Where wedgies dare

Popular as national symbols throughout history, eagles are indeed majestic birds, soaring effortlessly on rising currents of warm air. They are also, of course, strong and rapacious carnivores, preying on a range of creatures and scavenging carcasses (perhaps another reason why various States identify with them!).

Two eaglets about to fledge, sitting in a nest in a myall tree in the DSI area.

Of 34 eagle species in the world, we have but three in Australia: the white-breasted sea eagle, living near the coast or large bodies of water; the little eagle, which has a wide distribution but is not common; and finally, the largest of the three and the king of the inland sky, the magnificent wedge-tailed eagle — symbol of open space and wilderness.

The wedge-tailed eagle's scientific name is *Aquila audax*, which literally means 'daring — or audacious — eagle', perhaps in recognition of a claimed tendency for it to take young lambs from the paddock in front of an irate farmer's very eyes.

And so, for much of the past 200 years the species has been the subject of control campaigns throughout Australia. Governments encouraged the shooting, trapping, and poisoning of these birds, paying bounties for each corpse. Huge numbers of birds were killed — about 12 000 in Queensland in 1966 alone, for example. Eventually, attitudes changed and the last State to abolish the bounty system was Queensland in 1974. The bird is now fully protected throughout the country, apart from Western Australia.

In order to find out just what sort of a threat eagles posed to the pastoral industry, CSIRO carried out a number of scientific studies.

The late Dr Starker Leopold, from the University of California but working as a visiting fellow at the Division of Wildlife and Ecology, with an assistant, briefly examined the food of the birds in south-eastern Australia in 1964.

In 1966 a team headed by Dr Michael Ridpath and Mr Michael Brooker, of the Division's Perth laboratories, started a similar but more extensive 10-year study of the birds in the arid zone of Western Australia. Their intention was to find out whether eagles were important predators on lambs, and if the birds justified such a massive and costly control operation. At the same time they also wanted to discover whether the long-term survival of the wedge-tailed eagle as a species was itself in any jeopardy as a result of these campaigns against it. To answer these questions they had to uncover a great deal of the biology of the species.

Dr Ridpath and Mr Brooker chose two study areas — one in the dry southern inland (DSI) 400 km east of Kalgoorlie and the other in the region of the dry west coast (DWC) near Carnarvon. The DSI area comprised three sites straddling the boundaries between recently established pastoral properties, the Great Victoria Desert, and the Nullarbor Plain: one (about 410 sq. km) carried sheep; one (of 420 sq. km) 40 km north-west of that carried cattle; and an unstocked site (of about 670 sq. km) occupied uninhabited land a further 80 km north-east.

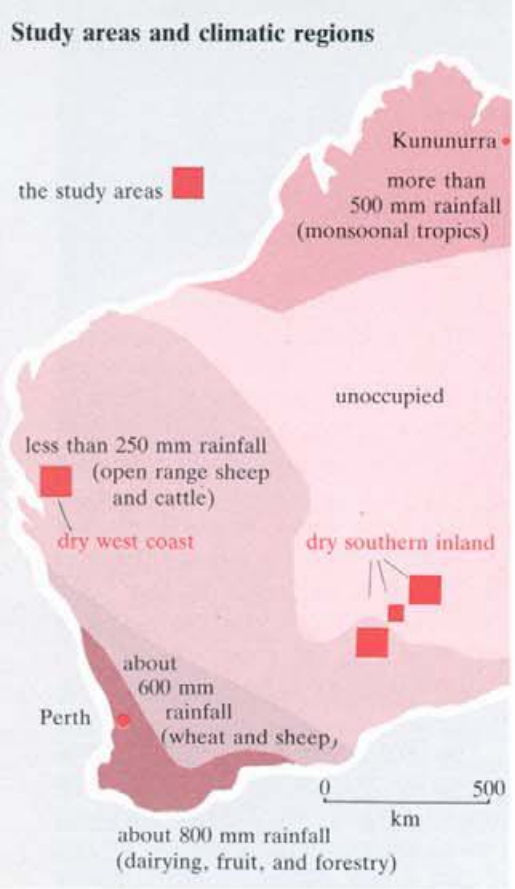
The DWC study area comprised about 650 sq. km. It lay on a sheep station in the long-established West Gascoyne pastoral region, and received an average of 203 mm of rain a year during the study, mainly between May and July, without great differences between years.

