



ISLAND CONSERVATION

Preventing Extinctions



GENETIC BIOCONTROL
OF INVASIVE RODENTS

Memo

16 June 2017

To: CBD Secretariat & Synthetic Biology Open Forum/Ad Hoc Technical Expert Group
From: Heath Packard, Director of Marketing and Communications, Island Conservation
Cc: Dr. Karen Poiani, Dr. Karl Campbell, Gregg Howald, Ray Nias, Dr. Nick Holmes, and Royden Saah

We appreciate your leadership and facilitation of these processes to enable the parties to the Convention on Biological Diversity (CBD) to consider the potential benefits, costs, and risks of emerging synthetic biology conservation tools, technologies, research, and information management. Thank you in advance for sharing this memo and the supporting documentation with the CBD Secretariat, Synthetic Biology Open Forum and Ad Hoc Technical Expert Group.

[Island Conservation](#) is a member of the [Genetic Biocontrol of Invasive Rodents partnership](#) (GBIRd) which is cautiously investigating the suitability of a potential gene-drive based self-limiting mouse for island restoration purposes. We welcome and look forward to contributing to ongoing dialogues regarding guidelines that can enable these important, step-wise investigations.

Background

Our world's island communities, plants, and wildlife are in crisis due to introduced, damaging (invasive) species, the leading cause of extinctions on islands. Most recorded extinctions have occurred on islands and 88% of IUCN RedList¹ Critically Endangered and Endangered Species reliant on islands are threatened by invasive rodents (*Mus musculus*, *Rattus rattus*, *R. norvegicus*, *R. exulans*) (Campbell et al 2015). This is a disproportionately large percentage of our world's Endangered species given that islands comprise a mere five percent of Earth's land area. Invasive species also negatively impact island peoples' food security, well-being, and livelihoods. Human activities have introduced invasive rodents (rats and mice) to 80 or 90 percent of our world's island groups (Atkins 1985; Towns 2006 respectively). There are approximately 400,000 islands on Earth (UNEP-WCMC (2015)).

But there is hope. Five hundred successful invasive rodent removal projects on islands demonstrate that eradication is one of the most impactful conservation interventions available to prevent island extinctions and benefit island communities, economies, and ecosystems. The importance of this conservation measure for protecting the world's most threatened species is well established (Jones 2016).

Unfortunately, these interventions are insufficient to match the magnitude of this global crisis. Current methods to eradicate rodents from islands rely on toxicants, and these methods have reached their limits. New tools are required to prevent island-based extinctions caused by invasive rodents, and gene drives hold significant promise (Campbell et al. 2015).

A 'horizons scan' exercise conducted in recent years by ecologists from Island Conservation and other island restoration partners researched and evaluated how combinations of new tools that may render previously intractable rodent eradication problems feasible (Campbell 2015).

¹ <http://www.iucnredlist.org/>

The horizons scan identified potential tools ranging from *rattus*-specific toxicants and self-resetting-traps to improved stakeholder community engagement methods. It also identified that the possibility of a self-limiting transgenic mouse, with a gene-drive construct that biases single-sex selection to be up to 100 percent. The notion of introducing such a mouse to a remote oceanic island to affect an eradication-by-attrition, holds great potential to be part of the transformative solutions needed to match the magnitude of the island invasive species challenge and opportunity.

Genetic Biocontrol of Invasive Rodents Partnership and Investigation

The Genetic Biocontrol of Invasive Rodents (GBIRd) program is a partnership of diverse experts from seven world-renowned universities, government, and not-for-profit organizations advancing gene drive research. Our not-for-profit conservation and humanitarian missions engage experts from governments, NGOs, and research universities including [CSIRO](#), [Island Conservation](#), [Landcare Research](#), [North Carolina State University](#), [Texas A&M University](#), [University of Adelaide](#), and [USDA's APHIS](#). Together we are cautiously investigating the feasibility of, and assessing the social, ethical, and biological risks of, gene-drive modified organisms for eradication of island invasive species. While the science and partnership have been underway for several years, GBIRd's formalized coordination and strategy emerged in 2016.

