keeping speed and transect width constant, they counted animals at different heights; then they repeated the experiment keeping transect width and height constant, but changing speed, and so on. In the laboratory, observers counted dots and circles projected onto a screen in a simulation of the aerial surveys.

The researchers found that the number of animals counted by observers decreased as speed, height, and width of transect increased. Next, they extrapolated the relation back to zero for each factor — that is, a height of zero metres (ground level), a speed of zero km per hour, and a zero width transect (a single point) — and thus determined the 'true' density of animals.

Dr Caughley and his colleagues then produced a set of equations for both open and wooded country, which allowed them to calculate what proportion of the red kangaroos in a transect were actually counted. For example, at a height of 76 m and speed of 160 km per hour, an observer could see 48% of the total number of red kangaroos in a 200-m strip in open country, and only 42% in lightly wooded areas.

Correction factors for grey kangaroos were not determined, so the researchers assumed they had the same visibility bias. Recent experiments show, however, that they are more difficult to detect than reds and are likely to be underestimated.

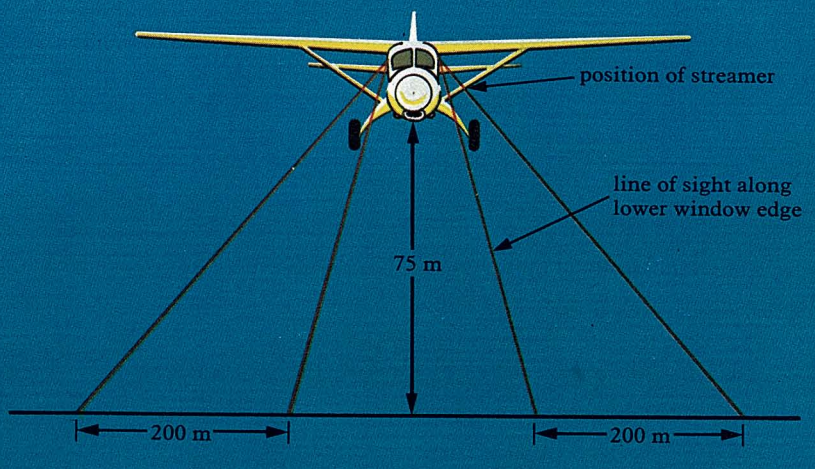
A similar set of correction factors was designed for, and tested on, the sheep at Nyngan. The team multiplied the number of sheep counted from the plane by the appropriate correction factor and compared the result with the known number on the property. The estimate of about 147 sheep per square kilometre was close to the actual number of 141.

Counting a strip

The CSIRO survey design, which has been adopted by other groups researching kangaroos, is based on a sample frame of blocks, each encompassing 1° of latitude by 1° of longitude and 10–12 000 sq. km in area. East–west flight transects are

The diagram shows how a transect is marked — on the outside by a streamer tied to the wing strut, and on the inside by the lower edge of the observer's window.

Marking transects with streamers



A western grey kangaroo.

drawn randomly or systematically across the blocks. A small high-winged plane flies at a fixed altitude (76 m) and speed (185 km per hour) along these transects, completing up to 10 in a day. The average daily surveyed area is approximately 60 000 sq. km.

Two observers on opposite sides of the plane count the animals within the counting area below and in front of them. Thin ropes tied to the wing struts on either side 'mark out' these transects or strips.

Like the scarf of an early aviator, each rope streams out horizontally and is so positioned that the observer sees a 200-m-wide ground area between the rope and the lower edge of the plane's window. The rope's position is initially set by flying the plane repeatedly at the appropriate height along a strip marked on the ground.

Survey teams standardize the length of the counting segments, usually 5 km, by using an electronic timer that triggers a whistle after 97 seconds. Then the whistle blasts for the next 7 seconds, during which time each observer writes down his tally and checks that his transect segment number matches that of his colleague. Precision, in terms of repeatability of results, hinges upon close duplication of methods between flights, and, in particular, depends on the pilot's skill in constantly maintaining correct height and speed.

How many kangaroos?