The DSI had a virtually identical yearly average, of 202 mm, but the rain here fell without any seasonal pattern and also showed considerable differences in the totals between years. Thus plant and animal life in the DSI often suffered essentially desert conditions because in several years scarcely any rain fell or, if it did, it came during the summer heat when intense evaporation quickly removed the moisture before it could do any good.

Searching ...

To record the birds' breeding and nesting, the scientists searched each study site

The scientists weighed and measured eagles, gathering much information about their general biology.



between July and December every year (bar one) for 9 years, observing nests, birds, and food remains. Further information on the diet of the animals came from brief observations in other, climatically different, regions of the State, including three inland areas — in the north, near Kununurra, the south-west, in the cereal belt, and the dry north-west (see the map).

All this was no easy task. The detailed work in the two main sites required diligent searching and recording of eagle nests. In the DSI, the scientists sat atop a vehicle and could see nests within 700 metres on either side. Their idea was to travel along a series of straight parallel transects from east to west, 1·3 km apart, thereby methodically searching an entire area. Their only problem derived from the remoteness: they had no roads to follow, so they somehow had to imprint the straight transects on the land so that they could follow these each time a search was carried out.

Dr Ridpath asked local bushmen about this and they recommended attaching to the vehicle a heavy metal chain, the dragging of which would leave a track visible for years to come (unlike the first wheel-tracks, which soon disappeared with wind or rain). It's no good doing things by halves in the bush, so Dr Ridpath obtained a chain of 7 m weighing 70 kg and duly towed it around. The problem was thereby solved and he could find his transects next year, and thereafter.

The scientists could not search the DWC region in the same fashion, because of its denser vegetation. Fortunately, however, as the site was on a property a series of tracks along fence lines already existed and these, along with frequent narrow belts of grassland, enabled the scientists to use their vehicle to obtain an effective coverage.

... and recording

Eagles nest in trees, and in these localities most trees are small and carry little foliage, thus making nests that much easier to spot. The scientists numbered each nest, noting its contents and location and tagging the host tree. They weighed any chicks, measuring wing-spans as a guide to age. They also recorded the number of young that reached the age at which they left the nest.

For information about the birds' diet the scientists took material from in and under nests. On the DWC and DSI sites, they collected the remains of prey from each occupied nest twice during each breeding season and once the following year. They also collected the birds' regurgitated pellets away from nests beneath 'perching trees', where birds often sit and eat. The food fragments and pellets were mostly bones, claws, fur, feathers, and scales, and careful analysis enabled them to determine the species and approximate age of the unfortunate victims.

To give them further help in judging how far the eagle's bad reputation with sheep-farmers was warranted, the scientists erected observation towers in the DWC site. From dawn to dusk they watched — one could say 'eagle-eyed' — the comings and goings of birds and lambs during the course of three lambings in separate years. In case they missed actually seeing the seizure of any creature, they counted the number of eagles, lambs, and adult sheep present in the paddock every 15 minutes.

Eagles and lambs

Painstaking analysis of pellets and food fragments showed that eagles are not fussy eaters — they take the most abundant available prey of the right size, including the occasional snake, although the rarity of these in the remains suggests that they are not popular items. Lizards are much preferred and are probably an important food item for very young chicks. Eagles have no qualms about eating other birds, either. Parrots (including large sulfur-crested cockatoos), magpies, currawongs, and emu chicks all contributed to the diet, and even a few birds of prey such as brown falcons and kestrels could find themselves on the other end of a food chain.

