

(Syn) Biology without Borders: Understanding the complexities and power of life?

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NC STATE

Our environmental futures?

- As bioengineering technology winds its way through the many passageways of life, stripping one living thing after another of its identity, replacing the original creations with technologically designed replicas, the world gradually becomes a lonelier place...we descend to a world stocked with living gadgets and devices
- Jeremy Rifkin – 1983, founder of Foundation on Economic Trends (FOET)

Storyline

- Realities and Promises of Synthetic Biology
- Environmentalism flipped on its head?
- Governance challenges
 - Global
 - IUCN
 - U.S.
- Rise of the Biocitizen(s)
- Art/design as ethical/societal reflections

Synthetic biology in your future everyday life



- 1 American chestnut tree**
Early versions of synthetic biology allowed scientists to engineer an American chestnut tree that is resistant to the deadly fungal disease that removed the trees from across the eastern U.S.
- 2 Athletic gear**
Synthetic biology was used to engineer PDO, an essential component in high-performance textiles like running and outdoor gear.
- 3 Fuel**
Synthetic amylases and other enzymes lower the cost of producing ethanol from grain.
- 4 Technical fibers**
Spider silk is both stronger and lighter than steel. Silkworms engineered to produce this spider silk may one day be used to produce safer and more efficient cars.
- 5 Bricks**
Biotechnology-based bricks are made with sand and bacteria fed with calcium carbonate, a key structural component of shells and coral reefs.
- 6 Furniture**
Silk proteins produced by engineered yeast are woven into fabrics and garments like clothing or sofas.
- 7 Medicine**
Synthetic biology technologies have been used to engineer immune cells to treat blood cancer.
- 8 Wood products**
Synthetic biology helped create an alternative to the milk-based casein protein for use in imitation wood décor and flooring.
- 9 Synthetic leather**
Microbes modified using synthetic biology approaches produce collagen that is formed into leather products.
- 10 Paper**
Microbes and enzymes modified by synthetic biology can increase the efficiency of paper production and decrease the effects of paper manufacturing.
- 11 Perfume**
Engineered yeast is now producing nootkatone, a food-safe product with many applications such as beverages and perfumes.
- 12 Skin care and cosmetics**
Oils and moisturizers for make-up and other personal care products are being produced through synthetic biology, rather than being harvested from natural sources.
- 13 Soap**
Soap made with oils extracted from synthetic algae instead of palm oil.
- 14 Eggs**
Synthetic biology created phytase for chicken and pig feed, which helps the animals absorb more nutrients from their food and reduces phosphorous waste.
- 15 Fruit**
Synthetic engineering helps prevent the browning process and reduces food waste.
- 16 Meat**
Yeast altered with synthetic biology produce large quantities of heme – one of the key components for making lab-produced beef taste like real beef.

<https://www.iucn.org/theme/science-and-economics/our-work/other-work/synthetic-biology-and-biodiversity-conservation>

IGI CLIMATE WORKSHOP

GENOMIC INNOVATION FOR CLIMATE IMPACT



April 6–7, 2021



Invitation: A few years ago, I founded the Innovative Genomics Institute (IGI) at the University of California to use genome editing to solve some of humanity's greatest challenges. We are pursuing research aimed at tackling climate change by advancing affordable and accessible solutions to increase biological capture, sequestration, and repurposing of carbon, reduce greenhouse gas emissions, and enhance agricultural and ecosystem resilience. We believe that through genomic innovation in plants and microbes, we can add another tool to the climate change toolbox, contributing to the broad, systemic efforts that need to be undertaken to forge a sustainable future.

- Dr. Jennifer Doudna

GENETIC BIOCONTROL OF INVASIVE RODENTS

Seeking a transformative innovation to responsibly prevent extinctions and protect communities

The Genetic Biocontrol of Invasive Rodents program (GBIRd) is a partnership of seven world-renowned organizations.



Could we do it?

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

Should we do it?

We know that critical questions remain to be answered and careful assessments are necessary. Learn more about North Carolina State University's (NCSU) multidisciplinary investigations [here](#).

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

Green Warfare?

SON Number: WPSO-20-C2

25 October 2018

**Strategic Environmental Research and Development
Program (SERDP)**

FY 2020 STATEMENT OF NEED

Weapons Systems and Platforms (WP) Program Area

**ADVANCED SYNTHESIS TECHNIQUES FOR MILITARY-
RELEVANT ENERGETIC MATERIALS OR SIGNIFICANT
PRECURSORS**


1. Objective of Proposed Work

The objective of this Statement of Need (SON) is to develop innovative scalable synthetic approaches leading to production of energetic materials and their precursors that will eliminate or drastically reduce hazardous waste streams from nitration processes and other synthesis steps that are widely used in manufacturing energetic materials. Typical nitration processes of aromatic


What about gene editing?