We are investigating both the feasibility and suitability of this potential tool. Our step-wise, values-based, scientific, ecological, social, and ethical investigations and risk-assessments aim to answer these key questions in the coming decade:

- *Could* we create a self-limiting gene-drive modified mouse that biases future generations to be male (or female) only, thereby achieving eradication by attrition?
- If so, *should* we do it and, under what conditions?

The research goal is to use a naturally-occurring (t-complex) and/or a CRISPR “gene drive” in mice to facilitate a bias of subsequent rodent generations to all be a single sex. If successful, GBIRd's proof of concept holds the potential to significantly expand conservationists' toolbox to reverse the impacts that invasive rodents have on islands, their terrestrial and marine ecosystems, and human communities.

But even if it's feasible that we could do it, we know that critical questions remain to be answered and careful assessments are necessary before we can determine if we *should* do it?

Gene-drive modified organisms hold promise for addressing difficult-to-solve challenges, such as the eradication of insect borne infectious diseases and the conservation of threatened and endangered species. However, proof-of-concept in a few laboratory studies to date is not sufficient to support a decision to release gene-drive modified organisms into the environment. The potential for gene drives to cause irreversible effects on organisms and ecosystems calls for a robust method to assess risks. A phased approach to testing, engagement of stakeholders and publics, and clarified regulatory oversight can facilitate a precautionary, step-by-step approach to research on gene drives without hindering the development of new knowledge.

(National Academies of Sciences, Engineering, and Medicine. 2016.)

We agree, and we align our own precautionary, step-wise approach to our research with the guidelines outlined by the US National Academies of Sciences, Engineering, and Medicine (NASEM) issued for gene-drive research. GBIRd brings together world class geneticists, evolutionary biologists, ethicists, risk assessors, math modelers, regulatory experts, social scientists, and conservation professionals to engage in

this suitability assessment.

Timeframe and Biosafety

We are probably a decade away from answering all these questions. Yet we have an obligation to undertake this research in a cautious, thorough, and step-wise way. We benchmark our assessments against the world's leading gene drive research and [public values alignment guidelines like these](#) issued by the US National Academy of Sciences and others. The diversity of assessments will need to run their course before we can collectively ask: *Could we? Should we? Under what conditions?*

While GBIRD's gene-drive research has been ongoing for a few years, it is still in its nascent stages. Developing a gene-drive modified mammal construct is a great challenge and may take years-more research to achieve proof-of-concept stages, even in the laboratory. All our gene-drive research partners are located at research universities or institutions in either Australia, the United States, or New Zealand. In every case, the researchers are adhering (as minimum standards) to the mature national, provincial, and local biocontainment laws, regulations, and protocols for genetic research. Any near-term potential risks will be well contained and managed by these jurisdictions and the researchers.

Guiding Values

We are all in this for the interests of society and nature. Like you, we want to save lives, support livelihoods, and preserve our natural world for generations to come. Our guiding principles include:

- Early and sustained consistent engagement with stakeholders and communities
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- Proceeding cautiously, with deliberate step-wise methods
- Uncompromising commitment to biosafety, existing regulations, and protocols as minimum standards
- Using international best practices for multiple risk analyses
- Soliciting external ethics reviews and considering unsolicited ones
- Transparency of research, assessment, findings, and conclusions

Partnering with CBD Parties, Stakeholders, and Communities

The investigation of the suitability of gene drive approaches for conservation, food security, and human health purposes requires time, expertise, and collaboration. Consistent with our values, adherence to existing protections, and alignment with the NASEM's gene-drive research guidelines, we welcome broadening our investigations, problem formulations, risk assessments, and social engagements with more parties. The CBD's Synthetic Biology fora provide ideal opportunities for GBIRD to strengthen our already cautionary, rigorous, step-wise investigations.

As NASEM also cautions, there is sufficient potential to warrant continued research. We cannot afford to overreact to under-informed reservations by foreclosing future options with premature research prohibitions. To be plain, we are advocates for continued, but well-guided, precautionary research and investigations that will ultimately enable local communities, society at large, and the CBD parties to determine if we could, and should, use gene drives for conservation purposes. Only together, we can answer these questions.

Thank you again for your leadership. We look forward to the coming discussions.

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