



PROMETHEAN TANGO:

A Guide to the Use of Genetic Engineering in Conservation

FOR ALL THE WILD THINGS



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Promethean Tango : Guide sur l'utilisation du génie génétique dans la conservation

Introduction

La plupart des défenseurs de la nature et des organismes de conservation ne passent pas beaucoup de temps à réfléchir à l'utilisation du génie génétique (GG) au service de la conservation. Ils ont d'autres tâches plus urgentes à accomplir. Pourtant, à mesure que la technologie évolue, de plus en plus d'organismes seront obligés de décider s'ils veulent appuyer ou utiliser des technologies comme CRISPR ou le forçage génétique dans leur travail.

Dans ce bref rapport, Nature Canada tente de fournir un peu de contexte, des perspectives et des recommandations aux autres groupes de conservation sur le sujet. On présente quelques éléments de contexte, un tour d'horizon des arguments pour et contre, ainsi que des considérations clés, avant de conclure par quelques observations et recommandations générales. Pour résumer la conclusion générale de ce rapport : on comprend tout à fait les défenseurs de la nature qui veulent utiliser tous les outils à leur disposition, mais on doute fortement que l'utilisation de ces technologies apporte un bénéfice net à la nature.

Nature Canada possède déjà [une expérience dans ce domaine](#).¹ Lorsqu'une entreprise a voulu élever du saumon génétiquement modifié à l'Île-du-Prince-Édouard, au Canada, en plein cœur de l'aire de répartition du saumon sauvage de l'Atlantique, de plus en plus menacé de disparition, on est intervenus. En tant que membre de longue date de l'Union internationale pour la conservation de la nature (UICN), on s'est retrouvés impliqués quand l'organisation a commencé à élaborer une politique sur le génie génétique à des fins de conservation.

La nature complexe et controversée du génie génétique pourrait empêcher certaines organisations de définir leur position à ce sujet. [Les reportages médiatiques](#) l'ont décrit comme le sujet le plus controversé du Congrès mondial de la nature de l'UICN de 2025.² Certaines ONG et certains gouvernements, ainsi que le secteur des biotechnologies et une grande partie des dirigeants de l'UICN,

¹ Butler, Mark. (2020) Genetic Pollution is Irreversible: FDA Requires Reassessment. Will Canada Follow? <https://naturecanada.ca/news/blog/genetic-pollution-is-irreversible-fda-requires-reassessment-will-canada-follow/>

² Barnhart, Max. (2025) Conservationists Clash over the Use of Synthetic Biology. Chemical and Engineering News. <https://cen.acs.org/biological-chemistry/synthetic-biology/Conservationists-clash-over-use-synthetic/103/web/2025/10>

On comprend tout à fait les défenseurs de la nature qui veulent utiliser tous les outils à leur disposition, mais on est aussi très sceptiques quant à l'idée que l'utilisation du génie génétique puisse apporter un bénéfice net à la nature. On espère que les organismes de conservation trouveront ce rapport utile alors qu'ils tentent de s'y retrouver dans ce débat et de faire des choix dans l'intérêt de la nature.

ont appuyé l'utilisation du génie génétique à des fins de conservation. De l'autre côté, d'autres ONG, soutenues par certains gouvernements, réclamaient un moratoire ou un « report préventif ». Et entre les deux, la majorité des ONG et des gouvernements essayaient de s'y retrouver.

Recommandations

1. Les solutions ne sont, pour l'essentiel, pas d'ordre technique

Lorsqu'une organisation ou un organisme de conservation est invité à utiliser ou à appuyer le génie génétique à des fins de conservation, la prudence s'impose. Le domaine est complexe et regorge encore d'incertitudes scientifiques, législatives et éthiques. Oui, la crise de la biodiversité est urgente et souvent déchirante, mais les solutions ne sont, pour l'essentiel, pas techniques; elles sont politiques, économiques et sociales. Dans la plupart des cas, malgré le battage médiatique et le débat acharné, la technologie n'est toujours pas prête. Attendre deux ou cinq ans, c'est acceptable.

2. Une approche au cas par cas n'offre pas une protection adéquate

Adopter une approche au cas par cas et soumettre les applications envisagées du génie génétique à une évaluation environnementale, comme le prévoient la motion 087 et la politique désormais adoptée par l'UICN, c'est mieux qu'une approbation générale d'une technologie, mais ça revient à continuer comme avant. De nombreux projets et produits qui se sont révélés extrêmement nuisibles à la nature ont fait l'objet d'évaluations au cas par cas. De plus, la participation du public aux évaluations des risques liés au génie génétique est souvent limitée. C'est l'une des principales raisons pour lesquelles Nature Canada appuie actuellement un moratoire sur l'utilisation du génie génétique dans la nature.

3. Rester ouvert à la technologie

On ne soutient pas que la technologie soit intrinsèquement défectueuse; c'est son interaction avec les systèmes naturels qui nous préoccupe. Le génie génétique est déjà utilisé dans d'autres domaines, comme la production d'insuline, et son utilisation va probablement augmenter dans le domaine de la santé, par exemple avec la thérapie génique somatique (par opposition à la thérapie génique germinale).

Il y a des situations et des décisions terriblement difficiles en matière de conservation, comme l'extinction imminente d'une espèce. Avec plus de recherche, d'essais et de dialogue, un consensus plus large pourrait se dégager en faveur de l'utilisation du génie génétique dans la conservation de la nature dans certaines circonstances.

4. Consentement libre, préalable et éclairé

Les développeurs et les gouvernements devraient chercher à obtenir le consentement libre, préalable et éclairé des peuples autochtones, surtout quand il s'agit d'une espèce d'importance traditionnelle, comme le saumon.

5. Autres techniques utilisées en conservation

Ce rapport se concentre sur le génie génétique des espèces sauvages. On ne s'oppose pas à la recherche en laboratoire, aux [vaccins traditionnels ou qui ne se propagent pas](#), aux [technologies de reproduction assistée](#), à l'utilisation de la [bactérie Wolbachia](#), aux [substituts synthétiques](#) ou au [clonage](#).

6. « Continue comme ça »

Des initiatives comme la protection des habitats, la réduction de la pollution, l'éducation à la nature et la réduction de la consommation sont des mesures de conservation qui ont démontré leurs bienfaits pour la nature. Parfois, face à la perte continue, voire accélérée, de la biodiversité, une solution technique rapide peut sembler attrayante. Cependant, même si certaines de ces applications s'avèrent efficaces à long terme sans inconvénients, l'essentiel du travail de conservation restera ce qu'on fait déjà (mais à une échelle bien plus grande si on veut réussir).

7. Trouver des experts

Ça va être difficile de trouver des experts, surtout en génétique ou en biologie moléculaire, pour plusieurs raisons. Le sujet est complexe, et les scientifiques hésitent à s'exprimer sur les relations entre la science et les politiques publiques à cause de leurs liens avec l'industrie. Les éthiciens, les philosophes et les anthropologues spécialisés en science et technologie sont plus disposés à aborder les risques et les possibilités. Faire aussi appel à l'expertise des peuples autochtones.

8. Le gouvernement

Reconnaître que la position d'un gouvernement sur l'utilisation du génie génétique dans la nature n'est pas forcément déterminée par ce qui est le mieux pour la nature. Elle est plutôt façonnée et guidée par des considérations économiques nationales et internationales, et influencée par l'industrie biotechnologique. C'est un gros problème, car ce sont les gouvernements qui réglementent le génie génétique et qui sont chargés d'approuver les nouvelles demandes.

9. Influence des entreprises

Reconnaître que les entreprises ont des intérêts en jeu dans l'issue de ce débat, à la fois parce que ça représente un nouveau marché — le cofondateur de Colossal Biosciences utilise le terme « marché de la dé-extinction » — et parce que l'utilisation du génie génétique dans la conservation renforcerait l'acceptation sociale de cette technologie et de cette industrie.

10. S'opposer à l'utilisation du génie génétique dans les industries qui interagissent avec la nature

S'opposer aux applications industrielles du génie génétique lorsqu'il y a interaction avec le monde naturel. C'est particulièrement vrai pour l'aquaculture, la foresterie et le commerce des poissons d'aquarium. Ces industries dépendent d'espèces qui ont des équivalents sauvages; ainsi, si des espèces modifiées par l'industrie s'échappaient, elles pourraient se croiser avec des espèces sauvages. Certaines espèces utilisées en agriculture, comme le maïs et le coton, ont aussi des équivalents sauvages.

Promethean Tango: Una guía sobre el uso de la ingeniería genética en la conservación

Introducción

La mayoría de los conservacionistas y las organizaciones conservacionistas no dedican mucho tiempo a pensar en el uso de la ingeniería genética (IG) al servicio de la conservación. Tienen otras tareas más urgentes que atender. Sin embargo, a medida que la tecnología avanza, más organizaciones se verán obligadas a decidir si quieren respaldar o utilizar tecnologías como CRISPR o los impulsores genéticos en su trabajo.

En este breve informe, Nature Canada busca ofrecer algo de contexto, ideas y recomendaciones a otros grupos conservacionistas sobre el tema. Presentamos algunos antecedentes, un repaso de los argumentos a favor y en contra, así como algunas consideraciones clave, y concluimos con algunas observaciones y recomendaciones generales. Para resumir la conclusión general de este informe: comprendemos profundamente a los conservacionistas que quieren usar todas las herramientas a su alcance, pero somos muy escépticos con respecto a que el uso de estas tecnologías vaya a traer un beneficio neto para la naturaleza.



Comprendemos profundamente a los conservacionistas que quieren usar todas las herramientas a su alcance, pero también somos muy escépticos con respecto a que el uso de la ingeniería genética traiga un beneficio neto para la naturaleza. Esperamos que este informe les sea útil a las organizaciones conservacionistas mientras tratan de abrirse camino en este debate y tomar las decisiones que más beneficien a la naturaleza.

Nature Canada aborda este tema con cierta [historia](#).³ Cuando una empresa quiso criar salmón transgénico en la Isla del Príncipe Eduardo, Canadá, justo en medio del área de distribución del salmón atlántico silvestre —que está cada vez más en peligro de extinción—, intervenimos. Como miembros desde hace muchos años de la Unión Internacional para la Conservación de la Naturaleza (UICN), nos vimos involucrados cuando la organización comenzó a desarrollar una política sobre ingeniería genética para su uso en la conservación.

