

Horizon Scanning Series

The Future of Precision Medicine in Australia

Gene Editing in the Environment – The New Zealand Experience

This input paper was prepared by Dr David Penman (Co-Chair, Gene Editing Panel, Royal Society Te Apārangi, New Zealand) and Professor Peter Dearden, (Director of Genomics Aotearoa, Biochemistry Department, University of Otago)

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1. Abstract

New Zealand is examining how gene editing might be used within our unique cultural, social and regulatory context. The Royal Society Te Apārangi is contributing to the debate through an expert panel and this paper outlines our approach through the development of scenarios especially with respect to opportunities within conservation and environmental areas.

1.1. Background:

Gene editing provides technologies that will transform the precision and speed with which society can address key issues affecting human health, environmental management and food production. New Zealand, along with many other countries is considering how these technologies might be considered within a scientific, regulatory and societal acceptance framework.

The Society has established an expert panel with a broad disciplinary base to consider the social, cultural, legal and economic implications of revolutionary gene-editing technologies. The Panel has built on the Society's publication of an evidence update (1) on the range of new gene editing technologies now available and how they are currently being used around the world. With the area moving so quickly, the Panel agreed to produce a series of papers and presentations using a case study approach covering health, environment and agriculture. This paper outlines the Panel's approach with a focus on how New Zealand is looking at possible conservation and environmental opportunities.

1.2. Case study approach:

Case studies provide an effective mechanism to reach an audience beyond academics and researchers. They can provide practical scenarios of possible applications and challenges to their uptake. Within each area the Panel aims to consider scenarios of increasing complexity and challenges and highlight scientific, cultural social, legal, regulatory, environmental and economic issues.

The Panel has been very mindful of the need to develop meaningful consultation with Māori in producing a cultural perspective that may influence social acceptance, legislative and regulatory processes. We are aiming to move beyond consultation at the end of a review to embedding Māori views within the deliberations of the Panel.

1.3. Conservation/Environment Case Study:

New Zealand is subject to impacts of invasive pests, weeds and diseases with major implications to our natural and productive ecosystems. Once established New Zealand uses a wide range of approaches to control but with very few successful eradications. With restraints to many of the current approaches to pest management, such as animal welfare, pesticide resistance and environmental contamination, New Zealand is examining some more options. Gene drives have been suggested as a means of delivering modified reproductive controls (2). The development of gene technologies such as CRISPR–Cas9 provide the means for targeted reproductive manipulation. So what options and targets might there be and how acceptable might these be to the public?

The New Zealand Government has recently announced a policy goal of New Zealand becoming Predator-Free by 2050 (3) with a special focus on predators impacting on conservation targets. While there has been a rapid growth in community-led pest control demanding effective, safe and ethically approved management tools, it is recognised that eradication across large scales will require some new technologies. Gene drives have been touted as providing a potentially transformational technology.

Despite the 'hype' around the potential for gene drives, the Panel's case studies aim to show the significant challenges ahead and considers gene drives with invertebrate and vertebrate invasive predators (4).

Vespid wasps (the German and Common wasps) are introduced social insects to New Zealand that have had a major impact on birds, native invertebrates and tourism experience. While there is strong support for eradication of these wasps, the current tools are of limited effectiveness. Gene drive scenarios consider likely social acceptance of the technology while recognising that significant research hurdles remain. For example, understanding: wasp embryology; genetic transfer mechanisms in social insects; developing possible containment methods for population studies; understanding cultural (especially Māori) views of the interactions between humans and the natural world) and views on animal welfare, ethics and regulation.

Introduced mammals have significant impacts on conservation values. The brush-tailed possum, introduced from Australia, is a high priority for control options beyond a high reliance on toxins so a scenario examines gene drives in this context. Being a marsupial, a low reproductive rate and challenges in manipulating oocyte production suggest significant scientific barriers lie ahead. Likewise, mustelid predators especially stoats, have even more significant reproductive challenges. Rats have been intensively researched and may possess more of the characters needed for success with a gene drive. There are also concerns about possible reversibility of gene drives and risks of transfer of the modified genes to countries where our pests are native.

Gene drives may also offer potential for management of invertebrate pests in primary production. For example, the Argentine stem weevil is major pest of pastures and effective parasitic biological control is now breaking down (5). Gene drives could be targeted at the parasite or the pest. The Australian sheep blowfly is also a potential target.

Apart from gene drives, gene editing offers potential in other areas of environmental management. The incorporation of pest and disease resistance through plant breeding may be a low risk target and the recent detection of myrtle rust impacting on native plants may provide a pathway to build social acceptance for enhanced natural selection. Modified bacteria could also be important in reducing methane emissions from ruminants.

1.4. Conclusions

Rapid advances in gene technologies may outstrip societal and regulatory responses. There is much hype and excitement but we need to temper these with aligning public expectations by understanding the scientific, cultural, regulatory and societal challenges. There are opportunities but many complexities. The use of scenarios may encourage pragmatic debate and through publication in a range of media in the latter part of 2017, the Society is hoping to increase public understanding as science advances and legislative and regulatory responses are developed. The Panel recognises the need to frame the debate within national cultural, economic and environmental criteria so additional papers are being prepared on regulatory constraints and engaging with Māori.

References

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