The CRISPR Journal, Vol. 4, No. 1 | Perspectives

 Full Access

(Broken) Promises of Sustainable Food and Agriculture through New Biotechnologies: The CRISPR Case

Todd Kuiken , Rodolphe Barrangou, and Khara Grieger

Published Online: 19 Feb 2021 | <https://doi.org/10.1089/crispr.2020.0098>

 Sections  View article

 Tools  Share

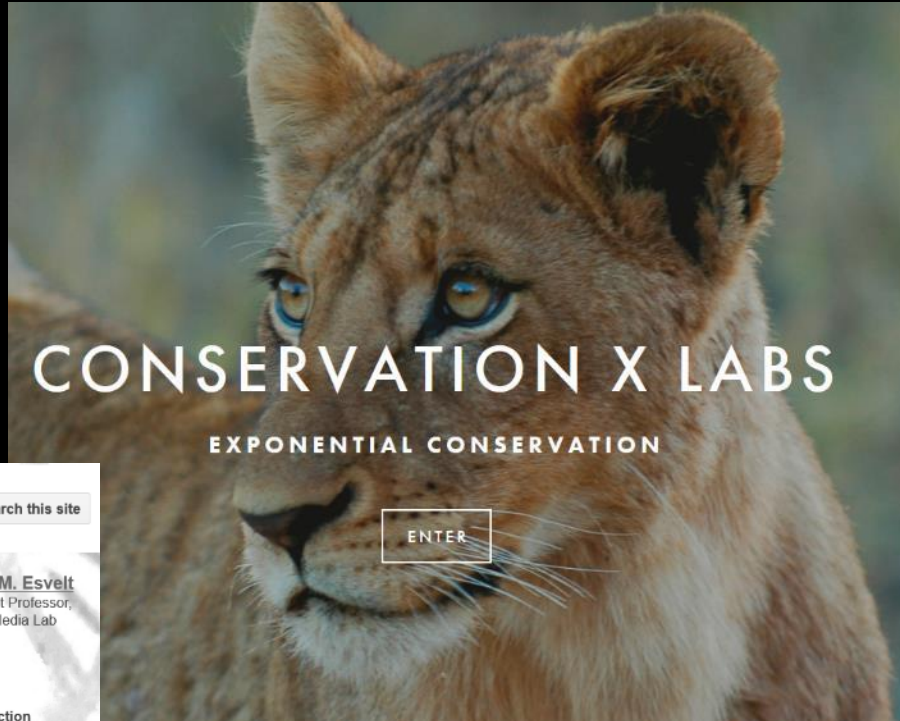
Abstract

In recent years, the development of diverse CRISPR-based technologies has revolutionized genome manipulation and enabled a broad scientific community in industry, academia, and beyond to redefine research and development for biotechnology products encompassing food, agriculture, and medicine. CRISPR-based genome editing affords tremendous opportunities in agriculture for the breeding of crops and livestock across the food supply chain that could benefit larger portions of the population compared to CRISPR applications in medicine, for example by helping to feed a growing global population, reach sustainability goals, and possibly mitigate the effects of climate change. These promises come alongside concerns of risks and adverse impacts associated with CRISPR-based genome editing and concerns that governance systems that are ill equipped or not well suited to evaluate these risks. The international community will continue to gather, in multiple venues, in the coming years to discuss these concerns. At the same time, responsible research and innovation paradigms also promise to evaluate the risks and benefits better while incorporating broad stakeholder engagement across the research and development process. The CRISPR community therefore must actively engage with these international deliberations, society, and national governance systems that have promised to build better agricultural systems and provide better food products to achieve equitable outcomes while protecting the environment. Without this active engagement, the promises discussed in this paper are sure to be broken.

<https://www.liebertpub.com/doi/10.1089/crispr.2020.0098>

What's old is new again

- As traditional methods for bringing about change fail, or do not bring change quickly enough, disaffected activists break off and form a new group or movement that advocates more extreme methods (Liddick, 2008)
- “what the environmental movement needs more than anything else right now is a collective step back to rethink everything” (Haq, 2012)...in relation to climate change [but what about synbio and gene drives?]



CONSERVATION X LABS

EXPONENTIAL CONSERVATION

ENTER

Sculpting Evolution

Search this site

Engineering biology in the light of evolution

Why Sculpt Evolution?

Evolved systems are very different from technologies designed by humans.

They're harder to predict and to design, and exhibit a frustrating tendency to evolve away from engineered behaviors.

At the same time, harnessing and directing evolution can generate useful organisms and biomolecules that we could never have rationally designed.

By working to understand why systems evolve in the ways that they do, we are learning to sculpt the evolutionary process and reliably engineer life in the laboratory and even the wild.

To learn more, see the [introduction](#) to evolutionary engineering, dive into our [research](#), or jump straight to [gene drives](#).

News

13 Oct 2016

Kevin spoke at President Obama's White House Frontiers conference ([video](#): talk starts at 1:28:20).

1 Sep 2016

Welcoming Devora Najjar and Avery Normandin to Sculpting Evolution!

15 Aug 2016

Epigenie's piece titled "[The Safer, Prettier Gene Drive](#)" is likely the best news coverage of a preprint we will ever see.

20 July 2016

We held our first public meeting on Martha's Vineyard on permanently immunizing mice against Lyme disease: 100+ attendees, great discussion ([video](#)). Special thanks to Sam Telford and Dr. Michael Jacobs for joining us!

08 June 2016

Kevin's views on gene drive were published as a Nature [World View](#).

07 June 2016

We discussed a proposal to alter white-footed mice to disrupt the cycle of Lyme disease transmission with the Nantucket Board of Health and local residents yesterday ([video](#)). We went to them before

Evolving Thoughts

[Discussing gain-of-function research](#)

In the course of promoting safeguards and transparency in the field of gene drives, many have drawn a comparison to so-called "gain-of-function" (GOF) research on influenza and ...

Posted Oct 19, 2015, 10:51 PM by Kevin Esvelt

[Safeguards for laboratory gene drive research](#)

I recently convened a diverse group of scientists from relevant fields, including those who published a drive-based genome editing method at UCSD in March, to agree on recommended safeguards ...

Posted Oct 19, 2015, 10:50 PM by Kevin Esvelt

[Sculpting Futures](#) I was fortunate to attend the MIT Media Lab's Knotty Objects celebration, which brought scientists and engineers together with artists and designers to spark creativity and new approaches. For ...