La naturaleza compleja y controvertida de la ingeniería genética puede impedir que algunas organizaciones adopten una postura al respecto. [Los informes publicados en los medios](#) la describieron como el tema más polémico en el Congreso Mundial de la Naturaleza de la UICN de 2025.⁴ Algunas ONG y algunos gobiernos, junto con el sector biotecnológico y gran parte de la dirección de la UICN, apoyaron el uso de la IG en la conservación. Por otro lado, había otras ONG, con el apoyo de algunos gobiernos, que pedían una moratoria o un «aplazamiento preventivo». Y en medio, estaba la mayoría de las ONG y los gobiernos tratando de entenderlo todo.

Recomendaciones

1. Las soluciones, en gran medida, no son técnicas

Si eres una organización o agencia de conservación a la que le piden que use o respalde la ingeniería genética en la conservación, actúa con precaución. Este ámbito es complejo y todavía está lleno de incertidumbre científica, legislativa y ética. Sí, la crisis de la biodiversidad es urgente y, una y otra vez, desgarradora, pero las soluciones, en su mayoría, no son técnicas; son políticas, económicas y

³ Butler, Mark. (2020). Genetic Pollution is Irreversible: FDA Requires Reassessment. Will Canada Follow? <https://naturecanada.ca/news/blog/genetic-pollution-is-irreversible-fda-requires-reassessment-will-canada-follow/>

⁴ Barnhart, Max. (2025). Conservationists Clash over the Use of Synthetic Biology. Chemical & Engineering News. <https://cen.acs.org/biological-chemistry/synthetic-biology/Conservationists-clash-over-use-synthetic/103/web/2025/10>

sociales. En la mayoría de los casos, a pesar del bombo publicitario y el debate acalorado, la tecnología todavía no está lista. Está bien esperar dos o cinco años.

2. Un enfoque caso por caso no brinda la protección adecuada

Adoptar un enfoque caso por caso y someter las aplicaciones propuestas de IG a una evaluación ambiental, tal como se describe en la Moción 087 y en la política ahora adoptada por la UICN, es mejor que aprobar una tecnología de manera generalizada, pero sigue siendo lo de siempre. Muchos proyectos y productos que han sido extremadamente dañinos para la naturaleza han sido sometidos a evaluaciones caso por caso. Además, la participación pública en las evaluaciones de riesgo de la IG suele ser limitada. Esta es una de las principales razones por las que Nature Canada apoya actualmente una moratoria sobre el uso de la ingeniería genética en el medio silvestre.

3. Mantente abierto a la tecnología

No sostenemos que la tecnología sea propiamente defectuosa; lo que nos preocupa es su interacción con los sistemas naturales. La IG se usa en otros ámbitos, como la producción de insulina, y es probable que su uso aumente en el sector de la salud, por ejemplo, en la terapia génica somática (en contraposición a la germinal). Hay situaciones y decisiones muy difíciles y angustiosas en la conservación, como la extinción inminente de una especie. Con más investigación, pruebas y diálogo, podría surgir un mayor consenso a favor del uso de la IG en la conservación de la naturaleza en ciertas circunstancias.

4. Consentimiento libre, previo e informado

Los desarrolladores y los gobiernos deben procurar obtener el consentimiento libre, previo e informado de los pueblos indígenas, sobre todo cuando se trate de una especie de importancia tradicional, como el salmón.

5. Otras técnicas utilizadas en la conservación

Este informe se centra en la ingeniería genética de especies silvestres. No nos oponemos a la investigación de laboratorio, a [las vacunas tradicionales o que no se propagan](#), a [las tecnologías de reproducción asistida](#), al uso de la [bacteria *Wolbachia*](#), a [las alternativas sintéticas](#) ni a [la clonación](#).

6. «Sigue haciendo lo que ya haces»

Programas como la protección del hábitat, la reducción de la contaminación, la educación sobre la naturaleza y la disminución del consumo son iniciativas de conservación que han demostrado ser beneficiosas para la naturaleza. A veces, ante la pérdida continua e incluso acelerada de la biodiversidad, una solución técnica rápida parece atractiva. Sin embargo, aunque se demuestre que algunas de estas aplicaciones son efectivas a largo plazo y no tienen desventajas, la mayor parte del trabajo de conservación seguirá siendo lo que estamos haciendo ahora (pero a una escala mucho mayor si queremos tener éxito).

7. Busca expertos

Va a ser difícil encontrar expertos, sobre todo en genética o biología molecular, por varias razones. El tema es complejo, y los científicos se muestran reacios a pronunciarse públicamente sobre la intersección entre la ciencia y la política debido a sus vínculos con la industria. Los especialistas en ética, filósofos y antropólogos que se dedican a la ciencia y la tecnología están más dispuestos a abordar los riesgos y las oportunidades. Recurre también a los conocimientos especializados de los pueblos indígenas.

8. El gobierno

Reconoce que la postura de un gobierno sobre el uso de la ingeniería genética en la naturaleza tal vez no se base en lo que es mejor para la naturaleza. Más bien, hay consideraciones económicas nacionales e internacionales que la moldean y la impulsan, y la industria biotecnológica influye en ella. Esto es un gran problema, ya que son los gobiernos los que regulan la ingeniería genética y son responsables de aprobar nuevas aplicaciones.

9. Influencia corporativa

Reconoce que al sector empresarial le interesa el resultado de este debate, tanto porque representa un nuevo mercado —el cofundador de Colossal Biosciences usa el término «mercado de la desextinción»— como porque el uso de la IG en la conservación contribuiría a obtener la licencia social para la tecnología y la industria.

10. Oponer al uso de la IG en industrias que interactúan con la naturaleza

Oponer al uso de aplicaciones industriales de la ingeniería genética cuando haya interacción con el mundo natural. Esto es especialmente cierto en la acuicultura, la silvicultura y el comercio de especies para acuarios. Estas industrias dependen de especies que tienen equivalentes silvestres y, por lo tanto, las especies modificadas genéticamente por la industria, si se escapan, podrían cruzarse con especies silvestres. Algunas especies que se usan en la agricultura, como el maíz y el algodón, también tienen equivalentes silvestres.

تانغو بروميثيوسي: دليل لاستخدام الهندسة الوراثية في مجال الحفاظ على الطبيعة

مقدمة

لا يكرس معظم دعاة الحفاظ على الطبيعة والمنظمات المعنية بهذا المجال الكثير من الوقت للتفكير في استخدام الهندسة الوراثية (GE) لخدمة الحفاظ على الطبيعة. فهناك أعمال أخرى أكثر إلحاحًا يتعين عليهم القيام بها. ومع ذلك، مع تطور هذه التكنولوجيا، ستتضرر المزيد من المنظمات إلى اتخاذ قرار بشأن ما إذا كانت ترغب في تأييد أو استخدام تقنيات مثل CRISPR أو «المحركات الجينية» في عملها.

في هذا التقرير الموجز، تسعى منظمة Nature Canada إلى تقديم بعض السياق والرؤى والتوصيات إلى المنظمات الأخرى المعنية بالحفاظ على الطبيعة حول هذا الموضوع. نقدم بعض المعلومات الأساسية، واستعراضًا للحجج المؤيدة والمعارضة، بالإضافة إلى بعض الاعتبارات الرئيسية، ونختتم ببعض الملاحظات والتوصيات العامة. ولتلخيص النتيجة العامة لهذا التقرير: نحن نتعاطف بشدة مع دعاة الحفاظ على الطبيعة الذين يرغبون في استخدام كل أداة متاحة، لكننا نشك بشدة في أن تكون هناك فائدة صافية للطبيعة من استخدام هذه التقنيات.

تتناول منظمة Nature Canada هذا الموضوع استنادًا إلى خبرة سابقة في هذا المجال.¹ فعندما أرادت إحدى الشركات تربية سمك السلمون المعدّل وراثيًا في جزيرة الأمير إدوارد بكندا، في قلب نطاق انتشار سمك السلمون الأطلسي البري الذي يتزايد تعرضه لخطر الانقراض، تدخلنا. وبصفتنا عضوًا منذ فترة طويلة في الاتحاد الدولي لحفظ الطبيعة (IUCN)، انخرطنا في هذا الموضوع عندما بدأت المنظمة في وضع سياسة بشأن الهندسة الوراثية لاستخدامها في مجال الحفاظ على الطبيعة.

نحن نتعاطف بشدة مع دعاة الحفاظ على الطبيعة الذين يرغبون في استخدام كل أداة متاحة، لكننا في الوقت نفسه نشك بشدة في أن استخدام الهندسة الوراثية سيحقق فائدة صافية للطبيعة. نأمل أن تجد منظمات الحفاظ على الطبيعة هذا التقرير مفيدًا في سعيها إلى تبين موقفها في خضم هذا النقاش واتخاذ خيارات تخدم مصلحة الطبيعة على أفضل وجه.

¹Butler, Mark.(2020) Genetic Pollution is Irreversible: FDA Requires Reassessment. Will Canada Follow? <https://naturecanada.ca/news/blog/genetic-pollution-is-irreversible-fda-requires-reassessment-will-canada-follow/>

4. الموافقة الحرة والمسبقة والمستنيرة

ينبغي على المطورين والحكومات السعي للحصول على موافقة حرة ومسبقة ومستنيرة من الشعوب الأصلية، لا سيما عندما يتعلق الأمر بنوع ذي أهمية تقليدية، مثل السلمون.

5. تقنيات أخرى مستخدمة في الحفاظ على الطبيعة

يركز هذا التقرير على الهندسة الوراثية للأنواع البرية. نحن لا نعارض الأبحاث المخبرية، ولا اللقاحات التقليدية أو اللقاحات التي لا تنتقل بين الأفراد، ولا تقنيات المساعدة على الإنجاب، ولا استخدام بكتيريا وولباخيا، ولا البدائل الاصطناعية، ولا الاستنساخ.

