



Policy Brief

Advancing conservation goals with gene drive technologies

Biodiversity is declining at an unprecedented rate, with up to one million species currently threatened with extinction. Despite decades of conservation action, biodiversity loss continues to outpace recovery. This is driven by a set of interacting pressures, including extractive land and sea use, climate change, pollution, and invasive alien species. Existing conservation tools remain essential, but they are often insufficient to respond at the scale and speed required to reverse this trend. Synthetic biology tools, such as gene drive technologies, could complement established interventions and ultimately accelerate progress towards meeting global biodiversity targets.

POLICY RECOMMENDATIONS

- **Expand investment in research and development of innovative conservation tools:** Conventional tools are reaching their limits. Despite ongoing conservation efforts, global wildlife populations have dropped by about 68% over the last 50 years. Invasive alien species (IAS) are a major driver of biodiversity loss, costing the global economy more than US\$423 billion annually as of 2019 – a figure that has at least quadrupled every decade since 1970. Islands are particularly vulnerable to IAS. Conventional eradication methods have proven highly effective where feasible, with 88% of the 1,550 eradication programs conducted across 998 islands reaching success. Yet these methods are feasible on only around 15% of the world's islands, leaving many larger and inhabited islands beyond their reach. Bridging this gap requires greater investment in innovative approaches, including synthetic biology tools such as gene drive technologies, alongside sustained support for established eradication methods.
- **Strengthen national capacity to research and assess new tools, building on existing decision-making systems:** Support countries to develop the scientific, regulatory, and institutional capacity needed to research and potentially use synthetic biology tools, including gene drive, in line with national priorities and circumstances. Efforts should build on the frameworks that already apply to gene drive organisms, including the [Cartagena Protocol on Biosafety](#), the [CBD Additional voluntary guidance materials on the risk assessment of living modified organisms containing engineered gene drives](#), the [IUCN Policy on Synthetic Biology in relation to Nature Conservation](#), and the [OECD's Framework for Anticipatory Governance of Emerging Technologies](#), which together provide an established basis for case-by-case risk assessment, risk management, public participation, and nationally led decision-making.

Why innovation is needed in conservation

The Convention on Biological Diversity (CBD)'s Kunming–Montreal Global Biodiversity Framework (KMGBF) sets ambitious global targets for halting and reversing biodiversity loss by 2030, such as restoring degraded ecosystems, halting human-induced extinctions of known threatened species, maintaining genetic diversity within populations, and reducing the impacts of invasive alien species. Meeting these targets depends on conservation tools that can operate at the scale and pace the framework implies. Conventional approaches, including habitat restoration, captive breeding and translocation, trapping and netting, rodenticides and pesticides, remain essential. However, their

implementation is constrained by high costs, logistical complexity, and impact on other species, making widespread and sustained action increasingly difficult.

Biodiversity will continue to decline, unless proven conservation measures and community stewardship is combined with technological innovation, according to the [IPBES Global Assessment Report on Biodiversity and Ecosystem Services](#). Synthetic biology, including gene drive technologies, is one of the avenues to explore, as recognized by the International Union for Conservation of Nature (IUCN) in [Genetic Frontiers for Conservation: An Assessment of Synthetic Biology and Biodiversity Conservation](#), which provides an evidence-based assessment of

the potential implications of synthetic biology for biodiversity conservation and sustainable use. The IUCN further recognized the potential of synthetic biology approaches in its [Policy on Synthetic Biology in Relation to Nature Conservation](#).

What gene drive technologies could contribute to conservation

Gene drive technologies draw on naturally occurring gene drive phenomena, in which certain genetic elements are inherited more frequently than expected under standard Mendelian inheritance, allowing associated traits to persist and spread through successive generations. Scientists are exploring whether these mechanisms can be adapted to help manage specific conservation challenges, such as invasive alien species, by increasing the likelihood that a selected trait is passed on through successive generations. For example, a gene drive might be designed to reduce the reproductive capacity of an invasive population or change a specific trait that makes the species harmful, such as its ability to spread disease to native wildlife.