Mammals were well represented in the remains. Perhaps unexpectedly, red kangaroos and euros were important constituents of the nest food for eagles in the DWC area, although rare in the DSI. Examination of the bones showed that the majority of kangaroos eaten were juveniles. Any adult material would most likely have come from shot animals or others already dead — eagles are not averse to carrion — as the birds can only lift about 5 kg so could never transport a fully grown roo. However, that doesn't stop them from occasionally hounding large animals like adult kangaroos and feral goats, even causing their deaths!

Small mammals, such as juvenile foxes and wild cats, were important components

Eagle facts and figures

The wedge-tailed eagle is the largest of all our birds of prey, with a wing-span of up to 2·5 metres and an average weight of 3·5 kg. It is a dark bird, with a pale bill, and feather-covered legs that make it appear to be wearing trousers! Its distinctive feature is its long diamond-shaped tail — the wedge of its name. Soaring to great heights by gliding in slow circles, it surveys its large territory for any signs of suitable prey. Like all birds of prey, it has superb eyesight. The wedge-tail has a rather sharp, grating call, most often heard when on the wing during the mating period.

Biologists estimate that these birds may live for up to 20 years, and we know that they take at least 6 years to reach sexual maturity. Thereafter, they can breed every year — usually in the winter — if conditions are suitable. The hen lays an average clutch of two eggs, which are large and therefore require some time to produce. The young remain in the nest for 6–7 weeks after hatching, but usually only one survives.

The nest is large, made of strong sticks, and lined with fresh leaves at the time when eggs are laid. Nests can be used again year after year.

Tagging experiments have revealed that eagles, particularly the immature ones, can travel several hundred kilometres, and may do so when conditions are bad in one region. The species has a very wide range, from woodlands, forests, and mountain heaths to dry almost treeless plains. It occurs throughout Australia, including Tasmania, and also in southern regions of the island of New Guinea.

Lambs and eagles

	dry west coast	dry southern inland	south-western inland
area per eagle breeding pair (sq. km)	72	103	130
number per 100 sq. km during 90-day lambing			
eagles present	6	4	3
lambs born	400	750	12 700
lambs dying (all causes)	80	150	2540
lambs eaten by eagles (some died from other causes)	17	4	11
lamb as percentage of food biomass	24	8	31

Eagles eat lambs, but are not a major cause of lamb deaths.

in the DWC study area. Goats roamed in some parts of it, and nest food here contained the remains of their kids. By contrast, in the DSI these food items were almost never seen, and rabbits formed the major source of food during nesting — whereas these accounted for only about 10% of the food in the DWC.

And what of sheep? The scientists found small quantities of their remains in the nest food wherever sheep occurred, and in whatever climatic zone. However, we can't jump to any conclusions yet, because during the dawn-to-dusk observations of lambings, which totalled 367 hours, the team only recorded two killings, although eagles did perch near ewes and fly low over lambs and their mothers. Eagle attacks leave distinctive marks on lambs, unlike those of other predators such as dogs and foxes, and so the scientists, travelling by motorbike through lambing areas, were able to identify any animals killed in this way — some were potentially viable when taken.

However, eagles are not only predators but also scavengers — Australia has no vultures — and it is important to take this into account in assessing how guilty they really are. On the two sheep stations studied, the estimated number of lambs they consumed as both live prey and carrion usually represented only a small proportion of the total lamb loss. The breeding season of the eagles coincided with lambing in most areas of southern Western Australia, so an examination of food remains found at nests gives some idea of the importance of lambs as a food source for them.

Analysis of information on the density of adult sheep, lambs, and eagles in the DWC area produced estimates that, on average, eagles ate 17 lambs per 100 sq. km during a 3-month lambing period and this represents about 4% of lambs born. The equivalent figures in the DSI area were lower — 4 lambs per 100 sq. km, which is less than 1% of lambs born. Many new-born lambs in Australia die due mainly to mismothering, starvation, exposure, and difficult births, with an average loss estimated at 20%. Clearly the few lambs eaten by eagles in this study included those that were either dead or doomed for reasons other than eagle predation.