6. «استمر في ما تفعله»

تعد برامج حماية الموائل، والحد من التلوث، وتوفير التثقيف البيئي، وخفض الاستهلاك، من برامج الحفاظ على الطبيعة التي أثبتت فوائدها للطبيعة. في بعض الأحيان، وفي مواجهة فقدان التنوع البيولوجي المستمر بل المتسارع أيضًا، يبدو الحل التقني السريع خيارًا جذابًا. ومع ذلك، حتى لو ثبتت فعالية بعض هذه التطبيقات على المدى الطويل دون أي آثار سلبية، فسيظل معظم العمل في الحفاظ على الطبيعة هو ما نقوم به الآن (ولكن على نطاق أوسع بكثير إذا أردنا أن ننجح).

7. البحث عن الخبراء

سيكون من الصعب العثور على خبراء، لا سيما في مجال علم الوراثة أو البيولوجيا الجزيئية، وذلك لعدة أسباب. فالموضوع معقد، والعلماء يترددون في التحدث علنًا عن التقاطع بين العلم والسياسات العامة بسبب علاقاتهم بالصناعة. أما خبراء الأخلاق والفلاسفة وعلماء الأنثروبولوجيا المتخصصون في العلوم والتكنولوجيا، فهم أكثر استعدادًا لمناقشة المخاطر والفرص. ابحث أيضًا عن خبرات الشعوب الأصلية.

8. الحكومة

أدرك أن موقف الحكومة من استخدام الهندسة الوراثية في الطبيعة قد لا يتحدد بناءً على ما هو أفضل للطبيعة. بل تشكّل الاعتبارات الاقتصادية الداخلية والدولية هذا الموقف وتوجّهه، كما تؤثر فيه صناعة التكنولوجيا الحيوية. وهذه مشكلة كبيرة، لأن الحكومات هي التي تنظم استخدام الهندسة الوراثية وتحمل مسؤولية الموافقة على التطبيقات الجديدة.

9. تأثير الشركات

اعلم أن قطاع الشركات له مصلحة في نتيجة هذا النقاش، لأن هذا المجال يمثل سوقًا جديدة — حيث يستخدم المؤسس المشارك لشركة Colossal Biosciences مصطلح «سوق إحياء الأنواع المنقرضة» — ولأن استخدام الهندسة الوراثية في الحفاظ على الطبيعة من شأنه أن يُكسب هذه التكنولوجيا والصناعة قبولًا اجتماعيًا.

10. معارضة استخدام الهندسة الوراثية في الصناعات التي تتفاعل مع الطبيعة

عارض استخدام التطبيقات الصناعية للهندسة الوراثية حيثما يوجد تفاعل مع العالم الطبيعي. وينطبق هذا بشكل خاص على تربية الأحياء المائية، وقطاع الغابات، وتجارة الكائنات المائية المخصصة لأحواض الزينة. تعتمد هذه الصناعات على أنواع لها نظائر برية، وبالتالي فإن الأنواع التي تعدّلها هذه الصناعات وراثيًا، في حال هروبها، قد تتزاوج مع الأنواع البرية. كما أن بعض الأنواع المستخدمة في الزراعة، مثل الذرة والقطن، لها نظائر برية أيضًا.

قد تمنع الطبيعة المعقدة والمثيرة للجدل للهندسة الوراثية بعض المنظمات من اتخاذ موقف بشأنها. ووصفتها التقارير الإعلامية بأنها الموضوع الأكثر إثارة للجدل في المؤتمر العالمي للحفاظ على الطبيعة لعام 2025 التابع للاتحاد الدولي لحفظ الطبيعة (IUCN).² أيدت بعض المنظمات غير الحكومية والحكومات، إلى جانب قطاع التكنولوجيا الحيوية وجزء كبير من قيادة الاتحاد الدولي لحفظ الطبيعة (IUCN)، استخدام الهندسة الوراثية في مجال الحفاظ على الطبيعة. وعلى الجانب الآخر، كانت هناك منظمات غير حكومية أخرى، بدعم من بعض الحكومات، تدعو إلى فرض وقف مؤقت أو «تأجيل احترازي». وفي الوسط، كانت غالبية المنظمات غير الحكومية والحكومات تحاول فهم الموضوع برمته.

التوصيات

1. الحلول ليست تقنية في الغالب

إذا كنت منظمة أو وكالة معنية بالحفاظ على الطبيعة وطلب منك استخدام الهندسة الوراثية أو تأييدها في مجال الحفاظ على الطبيعة، فتقدم بحذر. فهذا المجال معقد ولا تزال تحيط به أوجه عدم يقين علمية وتشريعية وأخلاقية. نعم، أزمة التنوع البيولوجي ملحة وتبعث مرارًا على الأسى، لكن الحلول ليست تقنية في الغالب؛ بل هي سياسية واقتصادية واجتماعية. في معظم الحالات، وعلى الرغم من الدعاية المبالغ فيها والنقاش الحاد، لا تزال التكنولوجيا غير جاهزة. ولا بأس بالانتظار لمدة سنتين أو خمس سنوات.

2. النهج القائم على دراسة كل حالة على حدة لا يوفر الحماية الكافية

إن اتباع نهج قائم على دراسة كل حالة على حدة وإخضاع تطبيقات الهندسة الوراثية المقترحة لتقييم بيئي، كما هو موضح في الاقتراح رقم 087 والسياسة التي أصبحت معتمدة لدى الاتحاد الدولي لحفظ الطبيعة (IUCN)، أفضل من الموافقة الشاملة على تقنية ما، لكنه يمثل استمرارًا للأوضاع الراهنة. فقد خضعت العديد من المشاريع والمنتجات التي كانت ضارة للغاية بالطبيعة لتقييمات على أساس كل حالة على حدة. بالإضافة إلى ذلك، غالبًا ما تكون مشاركة الجمهور في تقييمات مخاطر الهندسة الوراثية محدودة. وهذا سبب رئيسي يجعل منظمة Nature Canada تدعم حاليًا فرض وقف مؤقت على استخدام الهندسة الوراثية في الطبيعة البرية.

3. الحفاظ على موقف منفتح تجاه هذه التكنولوجيا

نحن لا نعتبر أن هذه التكنولوجيا معيبة بطبيعتها؛ بل ما يثير قلقنا هو تداخلها مع النظم الطبيعية. تُستخدم الهندسة الوراثية في مجالات أخرى، مثل إنتاج الأنسولين، ومن المرجح أن يزداد استخدامها في مجال الرعاية الصحية، مثل العلاج الجيني للخلايا الجسدية (مقابل العلاج الجيني للخط الإنتاشي).

هناك بعض المواقف والقرارات الصعبة والمؤلمة للغاية في مجال الحفاظ على الطبيعة، مثل الحالات التي يوشك فيها أحد الأنواع على الانقراض. ومع إجراء المزيد من الأبحاث والاختبارات والحوار، قد ينشأ توافق أوسع على استخدام الهندسة الوراثية في الحفاظ على الطبيعة في ظروف معينة.

²Barnhart, Max.(2025) Conservationists Clash over the Use of Synthetic Biology. Chemical and Engineering News. <https://cen.acs.org/biological-chemistry/synthetic-biology/Conservationists-clash-over-use-synthetic/103/web/2025/10>

Author's Note

This report started out as one thing and ended up being another. My participation in the International Union for the Conservation of Nature (IUCN) World Congress in Abu Dhabi in October 2025 was a defining moment, as it placed in stark relief the debate taking place in the conservation movement about the use of genetic engineering. Writing the report has taken a lot longer than intended, both because of the complexity of the topic, scientifically and ethically, and because of my own limitations. The field is fast-moving, and I know the day after the report is released, I will hear or read something that I wished I had included. Along the way I have talked to many people and would have liked to talk to more on all sides of the issue. Thank-you to the following people for talking to me and apologies in advance as many good points made by interviewees have not made it into the report: Franziska Achterberg, Francoise Baylis, Elizabeth Bennett, Gwendolyn Blue, Lorrie Boisvert, Michael Buttrey, Dolf DeJong, Andrew Flachs, Janice Harvey, Genti Kromidha, Natalie Kofler, Naomi Kosmehl, Jennifer

Kuzma, Liv Liberman, Michel Lortie, Andre Magalhaes, Albert Marshall, Gabriela Mastromonaco, Claire Robinson, Pat Roy Mooney, Peter Notebloom, Dana Perls, Lea Randall, Guy Reeves, Anthony Ricciardi, Melanie Sabourin, Graham Saul, Malick Shahbaz, Lucy Sharratt, Ricarda Steinbrecher, Joanna Sy, and Ali de Goamma Tapsoba.

Thanks to Graham Saul and Dr. Guy Reeves for reviewing the report. As per custom (and decidedly required here), the faults and omissions are mine alone. Appreciation to the Patagonia Foundation for funding Nature Canada's efforts to protect wild salmon from genetic contamination and also supporting the early stages of this report.

Thanks to the team at Nature Canada, specifically Emily McMillan, Akaash Maharaj, Scott Mullenix, Julie Baxter, Amy VanTorre, and Jamieson Findlay who have

both supported me in working on this topic — one that many conservation organizations avoid for multiple reasons — and for whipping the report into shape. Thanks to Lucy and Gretchen for letting me disappear into my office to work on “that darn report.”

Mark Butler, Senior Advisor for Nature Canada

1.0 Introduction

Most conservationists and conservation organizations don't spend a lot of time thinking about the use of genetic engineering (GE) in the service of conservation. They have other more pressing work to do. Yet, as the technology develops, more organizations will be forced to decide whether they want to endorse or use technologies like CRISPR or gene drives in their work.

In this short report, Nature Canada is attempting to provide some context, insights and recommendations to fellow conservation groups on the topic. We provide some background, a review of the arguments for and against as well some key considerations, and conclude with some high level observations and recommendations. To sum up the overall conclusion of this report: we are deeply sympathetic to conservationists who want to use every tool in the toolbox, but are deeply sceptical that there will be net benefit to nature from the use of these technologies.

Nature Canada comes at this topic with some [history](#).⁵ When a company wanted to raise genetically engineered salmon in Prince Edward Island, Canada, right in the middle of the range of wild and increasingly endangered Atlantic salmon, we intervened. As a long-time member of the International Union for the Conservation of Nature (IUCN), we got drawn in when the organization began developing a policy on genetic engineering for use in conservation.