Research into gene drive technologies for conservation spans several potential applications, but the work is at an early stage across the board, with most proposals at the

modelling, laboratory, or early proof-of-concept stage. The management of invasive alien species is currently the most advanced. Several approaches for certain invasive species are being investigated, including fertility-reduction systems in house mice, sex-ratio-biasing approaches and CRISPR-based homing drives studied in insects such as invasive wasps. If shown to be safe and effective, gene drive technologies could offer potentially targeted, cost-effective and durable options to help manage and eradicate invasive alien species populations.

Beyond invasive alien species, gene drives are being considered across a wider set of conservation problems. Parasites and disease vectors that harm wildlife are an area of growing interest. The resurgence of the New World screwworm (*Cochliomyia hominivorax*) across Central America and Mexico has prompted calls for wildlife health surveillance alongside the livestock-focused control that has historically shaped the response. Decades of control have relied on continuous sterile insect releases, but has fallen short of preventing the worm's first return to the United States in sixty years in 2026. Researchers are beginning to explore gene drive approaches that could reduce screwworm populations, including designs that only work under specific conditions, as a possible addition or alternative to current control methods.



CONSERVATION CASES WHERE GENE DRIVE APPROACHES COULD MAKE A DIFFERENCE

- **Invasive rodents on islands:** Invasive rodents are present on more than 80% of the world's island groups and rank among the leading causes of island extinctions. Eradication depends almost entirely on rodenticides and becomes markedly harder on larger and human-inhabited islands. The [University of Adelaide](#) is researching "tCRISPR," a genetic biocontrol approach that could potentially suppress invasive house-mouse populations by spreading reduced female fertility through generations. The work has reached laboratory proof of concept and has been modelled for island settings. No modified mice have been approved or released.
- **Controlling New World screwworm in the Americas:** The screwworm is a parasitic fly whose larvae feed on the living tissue of warm-blooded animals, affecting livestock, people, and wildlife including endangered species such as tapirs. Eradicated from North and Central America by 2006, it broke through the Panama containment barrier around 2021 and reached the United States in June 2026. Control depends on continuous releases of sterile flies, which works but is slow and costly. [Screwworm Free Future](#), a non-profit established in 2025, is coordinating a hemispheric response and building the scientific and regulatory groundwork for newer tools, including gene drive technologies, which could in principle sustain suppression without repeated releases.
- **Reducing avian malaria impacts in Hawai'i:** Avian malaria, transmitted by the introduced southern house mosquito (*Culex quinquefasciatus*), is the principal threat to surviving Hawaiian honeycreepers. 39 of 56 species are already extinct and 11 of the 17 remaining are listed as threatened or endangered. Warming temperatures are allowing the mosquito to move into the high-elevation forests that had served as the birds' last disease-free refuge. Teams at the [University of Hawai'i at Hilo](#) and UH Mānoa are developing an underdominance-based gene drive for *Cx. quinquefasciatus*. The design aims to spread malaria resistance through the local mosquito population, rather than eliminate it, and is built to stay within the area where it is released rather than spread indefinitely. Researchers succeeded in inserting a genetic "anchor point" into mosquitoes, to which a resistance trait could later be attached, the first time this particular insertion method has worked in a mosquito. The resistance trait itself has not yet been added, and no modified mosquitoes have been released.
- **Suppressing invasive social wasps in New Zealand:** Common and German wasps (*Vespula vulgaris* and *V. germanica*), introduced from Eurasia, reach their highest recorded densities anywhere in New Zealand's South Island beech forests, where their peak biomass exceeds that of all native birds, rodents and stoats combined. They monopolize honeydew, prey heavily on native invertebrates, and impose costs of roughly USD70 million a year, yet no existing control method works at landscape scale. Researchers at [Te Herenga Waka–Victoria University of Wellington](#) and [University of Otago](#), working with [Genomics Aotearoa](#) and [AgResearch](#), have assembled reference genomes and modelled a CRISPR gene drive targeting sperm development. Spatial modelling indicates that eradication is unlikely, and that suppression rather than elimination is the realistic outcome, depending heavily on dispersal and population growth rates. No gene drive wasps have been created or released.