Posted Jul 28, 2015, 7:15 AM by Kevin Esvelt

[Gene drives for kids](#) An explanation courtesy of the Up Goer Five Text Editor and inspired by xkcd: It would be nice if we could change how some animals and other living things act ...

Posted Jun 24, 2015, 2:13 PM by Kevin Esvelt

[Empirical grounding, legitimacy, and trust](#) The question

Main
Group

Introduction

▼ Research

Ecology

Evolution

Engineering

▼ Gene Drives

FAQ

Safeguards

Current Research

Daisy Drives

Publications

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Philosophy

Contact

revive&restore

genetic rescue for endangered and extinct species

Do we have the right

- Traditional ecological knowledge is the culturally and spiritually based way in which indigenous peoples relate to their ecosystems
 - This knowledge is founded on spiritual-cultural instructions from 'time immemorial' and on generations of careful observation within an ecosystem of continuous residence (Winona LaDuke)
- What counts as wildness and wilderness is determined not by the absence of people, but by the relationship between people and place
 - A place is wild when its order is created according to its own principles of organization
- Gene drives will (if they work) permanently alter a species and/or entire ecosystems
 - How do we evaluate whether we have the "right" to do this?
 - Will there still be "wildness" and "wilderness"?

Governance challenges raised by synthetic biology, genome editing, biotechnologies...

1. Hard to define what it actually is
2. Governance systems are struggling to keep pace with the technological change
3. New Transboundary Issues (International Governance) i.e. gene drives
4. Digital Sequence Information
5. Safety, Security & Environment

International Deliberations/Guidance

- U.N. Convention on Biological Diversity - <https://bch.cbd.int/default.shtml>
 - Convention on Biological Diversity will adopt a post-2020 global biodiversity framework, which will serve as a stepping stone towards the 2050 Vision of “living in harmony with nature.” (was October 2020; moved to 2021)
 - **Organisms, components and products of synthetic biology**
 - Cartagena Protocol on Biosafety to the Convention on Biological Diversity (Cartagena)
 - **Gene drives under its purview now**
 - Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (Nagoya Protocol)
 - **Digital sequence information**
- International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) - <http://www.fao.org/plant-treaty/en/>
- WHO Guidance framework for testing of genetically modified mosquitoes - <https://www.who.int/tdr/publications/year/2014/guide-fmrk-gm-mosquit/en/>
- International Union for the Conservation of Nature
 - World Congress September 2021
 - <https://www.iucn.org/theme/science-and-economics/our-work/other-work/synthetic-biology-and-biodiversity-conservation>

Research



Cite this article: George DR, Kuiken T, Delborne JA. 2019 Articulating ‘free, prior and informed consent’ (FPIC) for engineered gene drives. *Proc. R. Soc. B* **286**: 20191484. <http://dx.doi.org/10.1098/rspb.2019.1484>


Received: 24 June 2019

Accepted: 20 November 2019

Articulating ‘free, prior and informed consent’ (FPIC) for engineered gene drives

Dalton R. George^{1,2}, Todd Kuiken¹ and Jason A. Delborne^{1,2}

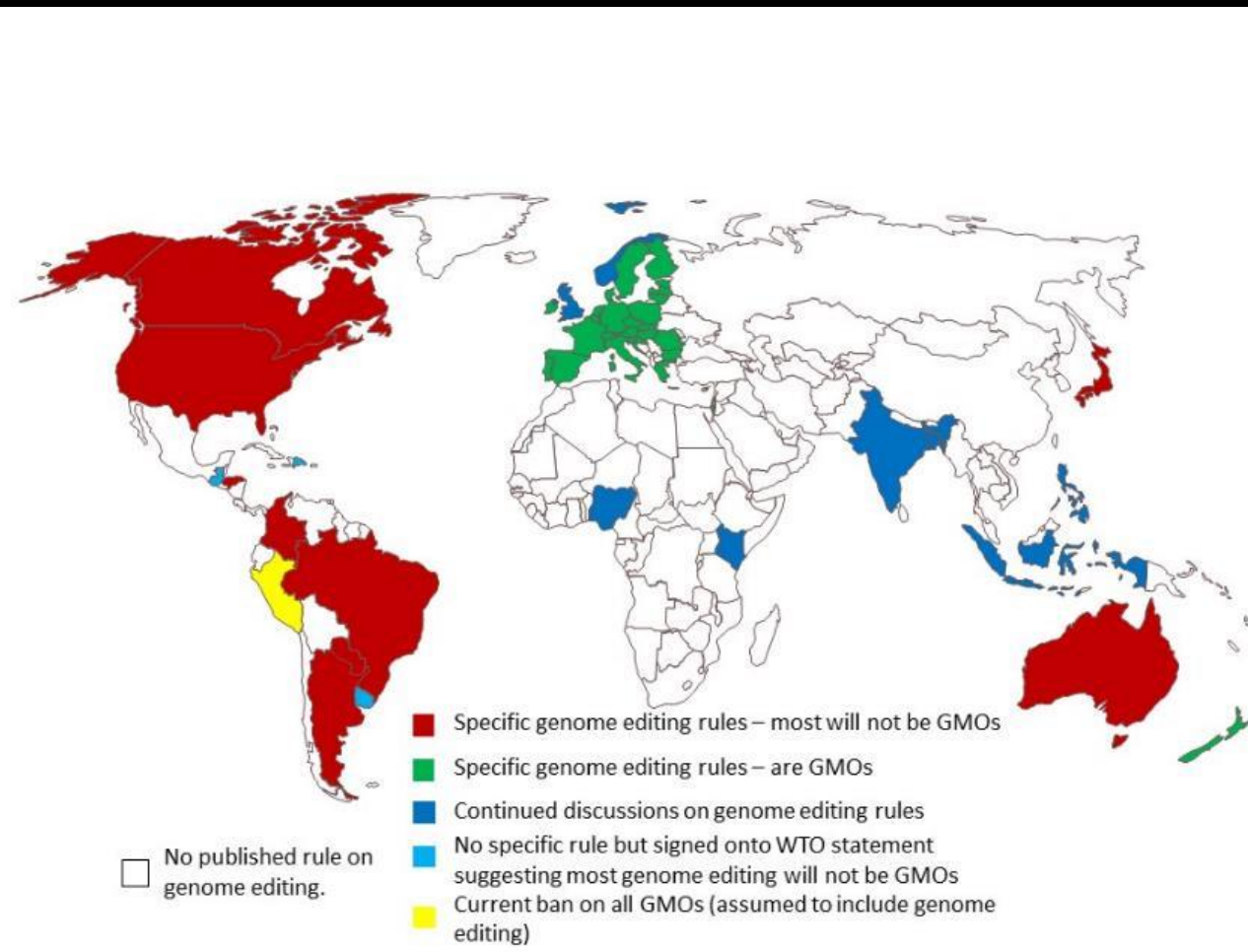
¹Genetic Engineering and Society Center, and ²Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC, USA