The complex and controversial nature of genetic engineering may prevent some organizations from developing a position on it. [Media reports](#) described it as the most controversial topic at the IUCN's 2025 World Congress.⁶ Some NGOs and governments, along with the biotech sector and much of the IUCN leadership, supported the use of GE in conservation. On the other side, you had other NGOs, with some governments' support, calling for a moratorium or a “precautionary deferment.” And in between, you had the majority of NGOs and governments trying to figure it all out.

⁵ Butler, Mark.(2020) Genetic Pollution is Irreversible: FDA Requires Reassessment. Will Canada Follow? <https://naturecanada.ca/news/blog/genetic-pollution-is-irreversible-fda-requires-reassessment-will-canada-follow/>
⁶ Barnhart, Max.(2025) Conservationists Clash over the Use of Synthetic Biology. Chemical and Engineering News. <https://cen.acs.org/biological-chemistry/synthetic-biology/Conservationists-clash-over-use-synthetic/103/web/2025/10>

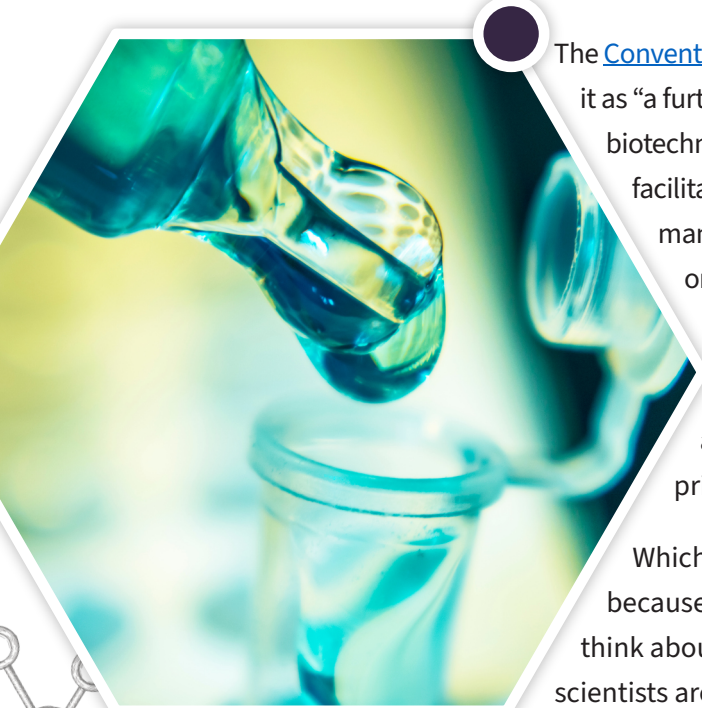
We are deeply sympathetic to conservationists who want to use every tool in the toolbox, but we are also deeply sceptical that there will be net benefit to nature from the use of genetic engineering. We hope conservation organizations will find this report useful as they try to wend their way through the debate and make choices in the best interests of nature.

Terminology

Genetic engineering (GE) refers to the direct manipulation of DNA in the laboratory. It's a term Nature Canada has used in its work because it is understandable and known to the public.

In the last two decades, developers have adopted the term “synthetic biology,” arguing that they increasingly have the capacity to create or synthesize DNA and that the term is also broader. However, as this biotech site notes, it's still genetic engineering:

“Almost everything done in synthetic biology is genetic modification but synthetic biology methods and new technologies allow us to do it much faster, much more high throughput [sic] and to find solutions to problems much more quickly.”⁷



The [Convention on Biological Diversity](#) uses “synthetic biology” and defines it as “a further development and new dimension of modern biotechnology that combines science, technology and engineering to facilitate and accelerate the understanding, design, redesign, manufacture and/or modification of genetic materials, living organisms and biological systems.”⁸ The IUCN also uses the term.

The term “synthetic biology” is less understood and probably less threatening to the public, which makes it attractive to proponents, research institutions and the private sector.

Which term to use? We’ve stuck with “genetic engineering” because it is known and because it reflects a shift in how researchers think about biology, and possibly even nature. Increasingly, many scientists are approaching biology through the mindset of engineering, using terms like “chassis” and “platform” to describe cellular or genetic

components. The ethos or language of ecology, and its emphasis on relationships, is not part of this new field. The use of AI or machine learning certainly accelerates the pace of research and, likely, this conceptual shift.

⁷ Australian Institute for Bioengineering and Nanotechnology, The University of Queensland. (2019) From Genetic Engineering to Synthetic Biology. <https://aibn.uq.edu.au/genetic-engineering-synthetic-biology>

⁸ Convention on Biological Diversity Secretariat(2025). Synthetic Biology: Most Recent Decision Related to Synthetic Biology. <https://www.cbd.int/synbio#:~:text=The%20COP%20also%20acknowledged%20that,the%20environment%20under%20specific%20criteria.>

2.0 Background

SO CLOSE: THE IUCN VOTE ON THE USE OF GENETIC ENGINEERING IN CONSERVATION

In October 2025, I flew halfway around the world to an event that would reveal a deeply divided conservation community.

On behalf of Nature Canada, I joined colleagues in Abu Dhabi at the International Union for the Conservation of Nature’s World Congress, which happens every four years. We were there to encourage IUCN members, both government and NGO, to extend a moratorium on the release, for conservation purposes, of genetically engineered organisms into the wild.

The vote on the moratorium motion was as close as it could be: 79 governments voted for it and 80 against, with 407(56%) of NGOs voting in favour. (In order for a motion to pass, both governments and NGOs have to vote in favour.)

Apart from the heartbreak, the vote revealed the split within the global conservation community on the use of genetic engineering. Some governments and larger conservation organizations were clearly for it, seeing opportunities with emerging technologies to protect nature. Other governments and organizations, including most Indigenous Peoples’ organizations, preferred a go-slow or more cautious approach. Zoos and similar institutions were split.

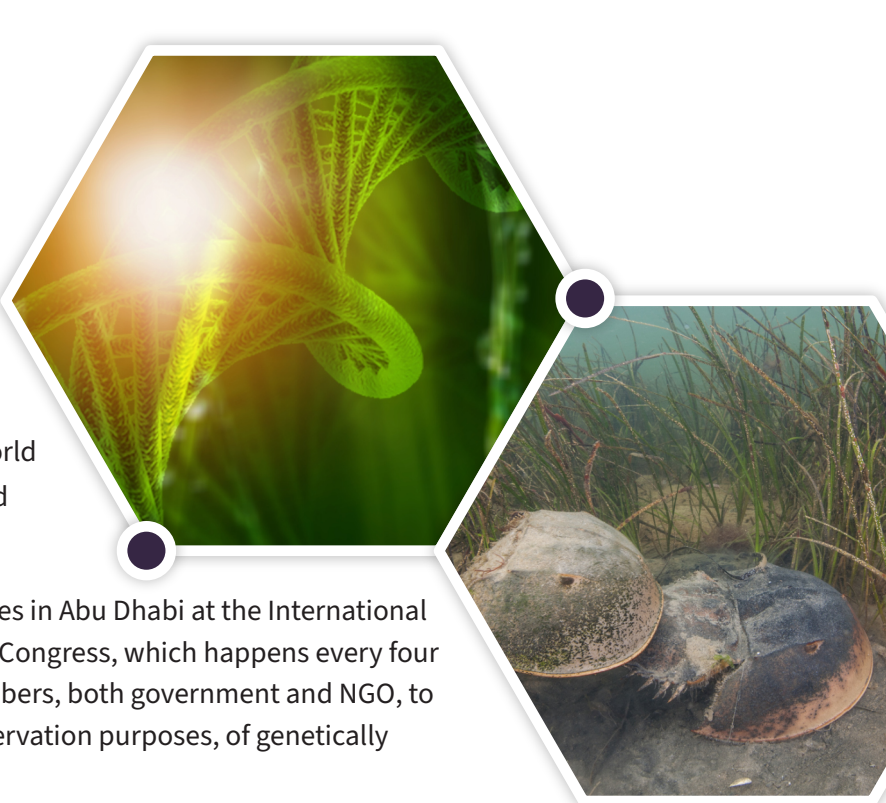
The debate —before, during and after this vote — underlines the need for a report of this kind.

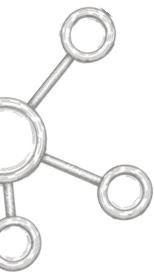
IUCN AND GENETIC ENGINEERING

The IUCN provides a [timeline](#) of the organization’s efforts to come up with a satisfactory policy on genetic engineering.⁹ The IUCN “establishment” has been in favour of endorsing the use of GE in nature conservation, subject to a risk assessment, for over a decade.

At the 2025 World Congress there were two motions on genetic engineering that were voted on by members. [Motion 087](#) proposed that applications for genetic engineering be assessed on a case-by-case basis.¹⁰ This motion was strongly supported by IUCN leadership and passed with comfort. [Motion 133](#), sponsored by eight NGOS including Nature Canada, proposed a continuation of the moratorium on the release of genetically engineered organisms into the wild. As mentioned above, it was defeated by one vote in the government category.¹¹

⁹ IUCN. Synthetic Biology and Nature Conservation. ¹⁰ IUCN World Conservation Congress (2025). ¹¹ Ibid





In the lead-up to the votes on the two motions, there were intense discussions between proponents of the two motions. As part of these discussions, proponents of Motion 133 made efforts to clarify that they weren't targeting laboratory research, traditional or non-spreading vaccines, the use of [Wolbachia bacteria](#), production of [synthetic alternatives](#) in contained facilities, or [cloning](#).^{12,13,14} Moratorium supporters stressed that research could and would continue, but proponents of Motion 087 said that Motion 133 would have a chilling effect on research.

POTENTIAL USES OF GE

Supporters of genetic engineering argue that we must use 'every tool in the tool box' to save nature. At a time when species and habitats are disappearing at a heart-breaking rate, this is a compelling argument, particularly if it can be done faster and cheaper than conventional conservation methods.