Regulation of gene drives for conservation

Gene drive research falls under the same regulatory frameworks that apply to genetically modified organisms. At the international level, existing guidance provides mechanisms for stepwise assessment and public engagement throughout the research process and any potential future release. This includes the CBD's [additional voluntary guidance materials to support case-by-case risk assessments of living modified organisms containing engineered gene drives](#), and the [Cartagena Protocol on Biosafety](#), which aims to ensure the safe handling, transport and use of gene drive and other living modified organisms. The [IUCN Policy on Synthetic Biology in relation to Nature Conservation](#) also provides a useful framework for considering gene drive technologies for conservation purposes. Aligned with existing international frameworks, the policy emphasizes case-by-case risk assessment, the precautionary principle as set out in the [1992 Rio Declaration](#), informed decision-making by governments, and weighing the benefits and risks of an intervention against the costs of inaction. The Organisation for Economic Co-operation and Development (OECD)'s [Framework for Anticipatory Governance of Emerging Technologies](#) is also a useful complement as it

sets out how governments can engage ethical, social and legal questions early, through foresight, stakeholder engagement, adaptable regulation and international co-operation.

At the national level, oversight rests primarily with biosafety authorities and the ministries responsible for issuing research permits and monitoring compliance, with research institutions providing the first layer of day-to-day supervision through institutional biosafety committees and internal review processes. Many countries already have frameworks in place to assess genetically modified organisms, which would be broadly adequate to assess gene drive technologies for conservation applications. To ensure new technologies can be assessed and used, it is critical that countries are able to implement those international frameworks and adapt existing international guidelines and regulation to national contexts. Capacity building initiatives remain crucial in building regulatory and scientific expertise, enabling countries to research, develop, and apply gene drive technologies in line with their own priorities, risk tolerances, and conservation objectives.

CONCLUSION

Gene drive technologies could expand the conservation toolbox where invasive species, wildlife disease, and the vulnerability of small or isolated populations remain difficult to address. As the research advances, these tools could potentially complement established approaches by supporting threatened species recovery, ecosystem restoration, and progress towards the KMGBF's biodiversity goals. Existing policy frameworks also offer a foundation for advancing this work through science-based, inclusive, and nationally led decision-making. Sustained investment in capacity building will be essential, so that all countries have the expertise to assess these technologies and decide what role, if any, they should play in conservation.

REFERENCES

- Birds, Not Mosquitoes. Incompatible insect technique. <https://www.birdsnotmosquitoes.org/>
- Bunting, M. D., Godahewa, G. I., McPherson, N. O., Robertson, L. J., Gierus, L., Piltz, S. G., Edwards, O., Tizard, M., & Thomas, P. Q. (2024). Investigating the potential of X chromosome shredding for mouse genetic biocontrol. *Scientific Reports*, 14, Article 13466. <https://doi.org/10.1038/s41598-024-63706-4>
- Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Montreal, 29 January 2000, United Nations Treaty Series, vol. 2226, No. 30619. <https://bch.cbd.int/protocol/text/>
- Centers for Disease Control and Prevention. (2026, August 11). New World screwworm outbreak. <https://www.cdc.gov/new-world-screwworm/situation-summary/index.html>
- Chan, K. M. A., Agard, J., Liu, J., Carbiener, M., Kastner, T., Sathyapalan, J., ... & Wackernagel, M. (2019). Pathways towards a sustainable future. In E. S. Brondizio, J. Settele, S. Díaz, & H. T. Ngo (Eds.), *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES Secretariat. https://orbilu.uni.lu/bitstream/10993/66074/1/2020%20IPBES%20GLOBAL%20REPORT%20%28CHAPTER%205%29_V4_SINGLE.pdf
- Conference of the Parties to the Convention on Biological Diversity. (2022). Kunming–Montreal Global Biodiversity Framework (Decision 15/4). <https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf>
- CSIRO. (2022, November 9). World-first technology to suppress invasive mice. <https://www.csiro.au/en/news/All/News/2022/November/World-first-technology-to-suppress-invasive-mice>
- Faber, N. R., McFarlane, G. R., Gaynor, R. C., Pocrnic, I., Whitelaw, C. B. A., & Gorjanc, G. (2021). Novel combination of CRISPR-based gene drives eliminates resistance and localises spread. *Scientific Reports*, 11, Article 3719. <https://doi.org/10.1038/s41598-021-83239-4>
- Feng, X., et al. (2026). Self-limiting population suppression gene drive design in the West Nile vector mosquito, *Culex quinquefasciatus*. *Nature Communications*. <https://doi.org/10.1038/s41467-026-73641-9>
- Genetic Biocontrol of Invasive Rodents. (2021, May 25). Genetic Biocontrol of Invasive Rodents: GBIRD. <https://www.geneticbiocontrol.org/>
- Gierus, L., Birand, A., Bunting, M. D., Godahewa, G. I., Piltz, S. G., Oh, K. P., Piaggio, A. J., Threadgill, D. W., Godwin, J., Edwards, O., Cassey, P., Ross, J. V., Prowse, T. A. A., & Thomas, P. Q. (2022). Leveraging a natural murine meiotic drive to suppress invasive populations. *Proceedings of the National Academy of Sciences of the United States of America*, 119(46), Article e2213308119. <https://doi.org/10.1073/pnas.2213308119>
- Harrop, T. W. R., et al. (2020). High-quality assemblies for three invasive social wasps from the *Vespula* genus. *G3: Genes|Genomes|Genetics*, 10(10). <https://doi.org/10.1534/g3.120.401579>
- Harvey-Samuel, T., Ant, T., & Alphey, L. (2017). Towards the genetic control of invasive species. *Biological Invasions*, 19, 1683–1703. <https://doi.org/10.1007/s10530-017-1384-6>