Rabbits

It seems fairly conclusively proved that, although they do kill the occasional lamb, eagles are not guilty of seriously harming the sheep industry, and the intensive control campaigns of earlier this century are certainly unwarranted. Studies in eastern australia in the mid '60s drew similar conclusions (see *Rural Research* 86, 1974, pp. 15–16).

What the birds eat varies considerably with the availability of suitable prey, which depends on the location. Dr Ridpath and Mr Brooker noticed pronounced differences in the composition of food between the DWC, the DSI, and the south-western inland areas.

For instance, although present in the DSI, grey kangaroos were absent from the DWC area, which nevertheless contained a far greater variety of prey on the whole. In the DSI, rabbits were the main component of the diet. Indeed, in the unstocked portion of this site, they accounted for 98% of the biomass of the food! From careful observation and feeding trials with captive birds, the scientists estimated that two adult eagles — feeding only themselves — would take, during the course of a year, about 9 rabbits per sq. km in this area, compared with an average of 0·5 per sq. km in the DWC area.

Are the eagles therefore useful in controlling the numbers of some pest species? After finding them innocent of being pests themselves, it would be nice to award them this accolade, but the facts suggest otherwise. The scientists estimated the rabbit population in the DSI site as 170 per sq. km in September 1974, when the rabbit numbers were not excessive. If all eagles in the area ate only rabbits, day in and day out (which sometimes is almost the case),

The birds were also banded, and then released.

they would only take about 6% of the rabbits in a year. (Partly this arises from the fact that the land carries so few eagles per sq. km because each bird's territory can cover as much as 40 sq. km.)

At times, rabbit densities can be far higher. During a rabbit plague in South Australia the population density reportedly reached 3500 per sq. km. Even the most gluttonous eagles would be hard pressed to make a tiny dent in such a figure!

So it seems that rabbits, by breeding in the way for which they are renowned, far outstrip the predators' capacity to exert any significant brake on their numbers. In fact the relationship works the other way round — that is, in an area such as the DSI study site, the breeding of eagles depends on the number of rabbits.

With their figures for eagle-breeding derived from their data from all the nests, the scientists saw that breeding in the DSI study area only occurred when the rabbit population already stood above a critical threshold 3–4 months earlier. They calculated that the eagles never bred there unless the density of rabbits had reached 60 per sq. km in either late summer or early winter. In very similar arid country on the other side of the continent, Mr Graham Robertson of the New South Wales Parks and Wildlife Service, working co-operatively with the Division from 1980 to 1985, found that, in order to breed, eagles needed the same minimum density of rabbits there as they needed in the west.

As the rainfall was unpredictable in the DSI, some years were far drier than average and food for the rabbits was thus much reduced. Their numbers then sharply declined, and the eagles could not breed. In some places eagle breedings could be as much as 4 years apart.

An eagle nest in the Dry West Coast area.

Some nests are a little higher up, such as this one perched in a myall tree in the dry southern inland area.

Eagle eggs in a nest lined with fresh green leaves; later, young chicks will be surrounded by pieces of rabbit prey brought by the parents.

But most of the adult eagles present would survive these lean times, unlike other predators such as foxes and cats. Especially during bad times, 'adolescent' non-breeding birds would leave the area in search of better conditions, some travelling as much as 600 km, according to the scientists' banding experiments. Their hunting abilities would become finely honed during these immature years. The older, settled birds would remain in the area, scouring their vast territories by gliding on warm air currents, to conserve energy. Thus they would spot any signs of living creatures in their domain, whereas the ground-based predators, unable to cover such wide areas, would most likely starve before chancing upon a living rabbit.