Here are some technologies and proposed uses in the field of conservation:

CRISPR genome editing (clustered regularly interspersed palindromic repeats) is a defense that bacteria and **archaea** use to protect themselves from invading viruses. Scientists have adapted it to edit DNA. It is cheaper and quicker than previous technologies.

Examples: altering the genome of a species such as changing the zooxanthellae found in corals to make them more resistant to rising ocean temperatures. (A Canadian example: editing the genome of leopard frogs in Northern B.C. to make them more resistant to the chytrid fungus.)

Gene drives allow scientists, using a tool like CRISPR, to drive a trait through a population faster than would occur through natural inheritance.

Example: eradicating introduced rats on an island by driving an engineered trait, such as infertility, through the rat population.

[Self-spreading viral vaccines](#) are modified viruses that confer immunity as they spread.¹⁵

Example: conferring immunity in an endangered population such as gorillas threatened by disease.

Despite the potential, along with the hype and controversy, few of these proposed applications have gone through a peer-review process and are ready to be tested in the wild in any meaningful way.

¹² World Mosquito Program. How it Works. <https://www.worldmosquitoprogram.org/en/work/wolbachia-method/how-it-works>

¹³ Maloney, Tom, Phelan, Ryan and Simmons, Naira(2018). Saving the Horseshoe Crab: A Synthetic Alternative to Horseshoe Crab Blood for Endotoxin Detection. <https://pmc.ncbi.nlm.nih.gov/articles/PMC6200278/>

¹⁴ Revive and Restore. The Black-Footed Ferret Project. <https://reviverestore.org/projects/black-footed-ferret-old/major-milestones/>

¹⁵ Lentzos, Fillipa and Reeves, Guy(2020). Scientists are Working on Vaccines that Spread Like a Disease. What could Possibly Go Wrong?

De-extinction projects, like trying to recreate the [dire wolf](#) or [woolly mammoth](#), have captured lots of headlines and public attention and were a topic of conversation at the IUCN Congress, but there is widespread agreement amongst conservationists, even those who support the use of GE, that these efforts have little to [no conservation value](#).^{16,17,18}

Genetic engineering is being used in agriculture, aquaculture, forestry, the pet trade and other human activities that intersect with nature. The use of GE in any sphere is a potential danger, and all claims of benefits should be scrutinized carefully; however, this short report limits itself to direct applications in conservation.



3.0 Genetic Engineering: The Pros

EVERY TOOL IN THE TOOL BOX

The debate over the use of GE in conservation is happening in the context of an ever-shrinking nature and continued loss of species and habitat. The votes on synthetic biology at the 2025 IUCN World Congress occurred alongside the now expected announcement of more species being added to the [IUCN Red List](#). Proponents of synthetic biology argue that the biodiversity crisis compels us to use every tool in the toolbox to save species and nature.¹⁹

Here is Helen Pilcher making that argument in an October 23rd, 2025 op-ed in [The Guardian](#) in response to the vote in Abu Dhabi.²⁰

“So it was a win for conservation when IUCN members in Abu Dhabi chose to reject the moratorium on releasing GM wild species and instead, accept a policy that enables researchers to proceed with genetically modifying wildlife cautiously, with key decisions made on a case-by-case basis. Humans are the ones driving biodiversity loss among all species. We have new tools that could help to address this travesty, so isn't that at least worth exploring?”

¹⁶ Maiman, Kevin(2025, April 8)). A Bio-tech Company has, Sort of, Revived, the Long-Extinct Dire Wolf. CBC News. <https://www.cbc.ca/news/dire-wolf-deextinction-1.7505369>

¹⁷ Revive and Restore. Woolly Mammoth Revival. <https://reviverestore.org/projects/woolly-mammoth/>

¹⁸ Sideris, Lisa(2025). Bringing back the Mammoth Won't Fix the Future.Yale Climate Connections. <https://yaleclimateconnections.org/2025/04/bringing-back-the-mammoth-wont-fix-the-future/>

¹⁹ IUCN. The IUCN Red List of Threatened Species.<https://www.iucnredlist.org/>

²⁰ Pilcher, Helen(2025, October 23). Leading Conservationists Just Decided that Genetically Engineering is Ok-Sometimes. They're Right. <https://www.theguardian.com/commentisfree/2025/oct/23/conservationists-genetically-engineering-wild-animals-dna-lab>



CONSERVATIONISTS ARE THE PROBLEM

[Ben Lamm](#), co-founder of Colossal Biosciences, has stated that “the worst part of conservation is conservationists.”²¹ He criticizes the conservation movement for using outdated approaches and thinking that isn’t commensurate with the scale and speed of the extinction crisis. This is an extreme version of the above “every tool in the tool box” argument, i.e., the old tools aren’t working.

RISK ASSESSMENT ON A CASE-BY-CASE BASIS

The IUCN, in rejecting a long-standing moratorium on the introduction of genetically engineered organisms into the wild, is instead supporting a case-by-case approach to proposed applications, as most countries do for major industrial projects and new chemicals. The argument is that risk assessments will catch any mistakes or unintended consequences.

Senior leadership in the IUCN stresses that this is not a blanket endorsement of the application of synthetic biology but rather a cautious approach with the option for member states to reject or approve the use of GE. Proponents of the case-by-case approach also argued that a moratorium would remove the right of sovereign states to make their own decisions on the use of GE.

FEAR OF THE NEW

Proponents of synthetic biology argue that every new technology is initially greeted with apprehension and resistance but over time becomes accepted and widely used. Synthetic biology is no different. Similarly, proponents of genetic engineering, particularly in agriculture and related fields, argue that opposition to the use of GE generally is irrational and driven by a lack of understanding of science and the risks.

GE IS JUST SELECTIVE BREEDING SPED UP

The biotech industry and supporters have long argued that genetic engineering is just selective breeding or even evolution, sped up; humans are giving nature a helping hand. What occurred over generations or millennia can now happen within a generation. [The Science Literacy Project](#), whose tagline is science not ideology, has consistently articulated this position.²²

NATURE NO LONGER EXISTS SEPARATE FROM HUMANS

“The notion that ‘nature’ exists in a pure state is itself dubious, but if it were ever so, that time has long passed.” In the [same article](#), the author, David Farrier, observes that humans are now the “planet’s

²¹ Greenfield, Patrick(2025, 31 December). ‘They didn’t de-extinct anything’: Can Colossal’s Genetically Engineered Animals Ever Be the Real Thing? The Guardian. <https://www.theguardian.com/environment/2025/dec/31/colossal-ben-lamm-deextinction-dire-wolf-dodo-tasmanian-tiger-aoe>

²² The Science Literacy Project. How Does Genetic Engineering Differ from Conventional Breeding? <https://geneticliteracyproject.org/gmo-faq/how-does-genetic-engineering-differ-from-conventional-breeding/>

greatest evolutionary force.”²³ It is (in part) this recognition that human influence is ubiquitous that leads Farrier to endorse the use of genetic engineering in the service of conservation.

An extension of this argument or thinking is [Stewart Brand’s](#) famous quote: “We are as gods and might as well get good at it.”²⁴ In response to those who encourage restraint in intervening in nature with new technologies, the response from Brand and others is that we are way past that and we have an obligation to intervene.

There are also those who come to the conclusion that we must intervene, whether it be geoengineering or genetic engineering, with obvious reluctance. Elizabeth Kolbert, a thoughtful and award winning science journalist, [writes](#) about the devastation the introduced cane toad has inflicted on Australian fauna and flora and the efforts of scientists to come up with a genetic intervention.²⁵

INTERVENTION FOR CONSERVATION PURPOSES IS SUCCESSFUL

Ryan Phelan and colleagues at Revive and Restore carried out a [study](#) on the translocation of individuals to bolster dwindling populations and found that in nearly all cases, the intervention was a success or had no negative consequences.²⁶ Extrapolating more widely, [they argue](#) that technological interventions for conservation purposes usually end well.²⁷

²³ Farrier, David.(2025, Sept. 26) Should We Edit Nature? Aeon. <https://aeon.co/essays/should-we-intervene-in-evolution-the-ethics-of-editing-nature>
²⁴ Solomon, Lisa Kay.(2022, March 30) The Man Who Saw and Sparked the Future(Again, Again and Again). Medium. <https://medium.com/@lisakaysolomon/the-man-who-saw-and-sparked-the-future-again-and-again-and-again-55a279ce1d02>
²⁵ Kolbert, Elizabeth. (2021, January 11). CRISPR and the Splice to Survive. In the New Yorker. <https://www.newyorker.com/magazine/2021/01/18/crispr-and-the-splice-to-survive>
²⁶ Novak, Ben J., Phelan, Ryan, and Weber, Michele.(2021, March 05) US Conservation Translocations: Over a Century of Intended Consequences. In Conservation Science and Practice. 3(4).
²⁷ Revive and Restore. Intended Consequences at TED Monterey.<https://reviverestore.org/what-we-do/ted-talk/>

Saving Horseshoe Crabs with Genetic Engineering

The blood of horseshoe crabs has been used in the production of medical compounds and thousands of crabs were killed annually. All four species of horseshoe crab are endangered or threatened; in addition, the eggs of the crabs serve as a food source for migrating shorebirds, many of them threatened, including the red knot in Eastern North America. Starting in the 1970s, scientists began searching for alternatives and recently have come up with a synthetic compound which reduces the need to use horseshoe crabs by 90%. Genetic engineering played a part in the development of this alternative.²⁸

²⁸ Maloney, Tom, Phelan, Ryan and Simmons, Naira(2018). Saving the Horseshoe Crab: A Synthetic Alternative to Horseshoe Crab Blood for Endotoxin Detection. <https://pmc.ncbi.nlm.nih.gov/articles/PMC6200278/>

4.0 Genetic Engineering: The Cons

TECHNOLOGY

Most technologies — from the earliest, such as fire and farming, through to the internal combustion engine and modern chemistry — have greatly benefited humans but have had major impacts, mostly harmful, for nature. It is probably safe to say that the developers of these technologies gave little thought to what they meant for nature.

Genetic engineering, particularly coupled with AI, is one of the most powerful technologies humans have developed. It seems naïve to think that this time it will be different for nature. And once various applications of this technology are in use, it will be hard to stuff them back into the proverbial box.