 DRG, 0000-0003-2885-7412; TK, 0000-0001-7851-6232; JAD, 0000-0001-6436-782X

Recent statements by United Nations bodies point to free, prior and informed consent (FPIC) as a potential requirement in the development of engineered gene drive applications. As a concept developed in the context of protecting Indigenous rights to self-determination in land development scenarios, FPIC would need to be extended to apply to the context of ecological editing. Without an explicit framework of application, FPIC could be interpreted as a narrowly framed process of community consultation focused on the social implications of technology, and award little formal or advisory power in decision-making to Indigenous peoples and local communities. In this paper, we argue for an articulation of FPIC that attends to issues of transparency, iterative community-scale consent, and shared power through co-development among Indigenous peoples, local communities, researchers

<https://royalsocietypublishing.org/doi/10.1098/rspb.2019.1484>

Current gene editing landscape



- Potential conflict with Cartagena Protocol and other country interpretations
 - Cartagena has not yet clarified whether products of gene editing fall under the definition of an LMO
 - CBD has been focusing on “synthetic biology” since 2010; gene editing was first mentioned in the 2019 AHTEG report

Updated and adapted from (Schmidt, Belisle, and Frommer 2020).

IUCN process/outcomes



Genetic frontiers for conservation

An assessment of synthetic biology and biodiversity conservation

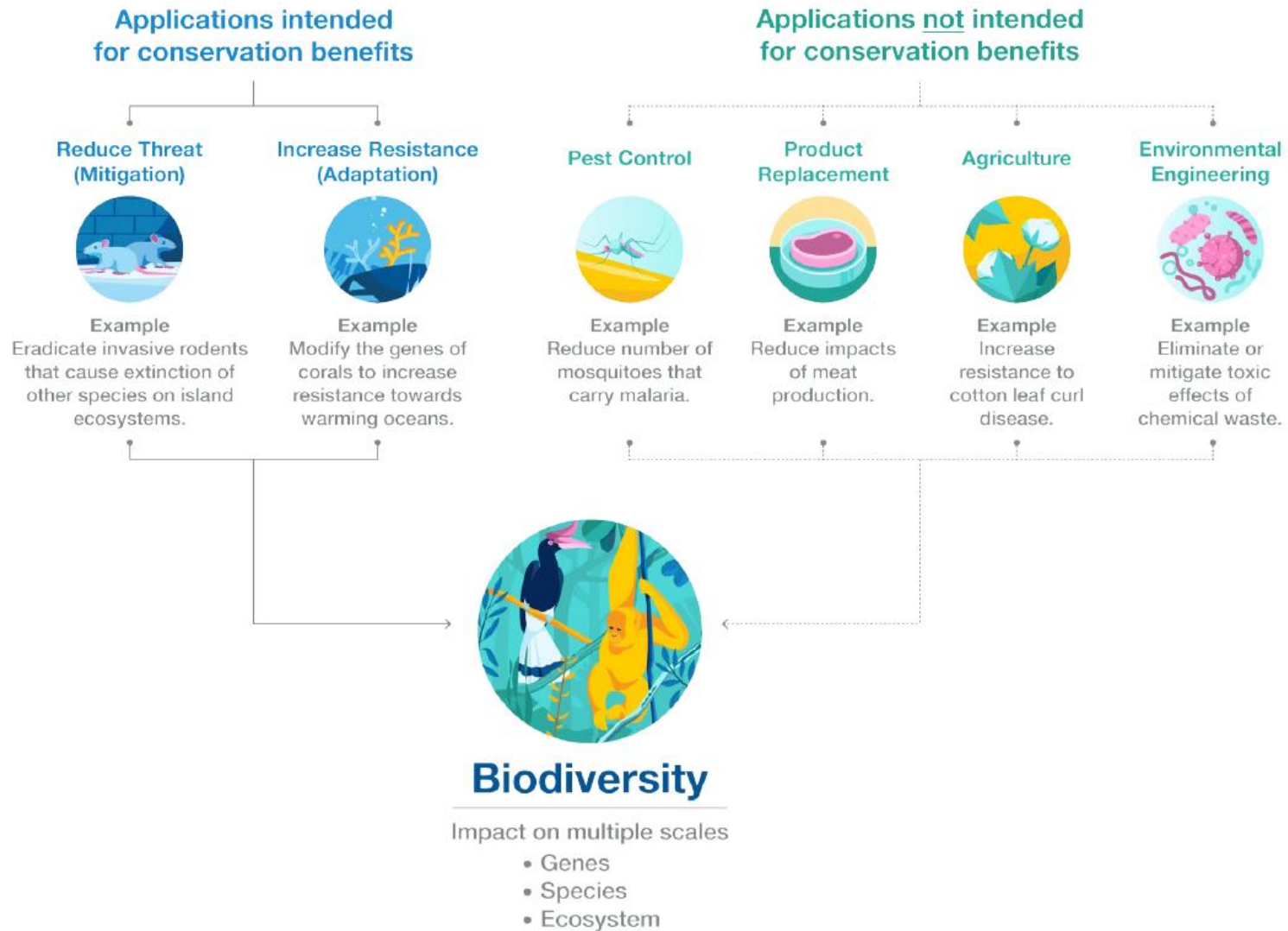
Edited by: Kent H. Redford, Thomas M. Brooks, Nicholas B.W. Macfarlane, Jonathan S. Adams