- Harvey-Samuel, T., Feng, X., Okamoto, E. M., Purusothaman, D.-K., Leftwich, P. T., Alphey, L., & Gantz, V. M. (2023). CRISPR-based gene drives generate super-Mendelian inheritance in the disease vector *Culex quinquefasciatus*. *Nature Communications*, 14, Article 7561. <https://doi.org/10.1038/s41467-023-41834-1>
- Howald, G., Donlan, C. J., Galván, J. P., et al. (2007). Invasive rodent eradication on islands. *Conservation Biology*, 21(5), 1258–1268. <https://doi.org/10.1111/j.1523-1739.2007.00755.x>
- Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019). Global assessment report on biodiversity and ecosystem services (E. S. Brondízio, J. Settele, S. Díaz, & H. T. Ngo, Eds.). IPBES Secretariat. <https://doi.org/10.5281/zenodo.3831673>
- International Union for Conservation of Nature. (2024). Synthetic biology in relation to nature conservation: Briefing document. <https://doi.org/10.2305/UGAT2818>
- International Union for Conservation of Nature. (2025). IUCN policy on synthetic biology in relation to nature conservation (Resolution WCC-2025-Res-086). https://portals.iucn.org/library/sites/library/files/resrecfiles/WCC_2025_RES_086_EN.pdf
- Island Conservation. (2022, November 8). Island communities threatened by invasive rodents have potential new conservation tool. <https://www.islandconservation.org/island-communities-threatened-by-invasive-rodents-have-potential-new-tool-to-consider-for-conservation-toolbox/>
- Keatts, L., Guerra, L., Radachowsky, J., Rojas-Jiménez, J., Garcia-Anleu, R., Pérez-Flores, J., Walzer, C., & Montecino-Latorre, D. (2026). Screwworm reemergence, illegal cattle movements, and emerging risks to wildlife and protected areas in Mesoamerica. *Conservation Biology*, e70333. <https://doi.org/10.1111/cobi.70333>
- Kilpatrick, A. M., et al. (2024). Conservation of Hawaiian forest birds. *PLOS Pathogens*, 20(8), e1012052. <https://doi.org/10.1371/journal.ppat.1012052>
- Lester, P. J., Bulgarella, M., Baty, J. W., Dearden, P. K., Guhlin, J., & Kean, J. M. (2020). The potential for a CRISPR gene drive to eradicate or suppress globally invasive social wasps. *Scientific Reports*, 10, Article 12398. <https://doi.org/10.1038/s41598-020-69259-6>
- Lester, P. J., O'Sullivan, D., & Perry, G. L. W. (2023). Gene drives for invasive wasp control: Extinction is unlikely, with suppression dependent on dispersal and growth rates. *Ecological Applications*, 33, e2912. <https://doi.org/10.1002/eap.2912>
- MacIntyre, P., & Hellstrom, J. (2015). An evaluation of the costs of pest wasps (*Vespula* species) in New Zealand. Department of Conservation and Ministry for Primary Industries. <https://www.doc.govt.nz/about-us/science-publications/conservation-publications/threats-and-impacts/animal-pests/an-evaluation-of-the-costs-of-pest-wasps-in-new-zealand/>
- Manaaki Whenua – Landcare Research. Wasp impacts on biodiversity. <https://www.landcareresearch.co.nz/discover-our-research/managing-invasive-species/invasive-invertebrates/vespula-wasps/wasp-impacts-on-biodiversity>
- Organisation for Economic Co-operation and Development. (2024). Framework for anticipatory governance of emerging technologies (OECD Science, Technology and Industry Policy Papers No. 165). OECD Publishing. <https://doi.org/10.1787/0248ead5-en>
- Piaggio, A. J., Gierus, L., Taylor, D. R., Holmes, N. D., Will, D. J., Gemmell, N. J., & Thomas, P. Q. (2024). Building an eDNA surveillance toolkit for invasive rodents on islands: Can we detect wild-type and gene drive *Mus musculus*? *BMC Biology*, 22, Article 261. <https://doi.org/10.1186/s12915-024-02063-0>
- Redford, K. H., Brooks, T. M., Macfarlane, N. B. W., & Adams, J. S. (Eds.). (2019). Genetic frontiers for conservation: An assessment of synthetic biology and biodiversity conservation. Technical assessment. IUCN. <https://portals.iucn.org/library/sites/library/files/documents/2019-012-En-Syn.pdf>
- Scott, M. J., et al. (2020). Genomic analyses of a livestock pest, the New World screwworm, find potential targets for genetic control programs. *Communications Biology*, 3. <https://doi.org/10.1038/s42003-020-01152-4>
- Secretariat of the Convention on Biological Diversity. (2022). Synthetic biology (CBD Technical Series No. 100). <https://www.cbd.int/doc/publications/cbd-ts-100-en.pdf>
- Secretariat of the Convention on Biological Diversity. (2024). Additional voluntary guidance materials to support case-by-case risk assessments of living modified organisms containing engineered gene drives (CBD/CP/MOP/11/9). <https://www.cbd.int/doc/c/175e/90b0/89c0c71660cccc1539adf34f/cp-mop-11-09-en.pdf>