The scholar of technology David Collingridge developed the concept of ‘dilemma of control’: the full implications of a technology only become apparent once a technology is widespread and entrenched, and by then it is difficult to control or reel back.²⁹ This dilemma or conundrum is certainly relevant to the release of engineered species into the wild.

Langdon Winner, another scholar, described in his 1986 book, *The Whale and the Reactor: A Search for Limits in the Age of High Technology*, how technologies have inherent properties with implications for human society and nature.³⁰ His ultimate question, implicit in the subtitle and even more relevant today, is: Are humans capable of setting limits or saying no to technologies they develop?

Graham Saul in *Breaking the Pattern: Certainty, Technology and the Global Environmental Crisis* argues that a “precautionary approach should be taken to emerging biotechnologies in order to avoid repeating a pattern of technological development that is a primary cause of the modern environmental crisis.” “Breaking the pattern” is a good goal.³¹

PRECAUTIONARY PRINCIPLE

The most often cited definition of the precautionary principle comes from the Rio Declaration from the 1992 UN Earth Summit (Principle 15):

²⁹ Collingridge, David.(1980). *The Social Control of Technology*. Pinter. London.

³⁰ Winner, Langdon.(1986) *The Whale and the Reactor: A Search for Limits in an Age of High Technology*. The University of Chicago Press. Chicago.

³¹ Saul, Graham.(2025). *Breaking the Pattern: Certainty, Technology and the global environmental crisis*. Dissertation. University of Exeter.



“Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”³²

Introducing genetic changes into wild populations through tools like CRISPR carries the potential for serious, and certainly irreversible, damage to nature. There is also plenty of scientific uncertainty around how a novel or engineered organism will behave in the wild. Thus, not surprisingly, genetic engineering and the precautionary principle have a well established relationship which, also not surprisingly, is under attack by the biotech industry. Boiled down, the precautionary principle says be both careful and humble, which is typically good advice in our relationship with nature.

RISK ASSESSMENTS HAVE A MIXED RECORD OF PROTECTING NATURE AND HUMAN HEALTH

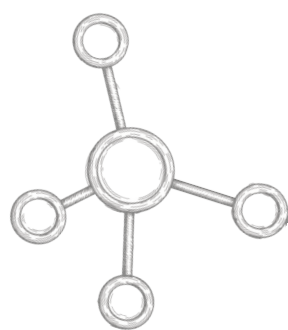
Motion 087, which proposed that applications for genetic engineering be assessed on a case- by- case basis and which passed comfortably at the 2025 World Congress, means that the IUCN is now perceived as endorsing the use of GE in conservation subject to a risk assessment. Anecdotally, we are hearing that behind closed doors the IUCN leadership does not object to that portrayal even though publicly they say they are neutral.

Risk assessments are currently used to assess new projects and products. Robust risk assessments can reduce unintended impacts on nature and human health and even identify better alternatives. However, overall, risk assessments have a mixed track record. For example, numerous chemicals now under review or recalled, such as phthalates, PCBs, PFAs or even plastics more generally, went through risk assessments. There are a number of reasons to be sceptical about the ability of risk assessments to identify and prevent unintended consequences of using GE in conservation: the science is uncertain; the quality of risk assessments varies across jurisdictions; public participation is often limited, particularly for GE applications; and projects are rarely rejected, suggesting that assessments have become a step in an approval process rather than an objective assessment of whether the project or product should be approved.

CRISPR APPLICATIONS ARE DIFFERENT FROM PREVIOUS TECHNOLOGIES OR NATURAL SELECTION

Everything exists on a continuum, but there are real differences between what is possible with new gene engineering techniques such as CRISPR versus traditional or selective breeding. CRISPR allows

³² United Nations.(1992). *Rio Declaration on Environment and Development*. https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf



researchers to make changes within a species genome that would be unlikely or impossible to occur through random mutations or through mutagenesis. [New research](#) shows that organisms may have developed mechanisms to specifically protect essential sections of their chromosomes from elevated mutation. CRISPR could override these “safeguards.”³³

And while there is movement of genetic material between species in nature through horizontal gene transfer, the scale of what is now possible does not exist in nature. A transgenic Atlantic salmon proposed for the aquaculture industry contained genetic material from an eel pout, a marine fish, and a west coast species of salmon. This would not happen in nature.

Presumably the term synthetic biology has emerged because it describes what would not occur in nature.

CRISPR MAKES UNINTENDED CHANGES TO THE GENOME

[Reviews](#) of gene editing using CRISPR reveals unintended modifications, including altering or deleting entire chromosomes (chromothripsis), an extreme effect.

In some cases, these changes were not detected by the developers carrying out the work. CRISPR is more precise than classical genetic engineering techniques but the widespread practice of describing it as precise is misleading.

³³ Monroe, Grey J.(2022, January 12).Mutation Bias Reflects Natural Selection in *Arabidopsis thaliana*. Nature. 602, 101-105.<https://www.nature.com/articles/s41586-021-04269-6>

The results of our literature review show that the impact of such CRISPR techniques in host genomes varies from small nucleotide polymorphisms to large genomic variation, such as segmental duplication, chromosome truncation, trisomy, chromothripsis, breakage fusion bridge, including large rearrangements of DNA vector-backbone sequences.³⁴

³⁴ Chu, Philomena and Agapito-Tenfen, Sarah Zanon(2022) Unintended Genomic Outcomes in Current and Next Generation GM Techniques: A Systemic Review. In Plants. 11(21):2997. <https://pubmed.ncbi.nlm.nih.gov/36365450/#:~:text=The%20results%20of%20our%20literature,detect%20and%20identify%20genomic%20interventions>

UNKNOWN AND UNCERTAINTIES IN GENETICS

It is not uncommon to read in a genetics textbook that “Only a few years ago the common understanding was *this*, and now it’s *that*. Phillip Ball, editor at the periodical *Nature* and a seasoned science writer, has written a thick book entitled [How Life Works](#), in which he argues for a new way of thinking about genetics largely because of all the new discoveries and ground-breaking research occurring.^{35,36} The field of genetics is developing rapidly, which is exciting for researchers, but at the same time it means there is a lot we don’t know or are just learning.

ENGINEERED INDIVIDUALS OUTCOMPETE NATURAL OR NON-ENGINEERED INDIVIDUALS

Engineered individuals introduced into a wild population, because they possess novel traits that could save that population, may out-compete and eventually eliminate the non-engineered natural population. Such an outcome, also referred to as outbreeding depression, while possibly protecting the species in the immediate term, would reduce the genetic diversity of the wild population and thus endanger it in the long-term.

³⁵ Rutherford, Adam.(2024, 11 Jan) How Life Works a Phillip Ball Review: the Magic of Biology. The Guardian. <https://www.theguardian.com/books/2024/jan/11/how-life-works-by-philip-ball-review-the-magic-of-biology>

³⁶ Ball, Phillip

Genetically Engineered Fish are Now Breeding in the Wild

The first genetically engineered animal to breed in the wild is a zebra fish containing a fluorescing gene from the jellyfish family. In 2022, [Brazilian researchers](#) published a paper documenting the spread and reproduction of one of these GE aquarium fish in Brazilian waterways. The transgenic zebra fish, originally from SE Asia, had escaped from local fish farms.³⁷

Spectrum Brands, the company selling this fish, is inserting these genes into a growing number of species of aquarium fish and marketing them all under the term [Glofish](#).³⁸ The zebrafish are not native to Brazil so are less likely to interbreed with native species, but it is likely only a matter of time before one of these transgenic fish escape in their home range and interbreed with their wild counterparts. From fish farms through to consumers releasing them into the local pond, there is no effective containment of aquarium fish.

³⁷ Mouthino, Sofia.(2022, Feb. 11). Transgenic Glowing Fish Invades Brazillian Streams. Science <https://www.science.org/content/article/transgenic-glowing-fish-invades-brazilian-streams>

³⁸ Company website. <https://www.glofish.com/>

SCALE

Proponents talk of using GE to make trees more resistant to drought, or corals more resilient to rising sea temperatures. Even if successful, a tree or coral is only one of thousands species in a forest or on a reef. It seems unlikely we will ever be able to engineer at scale, to engineer an entire ecosystem, even if we master the complexity of those ecosystems.

THE TECHNOLOGY DOESN'T WORK

Sometimes both those supportive or opposed to GE overlook a simple reason to be cautious about the technology: it's unproven and [may not work](#).³⁹ Efforts to reintroduce an engineered American chestnut lost the support of the American Chestnut Foundation because of poor performance and an embarrassing labeling mix-up. A transgenic Atlantic salmon, touted for its growth rate and the world's first GE food animal to receive government approval, didn't gain commercial acceptance in part because [similar growth rates](#) were likely achieved through selective breeding of Atlantic salmon without using GE.⁴⁰

DIY GENETIC ENGINEERING

You can now order [GE kits online](#).⁴¹ As with most technologies, as GE develops it will become cheaper and easier to use. It is hard to see that as a positive for nature.

COULD GE UNDERMINE SUPPORT FOR THE BASIC PRINCIPLES OF CONSERVATION?

Species are the fundamental unit of conservation. Think of endangered species, species richness, or even a birder's checklist with its list of species. Yes, there is interbreeding, hybrids, horizontal gene transfer and species within species, but overall, a species as a unit is both a biological reality and conceptually helpful.

With genetic engineering we now have the ability to change the genome of any species or to create new species. Theoretically we could create a red blue jay or a blue cardinal. Futurists talk of designer pets. And as genetic engineering gets cheaper and easier, what's to stop DIYers, rogue labs, companies or even states from creating new or altered species which could end up in nature either intentionally or by accident. If it becomes easier to change an existing species or create new ones, what are the implications for conservationists trying to protect the genetic integrity of species and ecosystems? All this activity could corrode the underpinnings of conservation and societal norms around protecting nature.