Eagles bred far more regularly in the DWC study area, despite the fact that it had practically the same average annual rainfall as the DSI. Its vegetation was far more diverse than that of the DSI, partly because of the nature of its soil, but also thanks to the comparative regularity of its rainfall and growing season. As a result it supported 31 suitable species of animal prey in sufficient abundance for eagles.

This wide range of prey tended to buffer the eagles against the effects of fluctuations in the numbers of one particular species that might occur from time to time. Furthermore, such fluctuations would actually be far less likely than in the DSI because of the more permanent nature of the vegetation. And that stability of their resources allowed most adult eagles to breed every year in the DWC and to successfully rear more young, on average, than in most of the DSI.

A conservative

The research of Dr Ridpath and others has also contributed some interesting insights to the field of desert animal ecology. Deserts are often thought of as largely the domain of opportunist animals, which quickly increase in number during the good times and disappear in the bad.

However this work has shown that the wedge-tailed eagle is a slow reproducer, living a long life. It usually produces only two eggs with each breeding, and needs 5–6 years before it can breed; but it may live as long as 20 years. It has a distinctive ability to 'hang in there' during tough times, when fast-breeding rabbits die. It doesn't take any reproductive risks, breeding only when the food supply permits. In brief, the eagle is a cautious 'long-term

The old days: wedge-tailed eagles killed by farmers and strung along a fence in Young, N.S.W., in 1965.

investor' — it even nests in long-lived, slow-maturing, reproductively conservative desert trees!

In these respects it differs considerably from many other species that are successful in arid zones. These are the opportunists that 'make hay while the sun shines' — which in this context, paradoxically, means when the rain falls — by breeding rapidly and producing large numbers of offspring from each breeding whenever the chance presents itself.

Such opportunists are generally small and short-lived; they mature quickly, have a brief gestation period or egg-production and development period, and have a large litter or clutch size. Their strategy can be risky, as the good times can dry up quickly and leave a large population with insufficient resources to support it. Examples of these boom-and-bust creatures are locusts, budgerigars, plague mice, and rabbits. But opportunism, although it can lead to the deaths of large numbers of individuals, usually succeeds as far as the species is concerned. The logic is that if sufficient individuals exist, then at least a few are likely to survive somehow or other when conditions are harsh, and just two will be sufficient to bring the population back again rapidly when the good times return.

It is interesting that the long-lived, slow-maturing, and reproductively conservative wedge-tailed eagle, with its very efficient adaptations, can also succeed in arid environments. Perhaps we identify with it — biologically speaking, humans fall into the same category — for somehow it seems right that the long-term conservative investors, diligently taking care over their reproduction, should be at least as successful as the fast opportunists of the animal world.

Young eagles possess a long brown bar on their wings, the width of which decreases with age, so by the time the animals are 6–7 years old the bar has disappeared.

The future

Wedge-tailed eagles are found in many climatically diverse areas: the cool subalpine regions of Tasmania, New South Wales, and Victoria; the tropical lowlands; the Mediterranean zone; and the unpredictable arid zone. The studies of Dr Ridpath and Dr Brooker have led them to conclude that it is the bird's dietary flexibility, great mobility, and reproductive conservatism that allow it to occupy such a wide range of habitats.

It is not, currently, in any obvious danger in most of these areas, being a protected species. However, its slow rate of reproduction could leave it in a shaky position if other factors disturb it. Foremost among these is probably not the occasional shot from an irate farmer, but rather — as with so many species — the destruction of habitat, as land clearance and some pastoral degradation proceed in the better parts of the eagle's range.

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More about the topic

The breeding of the wedge-tailed eagle, *Aquila audax*, in relation to its food supply in arid Western Australia. M.G. Ridpath and M.G. Brooker. *Ibis*, 1986, **128**, 177–94.

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Sites and spacing of nests as determinants of wedge-tailed eagle breeding in arid Western Australia. M.G. Ridpath and M.G. Brooker. *Emu*, 1987, **87**, 143–9.

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