INTERNATIONAL UNION FOR CONSERVATION OF NATURE

<https://www.iucn.org/theme/science-and-economics/our-work/other-work/synthetic-biology-and-biodiversity-conservation>

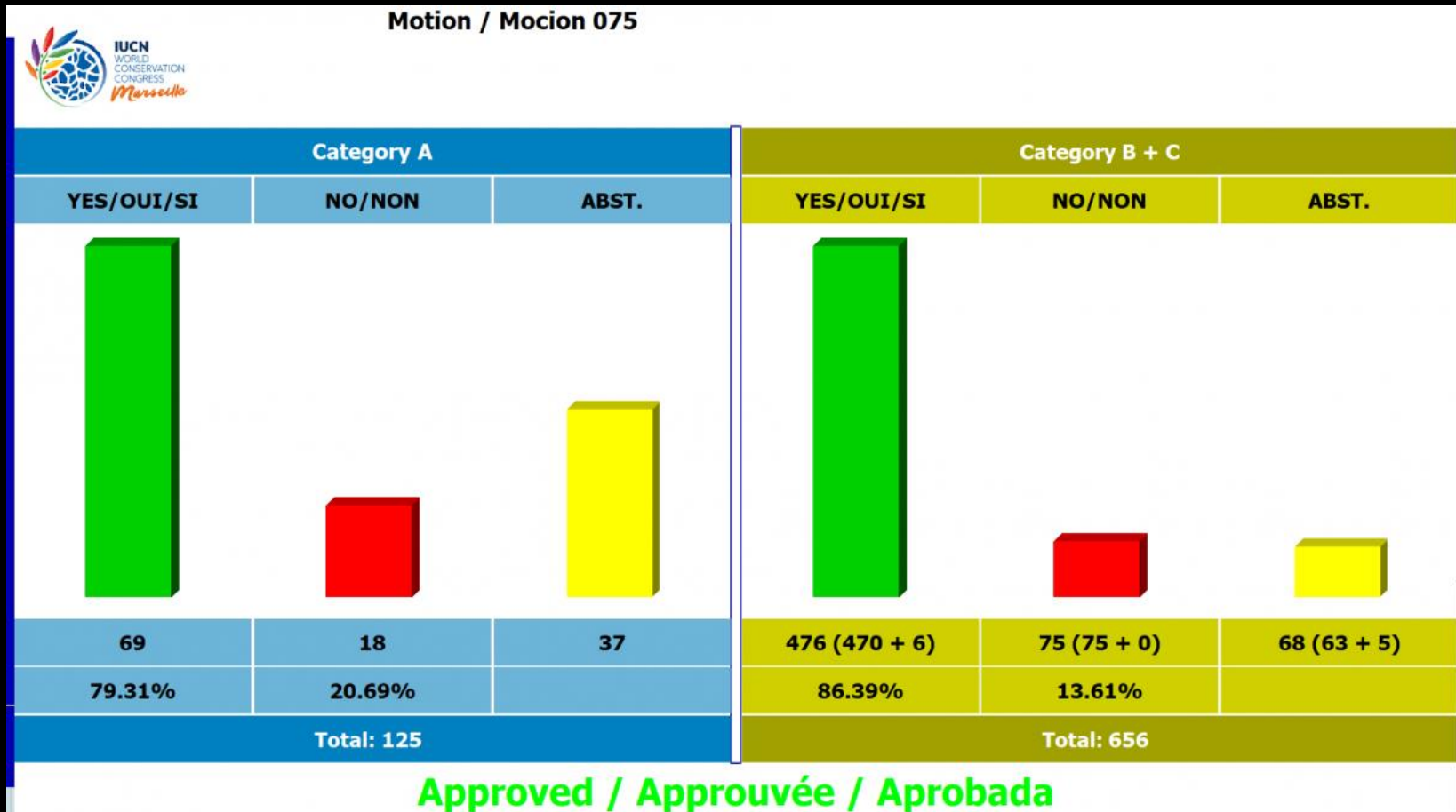
Ways that synthetic biology can affect conservation



Motion 075 - Towards development of an IUCN policy on synthetic biology in relation to nature conservation