³⁹ Peacock, Tony.(2021, May 7). A Potted History of Wildlife Fertility Control-and Lessons for Mission-Driven Research. <https://www.linkedin.com/pulse/potted-history-wildlife-fertility-control-lessons-research-peacock/>

⁴⁰ Devlin, Robert H.(2001). Growth of Domesticated Transgenic Fish. In Nature. 409, pages781–782 <https://www.nature.com/articles/35057314>

⁴¹ Company website: <https://www.the-odin.com/all-products/>

Worse still, such projects may undermine public understanding of conservation itself. If the public is led to believe that extinct species can simply be recreated in labs, it could weaken support for protecting those that are currently endangered.

During a 2025 House Natural Resources Committee hearing, U.S. Representative Lauren Boebert (R-CO) cited Colossal's dire wolf project while advocating to delist gray wolves from Endangered Species Act protections, asking:

"Didn't we just bring a wolf back that was here 10,000 years ago?" she said. "If it really gets that bad, you know, we could just bring woolly mammoths back and all that stuff."

That sentiment is shared with Interior Secretary Doug Burgum, under the Trump Administration, who has met with Colossal Biosciences Inc. to discuss how the company can be employed in federal conservation efforts. In a live-streamed town hall, he told Interior staff: "If we're going to be in anguish about losing a species, now we have an opportunity to bring them back. Pick your favorite species and call up Colossal."

The organization, Living with Wolves, has written a thoughtful [article](#) on the dire wolf.⁴²

In June 2026, the Trump administration and Colossal announced a [partnership](#) under which the company would collect the DNA of endangered species for storage and preservation.⁴³ Representatives of the Toronto and San Diego Zoos raised questions about whether a private company was the best partner.

⁴² Smith, Megan.(2025, August 8). The Illusion of De-Extinction: Colossal Biosciences and the Myth of the Dire Wolf. Living with Wolves. <https://www.livingwithwolves.org/the-illusion-of-de-extinction-colossal-biosciences-and-the-myth-of-the-dire-wolf/>

⁴³ Zimmer, Carl and Einhorn, Catrin.(2026, June 25) Trump Administration Moves to Preserve Cells and DNA of Imperiled Species. The New York Times. https://www.nytimes.com/2026/06/25/climate/colossal-biosciences-gene-bank.html?eafs_enabled=false



Colossal Biosciences

Below is an excerpt from the [2025 annual report of the Colossal Foundation](#).⁴⁴ We'll leave it to the reader to determine if the primary obstacle to conservation has been the lack of technologies or tools.

"The fabric of life on Earth is unraveling at a staggering pace. The good news is that, for the first time in history, we have the tools to begin stitching it back together. And Colossal is already reshaping what is possible. Advances in genomic sequencing, gene editing, artificial intelligence, and assisted reproductive technologies now allow us not only to prevent extinctions, but to restore what has been lost. But with possibility comes responsibility. We need a global community ready to embrace emerging technologies. A problem of this scale requires new approaches, new perspectives and a broader toolkit."

⁴⁴ Impact Report(2025). Colossal Biosciences.

PUBLIC TRUST

Conservationists largely enjoy the public trust. Genetic engineering is a controversial topic. As we have seen with vaccines, in times of polarization and misinformation, segments of public opinion can change quickly and unpredictably. It is important for conservation groups to pay attention to how the public reacts to the use of GE in conservation. How will the public feel if species or habitats (e.g. forests) are genetically engineered? How will they react to proposals to use self-spreading vaccines to control invasive species or feral populations? How will they react if the conservation organizations they support are seen to have advocated for such interventions?

Or conversely, will the public go from being cautious or ambivalent about GE to enthusiastic supporters, calling for the use of GE to control everything from pests to nuisance vegetation?

The German Federal Agency for Nature Conservation has produced a [report](#), one of the few conservation organizations to do so, on nature and genetic engineering.⁴⁵ The report, along with asking practical questions about how German legislation would handle proposals to engineer species, digs into these questions of how the public might react to proposals to engineer wildlife and nature.

DISTRACTION AND DIVERSION

Throughout the discussions and negotiations at the IUCN on genetic engineering, some of us wondered why the organization's leadership was willing to put so much effort (including establishing the IUCN's

⁴⁵ Federal Agency for Nature Conservation.(2022) Genetic Engineering, Nature Conservation and Biological Diversity: Boundaries of Design. Bonn, Germany. <https://www.bfn.de/en/publications/position-paper/genetic-engineering-nature-conservation-and-biological-diversity>

first ever Citizens' Assembly) into securing an endorsement of genetic engineering. Why not put the same effort into addressing the root causes of biodiversity loss or challenging the actions of powerful governments or corporations?

5.0 Genetic Engineering: Important Considerations

INDIGENOUS PEOPLES RIGHTS

[Coordinadora de Organizaciones Indígenas de la Cuenca Amazónica](#), an Indigenous Peoples organization from Ecuador, was one of the eight organizations supporting Motion 133 at the IUCN 2025 World Congress. Of the Indigenous organizations who voted on the motion, a majority were in support. Of course, there isn't one Indigenous world view, and Indigenous organizations and leaders take varying positions. Where there is a high level of agreement is around the need to obtain free prior and informed consent before genetic engineering tools are applied.

Mi'kmaw Elders, Albert and Murdena Marshall have developed and articulated the concept of Etuaptmuk or Two-eyed seeing which is best explained in [Albert's words](#): "I, you, and we need to learn to see from one eye with the best or the strengths in the Indigenous knowledges and ways of knowing... and learn to see from the other eye with the best or the strengths in the mainstream (Western or Eurocentric) knowledges and ways of knowing... but most importantly, I, you, and we need to learn to see with both these eyes together, for the benefit of all."⁴⁶

Exploring the use of genetic engineering in nature using two-eyed seeing might result in a more balanced conversation and consideration of the pros and cons.

The SING 2020 (Summer Internship for Indigenous Genomics) Indigenous Genomics Conference brought together leading thinkers and researchers in New Zealand and many of the [excellent presentations](#) are online.⁴⁷ In addition, there are some powerful reflections from Indigenous thinkers on the use of genetic engineering in food production: see [this essay from author](#) Robin Wall Kimmerer and [this interview with Valerie Segrest](#).^{48,49}

⁴⁶ Marshall, Albert.(2018). Learning Together by Learning to Listen to Each Other.<https://www.edcan.ca/articles/learning-together-learning-listen/>

⁴⁷ SING Indigenous Genomics Conference 2020 <https://www.singaotearoa.nz/singconference-2020>

⁴⁸ Wall Kimmerer, Robin.Corn Tastes Better on the Honor System. <https://emergencemagazine.org/feature/corn-tastes-better/>

⁴⁹ Vasquez Yolima Rivera. Northwest Tribes and Genetically Engineered Salmon: An Interview with Valerie Segrest. EcoTrust. <https://ecotrust.org/northwest-tribes-and-genetically-engineered-salmon-an-interview-with-valerie-segrest/>



CORPORATE INFLUENCE

The development of a technology, is in large part, driven by opportunities for revenue generation and profit, and backed by governments because of the opportunities for economic development and tax revenue. This dynamic plays out in several ways. First, harmful consequences for nature from the development of biotechnology are less likely to get consideration from developers, particularly in the early days when the downsides are not widely apparent. Second, the scientific expertise will largely be employed by industry and government, and there will be a reluctance by scientists, including those in academia, to speak publicly on risks because of their increasing ties with industry (coupled with scientists’ desire to be seen as “objective”). Finally, biotechnology allows for the further monetization of nature through the patenting of new engineered organisms or other biological “components,” adding further incentive to ignore negative impacts.

A number of organizations — including Save Our Seeds, Pollinis, GM Watch, Friends of the Earth and Canadian Biotechnology Action Network — document the role of corporations in GE development, particularly in the biotech, chemical and agriculture sectors.

GOVERNMENTS’ POSITIONS ON BIOTECHNOLOGY RARELY CONSIDER NATURE

Most governments’ positions on biotechnology are primarily determined by the nation’s trade and economic interests. Canada released a [Canadian Biotechnology Strategy](#) in 1998 and has strongly supported the growth of biotechnology both nationally and internationally since then.⁵⁰ Canadian parliamentarians, civil society and individual civil servants have called for modernization and reform but with [limited success](#).⁵¹

Canada did not approach the IUCN vote through the lens of what is best for nature. Rather, its position was determined by the country’s overall policy and regulatory position including its support for risk assessment. Even countries like Germany, where there is significant opposition to the use of GE, could only muster an abstention at the IUCN Congress, presumably because of pressure from trade related departments.

GE ORGANISMS REPRESENT A NEW CATEGORY OF INVASIVE SPECIES

Genetically engineered organisms represent a new category of invasive species. If engineered species become more widely available or used in the pet trade as well as in agriculture, forestry and aquaculture, we will see more engineered species present and breeding in the wild.

⁵⁰ Canada.(1998) Canada’s Biotechnology Strategy. <https://www.canada.ca/en/health-canada/services/science-research/emerging-technology/biotechnology/role/canada-biotechnology-strategy.html>
⁵¹ Rabson, Mla.(2023). Nature Group wants Government to Strengthen Reviews of Genetically Engineered Animals. The Globe and Mail. <https://www.theglobeandmail.com/canada/article-nature-group-wants-canada-to-strengthen-reviews-of-genetically/>

AI

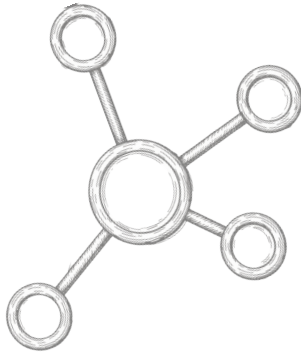
AI it seems is dramatically accelerating and expanding what is possible in genetic engineering. Scientists using AI have been able to create [new versions of CRISPR](#) as well as completely new or synthetic proteins and viruses.⁵² In June 2026 a team at Cambridge University⁵³ announced the development of the world’s first vaccine using AI. Supporters may see this as positive; sceptics, as intensifying the risks of already risky technology. And more broadly AI has a suite of [negative](#) environmental and social impacts.⁵⁴

IDEOLOGY

Traditionally, concern about the negative implications of GE has come largely from the left while the traditional right, with strong ties to the corporate sector, have largely championed the technology. In recent years, the populist right have started attacking the use of GE particularly in terms of human health. On platforms like X, a post on GE from a right-wing influencer might garner thousands of “likes,” while posts from established anti-GMO groups might get only a few.

