March 1992

A ROLE FOR FERTILITY CONTROL WILDLIFE MANAGEMENT IN AUSTRALIA?

Mary Bomford
Bureau of Rural Resources

Peter O'Brien
Bureau of Rural Resources

A ROLE FOR FERTILITY CONTROL WILDLIFE MANAGEMENT IN AUSTRALIA?

MARY BOMFORD and PETER O'BRIEN, Bureau of Rural Resources, P.O. Box 858, Canberra ACT 2601, Australia

ABSTRACT: Increasing community awareness of the moral and animal welfare issues associated with conventional pest animal control has focused interest on non-lethal alternatives, such as fertility control. In Australia, animal welfare organizations have proposed fertility control as a solution to pest problems with feral horses and kangaroos. Wildlife damage control achieved by non-lethal, non-toxic and humane means would have wide appeal and application. Importantly, assessments of effectiveness must focus on damage control, rather than fertility control, per se. Most tests of fertility control drugs and techniques examine effects on reproduction, rather than on population dynamics. Many tests and models have not been robust enough to allow clear conclusions about the usefulness of the technique in damage mitigation. The present role of fertility control in wildlife management in Australia is extremely limited. Its longer-term potential will depend on the successful outcome of future research, development and extension. It also requires an assessment of the economic, environmental and welfare implications of using fertility control for wildlife management. The main barrier to the use of fertility control to manage pest animals is the lack of delivery techniques suitable for widespread and abundant animals. If drugs become available that cause permanent infertility with a single dose, or if current research leads to a technique for the passive spread of anti-fertility agents via infectious organisms, the potential for population management by fertility control for some species, such as foxes, will be increased. No such drugs or techniques are currently available.

Proc. 15th Vertebrate Pest Conf. (J. E. Borrecco & R. E. Marsh, Editors) Published at University of Calif., Davis. 1992

INTRODUCTION

Wildlife managers in Australia currently control vertebrate pests by conventional methods that include lethal techniques such as poisoning, shooting and trapping. Biological control, habitat manipulation and exclusion are used to a lesser extent (Wilson et al. 1992). These are currently the only cost-effective means for wildlife population control. There is, however, an increasing public perception that fertility control is preferable to traditional lethal methods. This view is based largely on beliefs that methods in current use are inhumane, or that it is immoral to kill animals, and that fertility control offers a better alternative.

In response to persistent, large-scale opposition to conventional pest control in Australia, much of it from overseas, the Department of Primary Industries and Energy sought a review of fertility control by the Bureau of Rural Resources, with the following objectives:

- describe mechanisms of fertility control;
- evaluate application in Australia; and
- identify research directions.

The review was restricted to approaches that have been tested in wild animal populations. This paper describes the main findings and conclusions of that review (Bomford 1990).

MAIN FINDINGS

For fertility control to be successful, the following seven requirements must be met:

Available Drug or Technique

A great many drugs and chemicals cause temporary infertility in animals (Kirkpatrick and Turner 1988, Marsh 1988, Bomford 1990, Tyndale-Biscoe 1991). The application of fertility control to managing pest wildlife populations is not restricted by any lack of drugs that have been demonstrated to cause infertility in captive animals. Hence, the discovery and testing of more contraceptive drugs is unlikely to advance wildlife management by fertility control.

Research into reproductive inhibition by immunising animals against sperm or reproductive hormones or proteins is a relatively recent development in fertility control for wildlife management. Immunisation usually requires a minimum of two injections with a break between, plus annual booster injections. A new approach being investigated, is to use microencapsulated time-release immunocontraceptives, to enable a single inoculation to confer infertility for over a year (Stelmaziak and Van Mourik 1990).

Immunocontraceptive techniques will need to be field tested by designed experiments on large samples of wild animals before their effectiveness for animal damage control can be assessed. Further, the potential economic and environmental advantages of these techniques must eventually be weighed against social, ethical and ecological considerations and risks.