- 1. REQUESTS the Director General, Commission Chairs and Members to initiate an inclusive and participatory process to develop an IUCN policy on the implications of the use of synthetic biology in nature conservation to be debated and voted on by the next 2024 Conservation Congress.
- CALLS UPON the Director General and Commissions to remain neutral on all aspects of synthetic biology until the formal adoption of an IUCN policy on synthetic biology, remaining cognizant as new understanding develops during the process.
- Guiding criteria:
 - Integrity and diversity of nature
 - Intergenerational equity
 - Gender equity
 - Respect for rights, beliefs and cultures
 - Free, prior and informed consent
 - Inclusion of knowledge holders and right holders
 - Stakeholder and right-holder participation
 - Multiple sources of types of knowledge and expertise
 - Transdisciplinarity, intra-, inter- and multidisciplinary
 - Multiple values and ethics

Motion 075 - Towards development of an IUCN policy on synthetic biology in relation to nature conservation



Interaction with U.S. Coordinated Framework

- Diamondback moth (Upstate NY) [completed]
 - first open field release of a genetically engineered self-limiting insect in North America
 - Regulated under US Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS)
 - Results published Jan 2020 - <https://www.frontiersin.org/articles/10.3389/fbioe.2019.00482/full>
- American Chestnut [contained field trials underway]
 - USDA APHIS, responsible for approving genetically modified plants.
 - Food and Drug Administration, examine the food safety of the transgenic nuts
 - Environmental Protection Agency, which will review the tree's environmental impact under federal pesticide law
- Oxitec mosquitos (Florida Keys) [trial releases Summer 2021]
 - Was bounced from USDA → FDA → EPA
 - Faced referendum (voted yes for release)
 - EPA Experimental use permit: <https://www.regulations.gov/docket?D=EPA-HQ-OPP-2019-0274>
- Genetic Biocontrol of Invasive Rodents
 - Still unclear who would have final jurisdiction (US FWS/Endangered Species Act?)
 - <https://www.geneticbiocontrol.org/>

**Moving towards gene drive field
trials
(somebody has to do it?)**

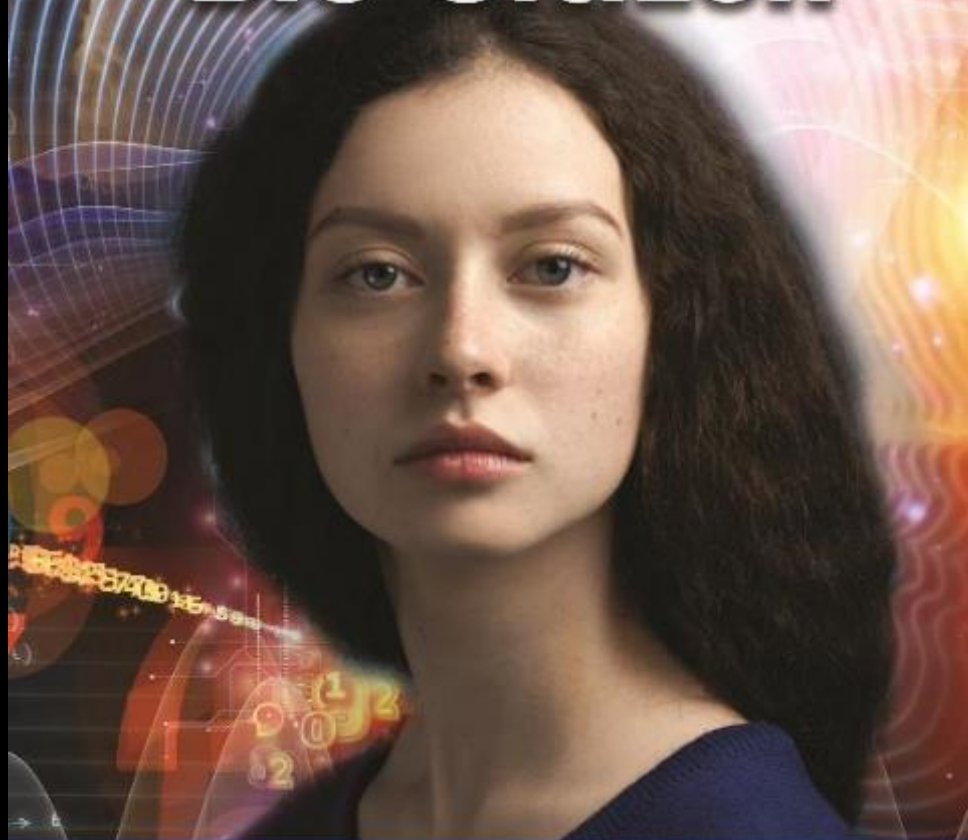
Field trials can be long and complicated (yet really interesting)

- Eco-evolutionary dynamics
 - Research should incorporate the simultaneous drivers of ecology and evolution, as opposed to progress in one area while holding the other constant.
 - Multiple variables
 - Generation of useful, adequate and robust ecological data follows ecological time-frames
 - Field trials at minimum take a year (seasonal data)
 - Gene drives you will want to understand longer time frames to capture evolution of gene drive and its interaction with the ecosystem over time
- Currently lacking “infrastructure” to conduct field trials of gene drives
 - Need large enough area to simulate the ecosystem in which gene drives will be introduced
 - Some of this can be simulated indoors
 - DRI - <https://www.dri.edu/labs/ecocells/>

Will NIH become a new “environmental agency?”