Kangaroos feed in the early morning and late afternoon and, in winter, can easily be seen from the air as they stand and graze. An animal's movement, sometimes as small as an ear twitch, is often what alerts observers to its presence. Winter is the best season for surveys because in summer kangaroos remain still and hidden from the air as they seek shade. Dr Caughley and his colleagues carried out most of their national survey in the winters of 1980, 1981, and 1982.

Combining the data from three sources — CSIRO, New South Wales National Parks and Wildlife Service, and Sydney University — Dr Caughley, together with Professor Gordon Grigg of Sydney University and Mr Jeff Short, also from CSIRO, attempted to provide the first systematically derived estimate of the number of kangaroos in Australia.

The combined survey area covered 5·8 million sq. km — 75% of the Australian mainland. Altogether, the three groups had surveyed the pastoral zones of Queensland, New South Wales, Victoria, South Australia, and Western Australia. From 1980 to 1982 Dr Caughley and his team filled in the 'gaps' between these surveys.

Some of the arid zone gaps, such as the Northern Territory and all of the central deserts, carried very few kangaroos. In these areas, the survey team flew fewer transects per degree block than they had flown in the more crowded pastoral zones. On some days, they did not sight one kangaroo.

As Dr Caughley explains, much of the tree-covered, eastern coastal area is hard to survey by plane because of the rough terrain. Here, the populations, predominantly eastern grey kangaroos, had to be estimated by the less precise method of intelligent guesswork based on field experience. Dr Caughley, Professor Grigg,

A streamer, attached to the survey plane's wing strut, marks the outer edge of a 200-metre-wide transect strip on the ground.

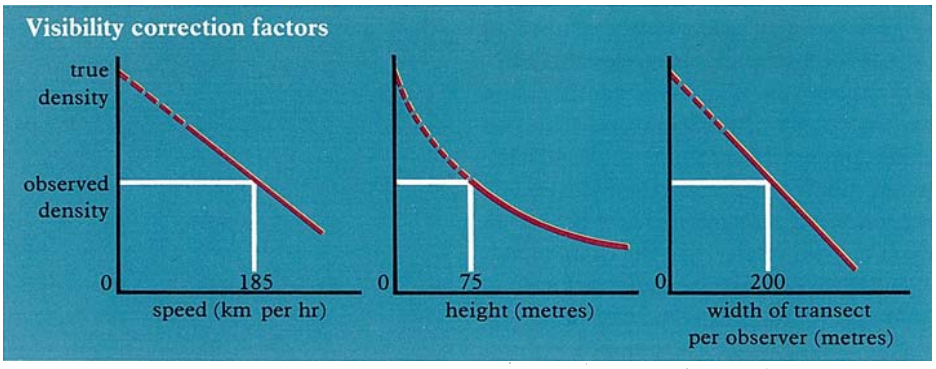
and Mr Short made what they believed to be a conservative estimate — about five per sq. km — and, as a result, added 4 million eastern greys to the survey figures.

Their physical likeness makes the two species of grey kangaroo difficult to distinguish quickly from the air. In the aerial survey, Dr Caughley's team dealt with the problem by counting them as a single species where they overlapped. They then estimated the approximate ratio of eastern to western greys in these areas from ground observations and used that information to divide the original count into a population estimate for each species.

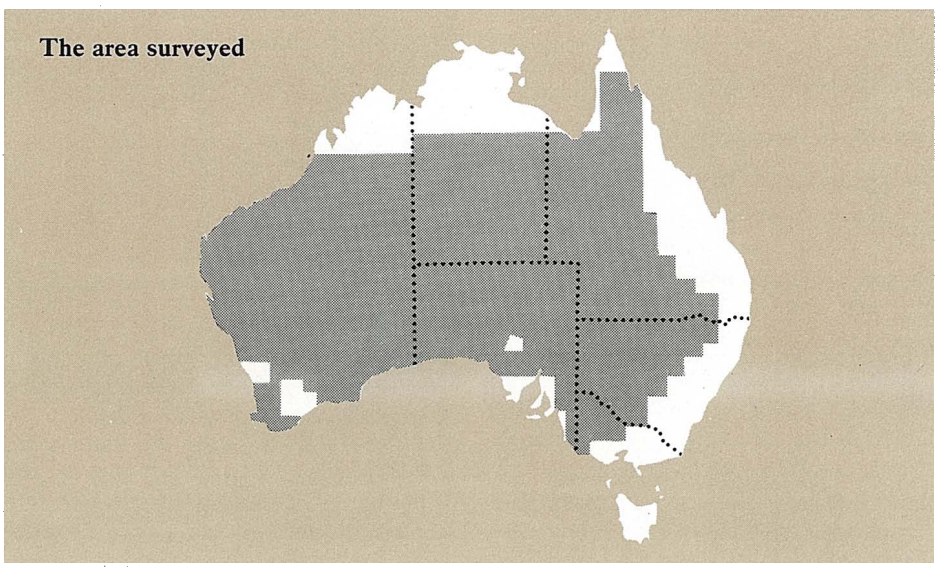
The surveys together covered the full range of the red kangaroo, most of the range of the western greys, and the mainland range of the eastern greys west of the eastern highlands. The densest concentration of red kangaroos occurred in the north-western corner of New South Wales, while the 'hot spot' for western greys was western central New South Wales, and that for eastern greys was southern central Queensland.