SHIFTING GEOPOLITICS

The [United States](#) exited the IUCN early in 2026.⁵⁵ Even though the U.S. Secretary of Health and Human Services, Robert Kennedy, is a long-time critic of GE, at the 2025 World Congress, the U.S. voted against Motion 133. It’s possible the administration wasn’t even aware of the vote. Recently, [Europe](#) has reversed long-standing positions on the use of genetic engineering in agriculture.⁵⁶ [China’s capacity](#) in the life sciences and biotechnology is strong and growing and may soon rival or outpace that of the United States or Europe. In the coming years China will likely have a growing influence on the direction and application of the technology.⁵⁷



⁵² Kim, Min-gyeong et al. (2025, July 31). Revolutionizing CRISPR Technology with Artificial Intelligence. In Nature.57, pages 1419–1431.
⁵³ Gallagher, James. (2026, June 4). World’s First Vaccine Developed by Artificial Intelligence. BBC. <https://www.bbc.com/news/articles/crrpggegewe0o>
⁵⁴ Thomas, Jim.(2025, Nov. 11) AI as a False Climate Solution. In Scan the Horizon. <https://www.scanthehorizon.org/p/ai-as-a-false-climate-solution>
⁵⁵ Associated Press.(2026, Jan. 6) Which are the 66 Global Organizations the US is Leaving under Trump? Aljazeera.<https://www.aljazeera.com/news/2026/1/8/which-are-the-66-global-organisations-the-us-is-leaving-under-trump>
⁵⁶ Save Our Seeds.(2025, 19 Dec.). EU Governments Sign Off on Far-Reaching GMO Deregulation. <https://www.saveourseeds.org/publications/eu-governments-sign-off-on-far-reaching-gmo-deregulation/>
⁵⁷ Drexel, Bill.(2025). The AI Genetics Revolution is Coming. In The New Atlantis. <https://www.thenewatlantis.com/publications/the-ai-genetics-revolution-is-coming>

6.0 Top Observations

- **The conservation community is split.** There are committed conservationists on both sides of the argument and a good number in the middle. For those working to protect and restore lemurs in Madagascar, endemic species in Australia or frogs in Central America, the pull of genetic engineering is understandable.
- **Canada’s position, and likely a number of other industrialized countries’ positions, on the use of genetic engineering in nature is determined by larger policy considerations.** The Canadian government’s position on biotechnology is largely shaped by economic and competitiveness considerations, not by what is best for nature. In addition, Canada employs (and is a stalwart defender of) the risk assessment approach proposed in Motion 087.
- **Biotech companies and their proxies are some of the most ardent promoters of GE in conservation.** These companies will benefit in a number of ways, from sales to positive publicity, from the use of biotechnology in conservation. There are also strong ties among the biotech industry, academic scientists and some conservation scientists.
- **De-extinction projects, in particular by Colossal Biosciences, have alarmed and turned off some conservation organizations and institutions such as zoos.** Most groups and scientists do not see de-extinction as a conservation priority and rather see it pulling resources from real, if less flashy, conservation work.
- **Ecology is the study of relationships between species and their environment and is expansive by nature whereas genetic engineering is reductionist by nature.**
- **IUCN Motion 087 is a green light to genetic engineering.** The IUCN leadership presents Motion 087 as a cautious and rational approach to GE. In practice, case-by-case assessments are how most nations assess and approve major projects, new chemicals or GMOs.
- **There is a dearth of scientific experts who are willing to speak publicly and critically about biotechnology.** Consequently, much of the scientific expertise is directly or indirectly tied to industry. In addition, because of the complexity and fast-moving nature of the field, scientists, even in related fields, are reluctant to speak out.



- **How can we break the pattern of technological development?** Successive waves of technology have had severe and negative consequences for nature. So much of conservation is rearguard action: reviving species, restoring habitat, and remediating polluted sites. Genetic engineering is a powerful emerging technology, particularly combined with AI. Society, and the conservation movement in particular, should learn from previous periods of technological innovation.
- **Nature’s time scale is different from ours.** Species like the American chestnut may develop genetic resistance to an invasive species, but this may take centuries or millennia, as would be expected for longer lived species like trees. (According to this [film](#), American chestnuts appear to be making a comeback in Maine.)⁵⁸ Of course, some species like flightless or ground nesting birds are not given the time to develop resistance to, or strategies to cope with, invasive species or diseases and other threats.

7.0 Recommendations

1. The Solutions are Largely not Technical

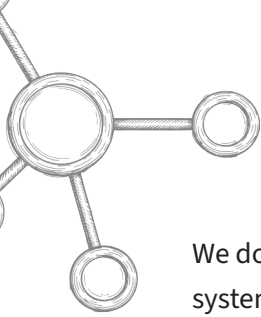
If you are a conservation organization or agency being asked to use or endorse genetic engineering in conservation, proceed with caution. The field is complex and still replete with scientific, legislative and ethical uncertainty. Yes, the biodiversity crisis is urgent and repeatedly heartbreaking but the solutions are largely not technical; they are political, economic and social. In most cases, despite the hype and fierce debate, the technology is still not ready. Waiting two or five years is ok.

2. A Case-by-Case Approach Does Not Provide Adequate Protection

Taking a case-by-case approach and subjecting proposed GE applications to environmental assessment, as described in Motion 087 and the now-adopted policy of the IUCN, is better than blanket approval of a technology, but it is business as usual. Lots of projects and products that have been extremely harmful to nature have been subject to assessments on a case-by-case basis. In addition, public participation in GE risk assessments is often limited. This is a major reason why Nature Canada currently supports a moratorium on the use of genetic engineering in the wild.



⁵⁸ The Campaign to Stop GE Trees.(2025) Wild American Chestnuts Making a Comeback in Maine-New Short Film
Airs Dec. 4. <https://naturecanada.ca/news/blog/saving-the-mainland-moose-of-nova-scotia/>



3. Remain Open to the Technology

We do not take the position that the technology is inherently flawed; it is the intersection with natural systems that concerns us. GE is in use in other spheres, e.g. production of insulin, and its use will likely increase in health care, e.g. somatic (vs. germline) gene therapy. There are some distressingly difficult situations and decisions in conservation, i.e. the imminent extinction of a species. With further research, testing, and dialogue, a greater consensus may emerge for the use of GE in nature conservation in certain circumstances.

4. Free Prior and Informed Consent

Developers and governments should seek free, prior and informed consent from Indigenous Peoples, particularly where the case involves a species of traditional importance, such as salmon.

5. Other Techniques Used in Conservation

The focus of this report is on the genetic engineering of wild species. We are not opposing laboratory research, [traditional or non-spreading vaccines](#), [assisted reproductive technologies](#), the use of [Wolbachia bacteria](#), [synthetic alternatives](#), or [cloning](#).

6. “Keep doing You”

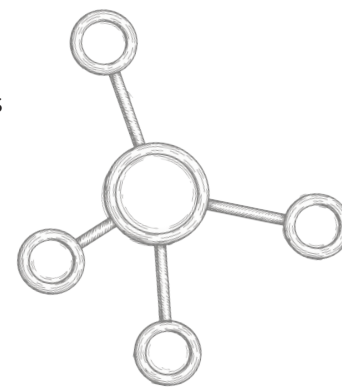
Programs such as, protecting habitat, minimizing pollution, providing nature education, and reducing consumption are conservation programs that have proven benefits for nature. At times, in the face of ongoing and even accelerating biodiversity loss, a quick technical fix seems attractive. However, even if some of these applications are proven to be effective in the long-term with no downsides, most conservation work will still be what we are doing now (but much more of it if we are to be successful).

7. Find Experts

It will be hard to find experts, particularly in genetics or molecular biology, for several reasons. The topic is complex, and scientists are hesitant to speak out on the intersection between science and policy because of their ties to industry. Ethicists, philosophers and anthropologists specializing in science and technology are more willing to address risks and opportunities. Also seek out Indigenous Peoples’ expertise.

8. Government

Recognize that a government’s position on the use of genetic engineering in nature may not be determined by what is best for nature. Rather, it is shaped and driven by domestic and international economic considerations and influenced by the biotech industry. This is a big problem, as it is governments that regulate genetic engineering and are responsible for approving new applications.



9. Corporate Influence

Recognize that the corporate sector has an interest in the outcome of this debate both because it represents a new market — the co-founder of Colossal Biosciences uses the term “de-extinction market” — and because the use of GE in conservation would build social licence for the technology and industry.

10. Oppose the Use of GE in Industries that Interact with Nature

Oppose the use of industrial applications of genetic engineering where there is interaction with the natural world. This is particularly true for aquaculture, forestry, and the aquarium trade. These industries rely on species with wild counterparts, and thus species engineered by industry, if they escape, could interbreed with wild species. Some species used in agriculture, such as corn and cotton, also have wild counterparts.

Epilogue

The IUCN, like most international bodies, has no direct control over what member governments do, but as the world’s premier conservation organization, its votes carry weight and credibility in the conservation world and beyond. The passage of motion 087 and the defeat by the narrowest of margins of motion 133 are being noticed.

There isn’t another World Congress until 2029. In the meantime, Motion 087 (now Resolution 086) contains language about “promoting additional precautionary safeguards.” Some groups are trying to turn this wording into meaningful protections for nature, but now that you’ve read this report you will understand the challenges.

Where does that leave IUCN members and the broader conservation community?

The IUCN describes itself as the largest and most diverse environmental network in the world. It’s true that the IUCN comprises an impressive range of members, both governments and NGOs. A love of nature, a love expressed in as many ways as there are members, is what binds us.

The vision of the IUCN is “a just world that values and conserves nature.” By any objective measure, the IUCN and most nature organizations are failing at ensuring a world that conserves nature (never mind the just part). Every day there is less nature, despite our efforts. How much nature will be left in a century, if present trends continue?

It is the conclusion of this report that relief and remedy for nature, particularly at the scale and speed required, does not lie with synthetic biology. Instead we need to demand more of the IUCN... and of ourselves.