An Effective Delivery Mechanism

The lack of techniques to deliver drugs to an adequate proportion of the target population is the major obstacle to using fertility control to manage extensive wild animal populations.

Many tests on caged animals, or animals in small enclosures, relied on drugs being delivered by surgical implantation, repeated injections or daily oral doses in food or drink (Kirkpatrick and Turner 1988, Marsh 1988). These approaches are not feasible for widespread and abundant wild populations, particularly in remote areas or inaccessible terrain.

There are a number of problems to be overcome in the delivery of implants and injections:

- high costs
- requirement for anaesthesia
- risk of infections
- capture trauma
- multiple dose toxicity
- requirement for repeat dosing of individuals
- failure to treat sufficient animals

Although fewer, there are also significant delivery problems with oral dosing:

- poor bait acceptance
- overdosing
- non-target species
- treating enough animals
- drug deterioration
- high costs

Virally vectored immunocontraception is a novel concept involving inserting foreign genes into live viruses to cause infertility, which is still in the early stages of research and development (Tyndale-Biscoe 1990). If this research comes to fruition, the technique will have the potential for passive spread of antifertility agents through a population, overcoming much of the expense and technical difficulty of delivery. Current research in this area focuses on the control of rabbits and foxes, Australia's major environmental pests.

There are very substantial problems to be overcome before virally vectored immunocontraception can be developed for field release, in the diverse fields of genetic manipulation, reproductive biology, virology and on the ecology and social behaviour of the target species (Bomford 1990, Tyndale-Biscoe 1990). It is not yet possible to assess the potential effectiveness of this technique in animal damage control.

Humaneness and Low Toxicity

Although many of the drugs used to control fertility are humane and non-toxic, some can affect animal health and welfare. They may have unpleasant side effects (Lofts et al. 1968, Ericsson 1970) or be toxic (Cummins and Wodzicki 1980).

Drugs that cause the death of embryos or the pouch young of marsupials may be perceived as inhumane, if the effect occurs after the development of sentience (Singer 1974). Delaying reproduction in seasonal breeders may subject young born late to increased mortality which may also be considered inhumane (Kirkpatrick and Turner 1985).

Target Specificity

Few drugs are species-specific in their antifertility action, and some are toxic to non-target species. For example, α-chlorohydrin causes temporary infertility in sheep and pigs, which may limit its use in agricultural areas (Ericsson 1982). Some drugs could cause infertility or other harmful effects in operators using them for wildlife control if accidentally ingested or absorbed through the skin. Carcinogenic compounds could pose a risk if used on wildlife taken for human consumption.

The proposed development of genetically engineered viral vectors that cause infertility in pests will require risk assessment for target specificity. These risks may lead to restrictions on the release of genetically modified organisms.

Environmental Acceptability

Residues of toxins and sterilants from baits or carcasses could enter the food chain and pose a risk to other wildlife or people (Marsh 1988). Genetically engineered organisms in particular will need to be rigorously tested to minimise the risk of undesirable environmental consequences (Tiedje et al. 1989).

Cost Effectiveness

Cost is a major obstacle in the use of fertility control as a wildlife management technique. Although the technology for fertility control of individuals does exist, its implementation can be prohibitively expensive for widespread and abundant pests.

In areas where land and native species are managed for conservation, and on agricultural lands subject to animal damage, the cost of fertility control must be no more than alternative conventional methods of pest control, unless there are advantages to justify additional expense, such as a reduced impact on non-target species, or community attitudes dictate acceptance of increased costs.

Most of the more expensive techniques for fertility control, such as those requiring surgery, implants or frequent or continuous dosing over an extended period, are likely to be used only where benefit-cost ratios are not a central consideration, such as in exhibition parks or small private collections.

The expense of delivery by conventional techniques means that only virally vectored immunocontraception shows any promise as a cost-effective technique for fertility control of widespread pests in remote areas.

Reduction in Population Size and Damage

Treatment effects on target populations must be of sufficient magnitude, rapidity and duration to achieve the objective of damage control.