Tracking densities

In addition to the national population survey, two States conduct continuous-monitoring aerial surveys, which track changes in kangaroo density in particular areas. Dr Judy Caughley and Mr Peter Bayliss, of the New South Wales National Parks and Wildlife Service, have been



The graphs indicate how the speed and height of the aircraft, and the width of the survey transect, affect the observed density. The researchers derived them by recording observed density for different heights, speeds, and transect widths, changing one variable at a time and keeping the other two constant. At the speed (185 km per hr), height (75 m), and transect width (200 m) used in the CSIRO surveys, about half the kangaroos actually present are counted.



The 1975–83 surveys covered the total range of the red kangaroo, nearly all that of the western grey, and the mainland range of the eastern grey, west of the eastern highlands.

monitoring survey blocks annually in the west of the State since 1978. Their work showed that the numbers of both red and grey kangaroos increased there at an average rate of 18% per year from 1975 (the year of Dr Graeme Caughley's initial surveys) to 1981. This coincided with a period of good rainfalls and conditions of plenty in western New South Wales.

The increase did not occur uniformly across the monitor blocks. The 1981 winter aerial survey showed higher-than-average densities of 30 kangaroos per sq. km in the far north-west. Subsequent harvesting had little effect on the numbers in many of the monitor blocks. The extensive 1982–83 drought, however, did bring the numbers down in many parts of the State.

The 1982 results failed to indicate a significant increase in mortality due to the drought. Not until the 1983 winter survey in Kinchega National Park did the first signs indicate that the drought had taken its toll: according to Mr Bayliss's preliminary figures, there was an average drop of 50% in kangaroo numbers. This figure is yet to be confirmed by independent estimates.

The compensating fluctuations in populations in response to variable rainfall reflect the adaptation of the three species to the drought-prone Australian environment. In drought conditions, young and old animals die off quickly, especially large, aged males that require more food and water than the smaller does and younger males. Research by Dr Alan Newsome of the Division of Wildlife and Rangelands Research has shown that red kangaroos more than 3 years old have a sex ratio of one male to about five females during drought.

After the drought breaks, the population still contains a high proportion of breeding females. They have not bred during drought, but return to oestrus soon after the first rains. Among reds and some eastern greys, adult females can also carry an embryo at an arrested early stage of development during severe seasonal conditions; when the conditions improve, the foetus resumes its growth. By these methods, red and eastern grey kangaroo populations can recover rapidly from prolonged drought, regaining pre-drought densities within a few years.

The States other than New South Wales have each developed their own monitoring programs.

For example, since 1978, the South Australian Department of Environment and Planning has contracted Professor Grigg to conduct annual aerial surveys of 207 000 sq. km of its pastoral lands. Mr Lindsay Best is responsible for the program, which includes additional ground survey work every few months during periods when numbers appear to be dropping. Large areas of South Australia are subject to severe drought and, according to Mr Best, an increase in the death rate from the 1982–83 drought began to show up in the 1982 surveys. The earliest 1983 figure indicated that 30–60% of the population had died during the drought.