- No one else is funding this work at the moment
 - Other agencies have said its not in their portfolios to fund ecological studies; or the infrastructure/facilities that will be needed to conduct field trials
 - EPA is beginning to fund “some” of this; although not field trials at the moment
 - Assessment Tools for Biotechnology Products: <https://www.epa.gov/research-grants/assessment-tools-biotechnology-products>
 - Total - \$4.4 million (In comparison, DARPA’s Safe Genes program was \$65 million)
- If NIH is funding gene drive development, they are obligated to fund the ecological impact assessments
 - Effluent from drugs is a good example of NIH research/development that has led to ecological impact
 - Appears NIH have funded field trials before
- Biosafety Guidance (NIH guidelines)
 - Lab to field (contained vs open release)
 - Harmonize guidance with other agencies and global institutions (particularly if funding projects outside US)

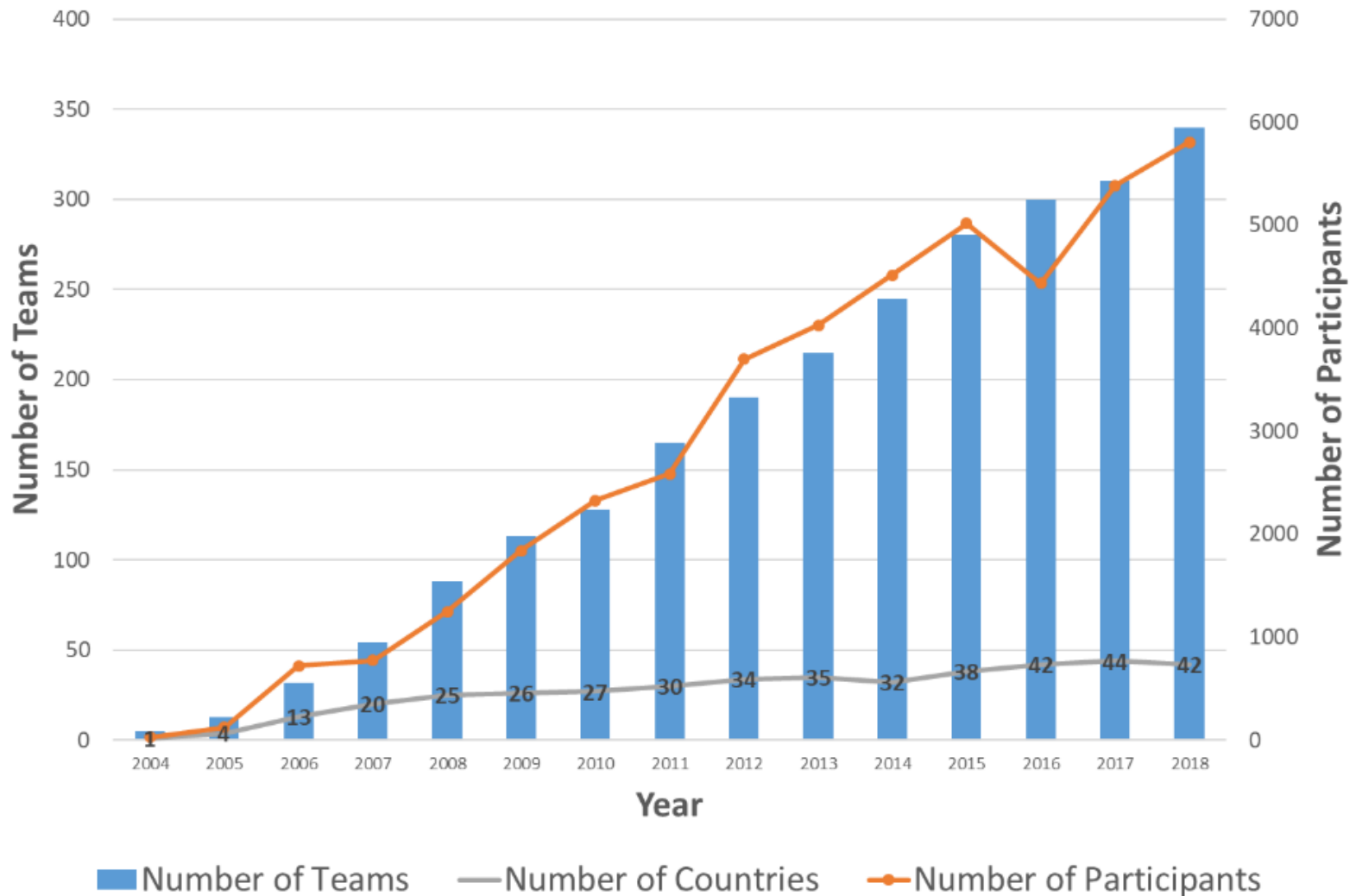
The Rise of the **Bio-Citizen**



W | Wilson
Center

<https://www.wilsoncenter.org/article/the-rise-the-new-bio-citizen>

Global Participation in iGEM 2004-2018



The iGEM Competition is an annual, worldwide synthetic biology event that gives students the opportunity to push the boundaries of synthetic biology by tackling everyday issues facing the world. https://igem.org/Main_Page

iGEM 2020 – 249 Teams



Human Practices Hub

Through Human Practices, iGEM teams consider whether their projects are responsible and good for the world. They creatively engage with issues in ethics, sustainability, inclusion, security, and many other areas. Human Practices questions are complex and don't have simple answers. Teams therefore often conduct public engagement; inviting stakeholder input to shape the direction of their work.

"Human Practices is the study of how your work affects the world, and how the world affects your work." — Peter Carr, Director of Judging

[VIDEO TRANSCRIPT](#)

What is Human Practices?

Learn about Human Practices and why it is an important part of iGEM.

[LEARN MORE](#)

How to Succeed

All teams are expected to engage in Human Practices. Check out our tips for teams and the medal and prize criteria.