An understanding of population ecology is the key to assessing whether fertility control will be an effective management tool for pests, and if so, in what circumstances it can be used for each species. Research into fertility control has largely neglected this critical test of effectiveness.

Theoretical models constructed to simulate fertility control in wildlife populations have overestimated its effectiveness (Bomford 1990). They are often based on higher levels of fertility control than have been achieved in field trials. Many models assume the use of a technique or sterilant that causes permanent infertility in both sexes without affecting libido or social behaviour. Other than surgical sterilisation, no such sterilants are known. Further, theoretical models tend to ignore or underestimate factors which would reduce the effect of fertility control on animal numbers, such as mating with more than one partner, and compensatory changes in immigration, emigration and mortality (Sturtevant 1970, Knipling and McGuire 1972, Spurr 1981). Control techniques for widespread and abundant pests must be directed at populations and based on processes influencing their dynamics.

Determining the factors that regulate density is an essential first step in assessing appropriate population control strategies, and will give a strong indication of the likelihood of success or failure for techniques using fertility control. We know disappointingly little about this central question in ecology when it comes to practical application. Specifically, we have insufficient information on any pest species to know what effect changing fertility levels will have on populations.

Producing infertility in a proportion of a population does not ensure a corresponding reduction in population growth. There is usually a non-breeding surplus of adults in a population, that may breed if other adults become infertile. For example, G. Caughley and co-workers (pers. comm.) modeled the effect of fertility control on animals that live in groups in which the dominant female suppresses breeding in subordinate females. Their model predicts that if an anti-fertility treatment prevents this natural suppression of breeding, then treatment of a random proportion of females in a target population could increase the total number of females that breed. These effects could occur even with an antifertility treatment that left animals endocrinologically intact

Compensatory responses in populations can have major influences on density. For example, where density dependent juvenile mortality is high, partial suppression of breeding is unlikely to depress population size. Decreased fertility may simply prevent the birth of young that would otherwise have died as juveniles. Hence, it is often necessary to produce infertility in a very high proportion of females to cause a decline in population growth rate.

If damage mitigation rather than reduced reproductive success is the objective, fertility control may not be an advantage and may even be counterproductive, if it allows large numbers of non-breeding individuals to remain in a population.

For most pest populations, fertility control is likely to be less effective at reducing numbers than conventional control techniques that enhance mortality. Fertility control is likely to be of more value for preventing or reducing the rate of growth of pest populations mat have already been reduced to levels well below uncontrolled density by other means, such as drought, disease or conventional control.

FUTURE RESEARCH

It is important that research objectives focus on the effects of fertility control on animal abundance and damage, rather than being limited to the effects on reproductive success.

Some research directions in fertility control show little or no promise for the regulation of abundant or widespread wildlife. They include investigation into techniques which:

- require continuous or repeated oral dosing, because of the cost and impracticality of this approach
- involve surgical implantation, because of the cost and difficulty of treating sufficient animals with this method
- affect males only, because promiscuous mating in most mammals negates the effect of even very high levels of male infertility.

Research directions that show promise of pay-off are:

- developing oral delivery techniques for drugs that control fertility of animals with short breeding seasons, for example, foxes; because the cost of treatment may be acceptably low if drugs only need to be delivered for a few weeks each year
- investigating fertility control to preventrecovery growth of populations reduced by other means, because population modeling indicates fertility control may be more effective for slowing population growth, than for reducing populations; and
- investigating the development of genetically engineered viruses to spread infertility through target pest populations, because this approach is potentially species-specific, and will reach most of the population with no distribution costs.

CONCLUSIONS

There are many drugs and techniques that cause infertility in pest animals, and that are both environmentally acceptable and humane. But delivery of fertility control drugs to wild populations, and achieving animal damage control that is cost-effective, are major problems, and these are the areas where research should be targeted.

The immunological approach to fertility control has considerable appeal because it is potentially species specific, humane, leaves no toxic residues, and the compounds are inactive orally, so there are no primary or secondary effects on non-target species.

