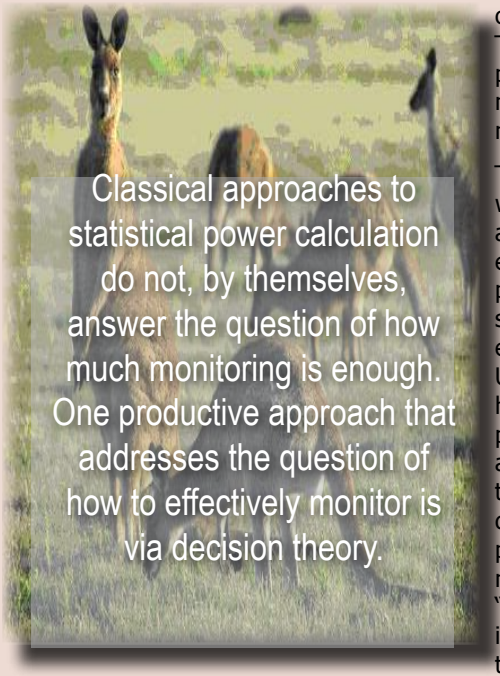
A more effective way of determining how much monitoring is enough

How do you know when you've got enough information from a monitoring program? When it comes to estimating the size of a wild animal population this question has been traditionally answered by implementing a monitoring program that collects enough data to ensure a statistically robust estimate. For ongoing management the monitoring program is usually repeated at the same intensity at regular time intervals (often once a year). However, a growing number of scientists are suggesting that we should be able to do better than this.

If the monitoring program is costing a lot of money, and almost every form of monitoring is expensive, we need to ask 'how much information do we need to make a good decision?' It could well be that it's possible to make an equally good decision without collecting all that (expensive) information. To underline what it might mean to design your monitoring around the management decisions you're informing, a group of ecologists from the University of Queensland analysed how this might apply to the setting of harvest quotas for red kangaroos. They investigated the optimal monitoring of a harvested population by integrating the costs and likely outcomes of monitoring within the framework of decision theory.



In South Australia the authorities undertake yearly aerial kangaroo surveys and use this data to estimate the size of the overall 'roo population. They then set the following season's 'roo harvest at a proportion of this population. In the last decade, the annual harvest has ranged between 12% and 22% of the estimated population in the previous survey.

These population estimates also provide feedback to the authorities on whether or not their management has been successful in the recent past. If the population is too small, there's a risk of extinction for the local 'roo population, and harvest isn't economically viable. If the population is too large, the 'roos cause unacceptable levels of damage to the graziers' property and compete with domestic livestock for food.

Even though counting kangaroos provides these benefits, it's a costly activity. A survey of the numbers of red kangaroos in the pastoral zone of South Australia costs about $50,000 Australian dollars. The current management procedure involves monitoring with the same effort each year, providing a population estimate with relatively constant precision and cost.

A less costly alternative to monitoring every year is to predict the population size using a population model and information from previous surveys. With over two decades of careful monitoring and data analysis already achieved, this is a feasible option for kangaroo management. The researchers weighed up the risks and savings associated with skipping a kangaroo survey and instead basing the harvest quota on a model-based prediction. In their model, 'roo population fluctuations are caused by variable rainfall and its effect on food availability. Freely available rainfall data are used to predict whether the 'roo population is likely to have increased or declined in the past year.

Using a model-based prediction of the 'roo population size to set the harvest quota would save money, but the prediction is subject to greater error. This increases the risk of setting an inappropriate harvest quota: take too many this year, and the population could decline dramatically and jeopardise future harvest; take too few and the graziers could be subject to property damage. Using an (expensive) aerial survey should provide a more accurate estimate and a reduced risk of these management problems. The researchers weighed up the probabilities and consequences of making such mistakes under each management approach.

Their analysis demonstrated that whether you should monitor in a given year depends on the estimated population size in the previous year, the uncertainty surrounding that population estimate, and past rainfall. Uncertainty in past estimates and high rainfall lead to a model-based prediction that is highly uncertain, and so an aerial survey is preferred to ensure an appropriate harvest quota is set. When past estimates predict that the population could now be teetering on the edge of "too small", again an aerial survey is warranted to reduce the risk that the population will be over-harvested. In other circumstances, however, there is sufficient evidence that the 'roo population is in a safe range. The authorities can save their monitoring dollars, set their harvest quota from the model prediction, and accept a low risk of having made a mistake.

The researchers' conclusion was that a monitoring regime that varies according to the state of the environment can outperform fixed interval monitoring. However the goals of management need to be clearly stated: here it was to use harvest to maintain 'roo population size within a certain range. The same approach to planning monitoring could be applied to other management issues such as invasive species control or the conservation of a threatened species.

Further reading

The ideas presented in this AEDA information sheet are based on the paper:

Hauser, CE, Pople, AR, Possingham, HP. (2006), Should managed populations be monitored every year? *Ecological Applications*, 16(2), pp 807-819.

AEDA Info Sheet #1.3 (Nov 07)
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