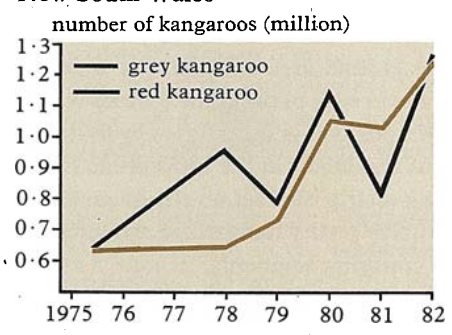
In Queensland, continuous monitoring of kangaroo populations involves checking the age and composition of monthly samples from professional shooters.

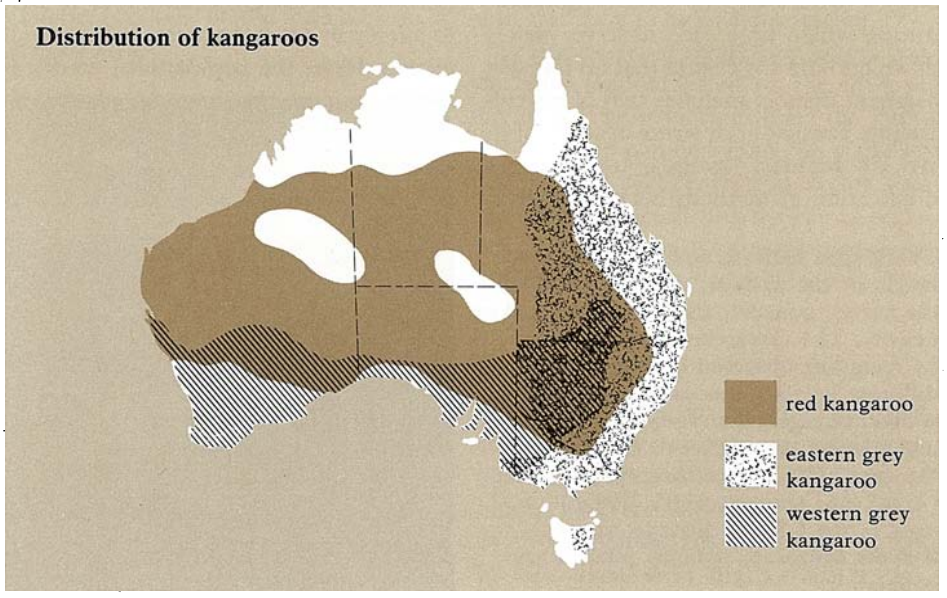
Implications for management

Management of kangaroo populations depends on knowledge of density changes over time so that excessive harvesting does not coincide with a period of population decline due to drought. In Australia, responsibility for native fauna is primarily vested in the State governments. Every year, after consulting the Australian National Parks and Wildlife Service and

The graph shows the estimated numbers of kangaroos in seven monitor blocks in New South Wales during 1975–82. Each monitor block measured about 15 000 sq. km, making a combined annual survey area of more than 100 000 sq. km.

Continuous surveys in New South Wales





obtaining approval from the Commonwealth Minister for Home Affairs and the Environment, each State sets an annual commercial harvest quota for kangaroos.

Because kangaroos are regarded as a problem in pastoral areas, damage mitigation is one of the primary goals of the National Kangaroo Management Program. This Program was initially drawn up in 1973 by the Council of Nature Conservation Ministers (CONCOM). A CONCOM working group first reviewed and updated the Program in 1980, and a further revision is being undertaken.

The commercial harvesting industry began as a means of keeping numbers down in those areas where kangaroos compete with domestic stock for food and water. In the past, quotas have been based largely on submissions from agriculturalists and the harvesting industry.

Quotas are often as high as 10–12% of the estimated population, and nearly always the actual authorized harvest for each State has ended up well below the quota figure. In some cases, the quota has stayed the same year after year — without being modified (for example, during periods of local drought).

Aerial counts provide a good basis for improving the management of kangaroos in Australia. Costs are low — about 4c per square kilometre of land surveyed at 1% coverage. New South Wales and South Australia can use data from their continuous-monitoring surveys in reviewing and setting State quotas. Combining the results of aerial surveys — together with information on local climate, land use, and harvesting — the way is open for State management programs to respond effectively to seasonal and regional fluctuations in kangaroo populations.

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More about the topic

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