Genetic engineering of viruses that cause immunological infertility in wild populations is the only approach that shows any real potential to overcome the problems of delivery and cost for widespread and abundant pest populations. However, this is high risk research, involving a series of complicated steps, and has a relatively low likelihood of successful implementation.

Antifertility agents will not be a panacea. If they work at all, they will need to be used tactically, with the choice of an appropriate chemical or immunogen and delivery mechanism, taking account of non-target species, environmental pollution, economics, numbers of animals and alternative methods.

Although the technology for fertility control does exist for some pest species, its implementation can be prohibitively expensive. None of the available techniques for fertility control have been demonstrated to be cost-effective for reducing pest density.

Although some approaches to fertility control may have application to pest management, the concept has been over-enthusiastically promoted by vested interests. This is perhaps unfortunate, because it has been at the expense of developing alternative measures, such as exclusion, habitat modification, enterprise substitution and commercial use, which are also potentially humane alternatives.

LITERATURE CITED

BOMFORD, M. 1990. A role for fertility control in wildlife management? Bureau of Rural Resources Bulletin No. 7. Australian Government Publishing Service, Canberra. 50 pp.

CUMMINS, J.M., and K. WODZICKI. 1980. Effects of alpha-chlorohydrin on the male reproductive tissues of the Polynesian rat *Rattus exulans.* New Zealand J. Zool. 7:427-434.

ERICSSON, R.J. 1970. Male antifertility compounds. U-5897 as a rat chemosterilant. J. Reprod. Fertil. 22:213-222.

ERICSSON, RJ. 1982. Alpha-chlorohydrin (Epibloc): a toxicant-sterilant as an alternative in rodent control. Proc. 10th Vert. Pest Cont. Conf. (R.E. Marsh ed.), University of California, Davis, Calif, pp. 6-9.

KIRKPATRICK, J.F., and J.W. TURNER. 1985. Chemical fertility control and wildlife management. BioScience 35:485-491.

KIRKPATRICK, J.F., and J.W. TURNER. 1988. Fertility control in wildlife management: a review. Unpublished report, 46 pp.

KNIPLING, E.F., and J.U. McGUIRE. 1972. Potential role of sterilisation for suppressing rat populations: a theoretical appraisal. US Department of Agriculture, Agricultural Research Service Technical Bulletin No. 1455:1-27.

LOFTS, B., R.K. MURTON, and J.P. THEARLE. 1968. The effects of 22,25 diazacholesterol dihydrochloride on the pigeon testis and reproductive behavior. J. Reprod. Fertil. 15:145-148.

MARSH, R.E. 1988. Chemosterilants for rodent control. In Rodent Pest Management. I. Prakesh (ed.). CRC Press Inc. Boca Raton, Florida, pp. 353-367.

SINGER, P. 1974. Animal Liberation, a new ethic for our treatment of animals. Avon, New York, 297 pp.

SPURR, E.B. 1981. Modelling of the effects of control operations on possum *Trichosurus vulpecula* populations. In Proceedings of the Symposium on Marsupials in New Zealand 1. B.D. Bell (ed.), Zoological Publication 74, Victoria University, Wellington, pp. 223-233.

STELMAZIAK, T., and S. VAN MOURIK. 1990. Contraception - the concept and practical applications in wildlife management. Proc. Fertil. Com. in Wildl. Conf. Melbourne. Unpublished.

STURTEVANT, J. 1970. Pigeon control by chemo-sterilization: population model from laboratory results. Science 170:322-324.

TYNDALE-BISCOE, C.H. 1990. Viral vectored immunosterilisation: a new concept in biological control of wild animals. Proc. Fertil. Cont. in Wildl. Conf. Melbourne. Unpublished.

TYNDALE-BISCOE, C.H. 1991. Fertility control in wildlife. Reprod. Fertil. Dev. 3:339-343.

WILSON, G.R., N. DEXTER, P. O'BRIEN, and M. BOMFORD. 1992. Pest animals in Australia: a survey of introduced wild mammals. Bureau of Rural Resources and Kangaroo Press, Canberra 95 pp.