- Secretariat of the Convention on Biological Diversity. (2026). Synthetic biology: Applications, initial perspectives and governance for biodiversity. Independent scientific study prepared by the Brazilian Bioinnovation Association (ABBI), SENAI Institute of Innovation in Biodiversity and Circular Economy, and SENAI Institute of Innovation in Biosynthetics and Fibers (CBD/SYNBIO/AHTEG/2026/1/INF/3). <https://www.cbd.int/documents/CBD/SYNBIO/AHTEG/2026/1/INF/3>
- Seunik, M. (2026, July 20). Building a screwworm-free future [Interview]. Outreach Network for Gene Drive Research. <https://genedrivenetwork.org/blog/building-a-screwworm-free-future/>
- Spatz, D. R., Holmes, N. D., Will, D. J., et al. (2022). The global contribution of invasive vertebrate eradication as a key island restoration tool. Scientific Reports, 12, Article 13391. <https://doi.org/10.1038/s41598-022-14982-5>
- United Nations Environment Programme Finance Initiative. (2025, March 3). Governments adopt first global strategy to finance biodiversity: Implications for financial institutions. <https://www.unepfi.org/themes/ecosystems/governments-adopt-first-global-strategy-to-finance-biodiversity-implications-for-financial-institutions/>
- U.S. Fish and Wildlife Service. Saving Kaua'i forest birds. <https://www.fws.gov/project/saving-kauai-forest-birds>
- Wilder, A. P., Steiner, C. C., Hendricks, S., Haller, B. C., Kim, C., Korody, M. L., & Ryder, O. A. (2024). Genetic load and viability of a future restored northern white rhino population. Evolutionary Applications, 17, e13683. <https://doi.org/10.1111/eva.13683>
- WWF (2020) Living Planet Report. (2020). Bending the curve of biodiversity loss. Almond, R.E.A., Grooten M. and Petersen, T. (Eds). WWF, Gland, Switzerland. <https://f.hubspotusercontent20.net/hubfs/4783129/LPR/PDFs/ENGLISH-FULL.pdf>