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The black-footed ferret recovery programme; a strong advocate for establishing semen banking programmes as support tools for small population welfare.

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The black-footed ferret rescue and reintroduction programme described in this issue by Howard et al. (2016) represents an outstanding, and possibly unique, conservation project. It has involved genuinely valuable collaboration between veterinarians, field biologists, ecologists, epidemiologists, regulatory authorities and reproductive technologists, all of whom focused their expertise on solving a single problem, the rescue of the black-footed ferret from extinction. These colleagues shared the same vision and sense of optimism; back in the early to mid-1980s it would have been all too easy for sceptics to have pointed out, citing a series of valid reasons, that their mission was hopelessly doomed to failure. Nevertheless, Howard et al. (2016) vindicates the enthusiasm shown by the originators of the black-footed ferret programme.

The success of this large programme can be traced back to the initial establishment of a suitable semen freezing and artificial insemination (AI) protocol for the black-footed ferret (for reviews, see Howard, Marinari & Wildt, 2003; Santymire et al., 2014). Without these technologies, it is much less likely that the project would have succeeded using conventional captive breeding techniques alone. Howard et al. (2016) highlights the genetic benefit to the black-footed ferret population that has been gained through the use of AI. By having the foresight in the early days to cryopreserve semen samples from a few of the original males, it has been possible to minimize the loss of genetic diversity within the extant population. This is clear in Howard et al. (2016), as animals bred from stored semen showed lower inbreeding coefficients and mean kinships than other individuals in the modern ex situ population. The establishment of a species-specific genetic resource bank and its use for genetic supplementation provides genuinely useful support to species conservation programmes. The biobanking community has been awaiting such a demonstration for many years.

As pointed out in the article, developing a successful AI method with frozen semen is a very demanding task. Collecting and freezing semen samples from a species that has not hitherto been investigated for this purpose is extremely difficult, and success requires both judgement and an element of luck. In the 1980s, many advocates of conservation via the use of frozen semen and AI were misled into thinking that semen freezing techniques are easily transferable between species. This view was coloured by the huge success of the dairy industry, where breeding from frozen semen had become the norm, and also the increasing use of semen freezing techniques in human clinical practice. I well remember David Wildt, a coauthor of the focal article, trying to rectify this view and convince people at numerous talks that cheetahs are not equal to cattle!

For an AI programme to be useful, it needs to achieve such a high level of success that it is almost boring! After all, in contrast to well-publicized stories about cloning endangered species, the birth of a cow or pig by AI no longer attracts media attention. Although there are papers in the literature listing AI births from over 50 species (Fickel, Wagener & Ludwig, 2007), most of these report small numbers of successes. The great achievement of the black-footed ferret programme was to develop an entire suite of techniques, including management of the females and the surgical delivery of a tiny volume of frozen-thawed semen, which could be relied upon to work. The secret of this success lies in the amount of effort and resources invested by the protagonists of this project, as well as the ability and enthusiasm of the researchers involved. It is noteworthy that the AI procedure involved surgical insemination directly into the female reproductive tract. This is a very demanding procedure that requires exceptional knowledge, skill and dexterity. Without doing a disservice to other practitioners of AI, it is clear to me that the project is likely to have been far less successful without JoGayle Howard's hugely valuable input.

From the outset, the researchers involved in the black-footed ferret project realized that their goal was not simply to breed as many ferrets as possible, but to use the technology for minimizing the deleterious problems of inbreeding. As demonstrated here, collecting and storing frozen, but viable, semen from threatened populations remains a valuable tool for supporting genetic diversity. Because small populations become progressively inbred without the importation of unrelated animals, it would be wise to bank semen from males in closed populations before they die and can no longer contribute to the next generation. Although this seems obvious to reproductive cryobiologists, it is rarely put into practice. In contrast, cryobiologists working in plant conservation have attracted major funding that supports grandiose plans such as the Millennium Seed Bank in the UK (Griffiths et al., 2015). Although this policy cannot in practice be applied to all candidate animal species (for example, it is still not possible to freeze and recover viable spermatozoa from marsupials (Johnston et al., 2001)), genetic resource banks should be integrated into species management plans where there are good grounds for believing that AI techniques are practical and likely to succeed. Unfortunately, although several modelling studies have confirmed that the genetic welfare of small populations would benefit from the establishment and use of genetic resource banks (Halbert, Grant & Derr, 2005; Harnal et al., 2002; Wildt et al., 1993), the black-footed ferret programme is probably still the only practical demonstration of its value. Howard et al. (2016) provides a glimmer of hope that the approach can be applied to active conservation management, and its success for the black-footed ferret will most likely result in more attempts with similar outcomes.

Fickel, J., Wagener, A. & Ludwig, A. (2007). Semen cryopreservation and the conservation of endangered species. Eur. J. Wildlife Res. **53**, 81-89.

Griffiths, K.E., Balding, S.T., Dickie, J.B., Lewis, G.P., Pearce, T.R. & Grenyer, R. (2015). Maximizing the phylogenetic diversity of seed banks. Conserv. Biol. **29**, 370-381.

Halbert, N.D., Grant, W.E. & Derr, J.N. (2005). Genetic and demographic consequences of importing animals into a small population: A simulation model of the Texas State Bison Herd (USA). Ecol. Model. **181**, 263-276.

Harnal, V.K., Wildt, D.E., Bird, D.M., Monfort, S.L. & Ballou, J.D. (2002). Computer simulations to determine the efficacy of different genome resource banking strategies for maintaining genetic diversity. Cryobiology **44**, 122-131.

Howard, J.G., Marinari, P.E. & Wildt, D.E. (2003). Black-footed ferret: Model for assisted reproductive technologies contributing to in situ conservation. In Reproductive

Science and Integrated Conservation.: 249-266. Holt, W.V., Pickard, A.R., Rodger, J.C. & Wildt, D.E. (Eds.). Cambridge: Cambridge University Press.

Howard, J.G., Lynch, C., Santymire, R.M., Marinari, P.E. & Wildt, D.E. (2016). Recovery of gene diversity using long-term cryopreserved spermatozoa and artificial insemination in the endangered black-footed ferret. Anim. Conserv. XX, XX-XX.

Johnston, S.D. & Holt, W.V. (2001). Germplasm conservation in marsupials. In Cryobanking the Genetic Resource. Wildlife Conservation for the Future?: 203-225. Watson, P.F. & Holt, W.V. (Eds.). London: Taylor and Francis.

Santymire, R.M., Livieri, T.M., Branvold-Faber, H. & Marinari, P.E. (2014). The black-footed ferret: On the brink of recovery? In Reproductive Sciences in Animal Conservation: 119-134. Holt , W.V., Brown, J.L. & Comizzoli, P. (Eds.). New York: Springer.

Wildt, D.E., Byers, A.P., Howard, J.G., Wiese, R., Willis, K., O'Brien, S.J., Block, J., Tilson, R.I. , Rall & W.F. (1993). Tiger genome resource banking (GRB) action plan. Global need and a plan for the north american region. Apple Valley, 12101 Johnny Cake Road, MA 55124, USA: CBSG.