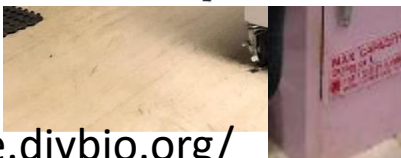
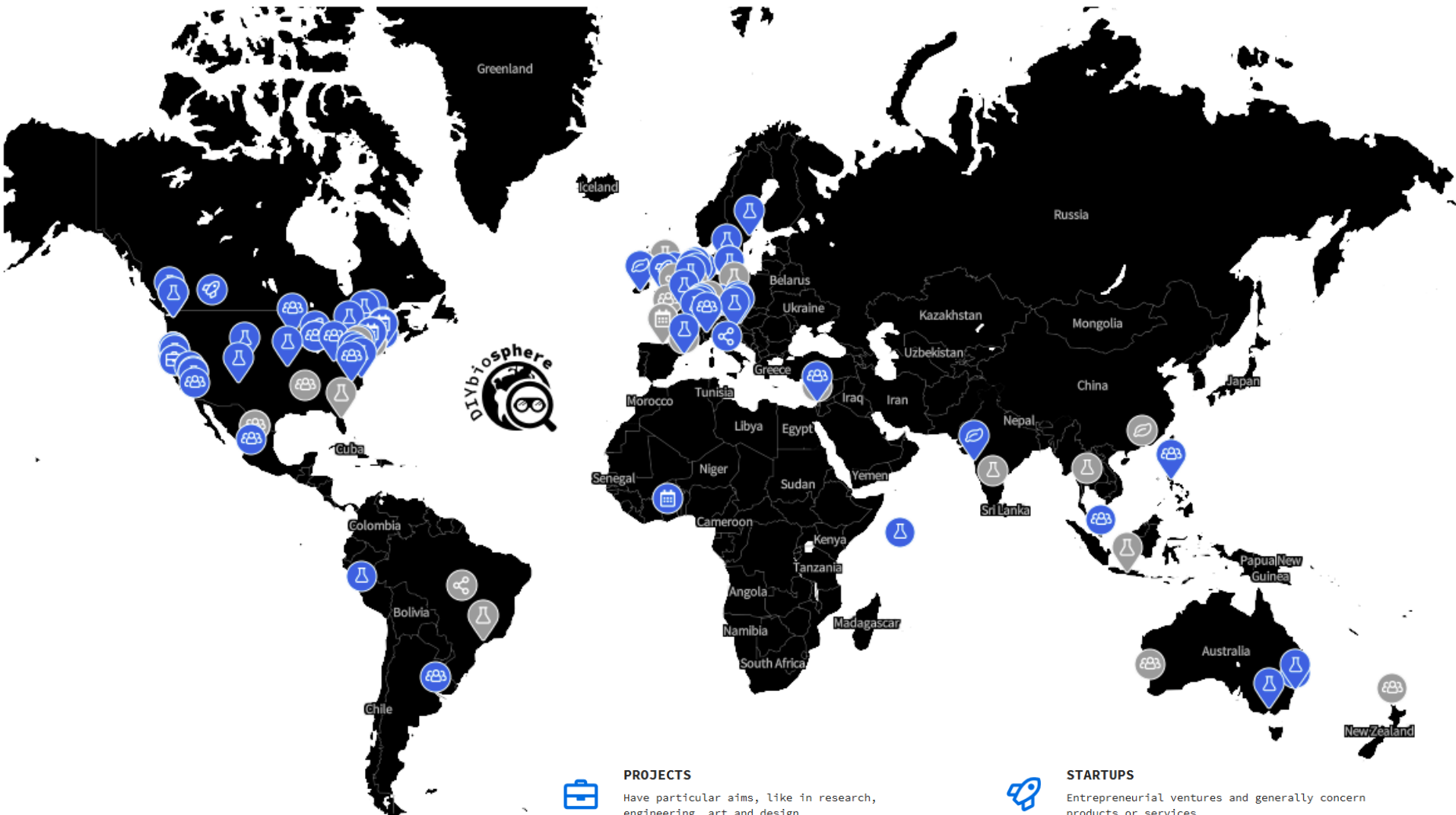
[SUCCEED](#)

Frequently Asked Questions

See answers to questions like "How can my team integrate Human Practices into our Foundational Advance project?"

[FAQ](#)

https://2021.igem.org/Human_Practices



<https://sphere.diybio.org/>



PROJECTS

Have particular aims, like in research, engineering, art and design



LABS

Dedicated physical spaces, static or mobile, with materials and equipment



GROUPS

Associations of people (online and offline) interested in DIYbio



EVENTS

Global or regional events by and/or for the DIYbio community



STARTUPS

Entrepreneurial ventures and generally concern products or services



INCUBATORS

Organizations and spaces that help projects and startups to develop



NETWORKS

Organizations that facilitate communication and collaboration



OTHERS

Umbrella term for the rest of misfit entries. New collections may arise

Learn from DIY biologists

The citizen-science community has a responsible, proactive attitude that is well suited to gene-editing, argues **Todd Kuiken**.

One of the top science stories of 2012 involved a furore about the wisdom of enhancing the transmissibility of the H5N1 avian influenza virus in ferrets. In that same year, fears mounted that do-it-yourself (DIY) biologists would cook up their own versions of the virus using information published in the academic press.

Now, journalists and others are again targeting the citizen-science community — a group of people with or without formal training who pursue research either as a hobby or to foster societal learning and open science — amid fears about the nascent gene-editing technology CRISPR–Cas9. In January, the *San Jose Mercury News* ran an article under a pearl-clutching headline: “Bay Area biologist’s gene-editing kit lets do-it-yourselfers play God at the kitchen table.” And although they are much less alarmist, scholars are advising policymakers to consider the potential uses of gene editing “outside the traditional laboratory setting” (R. A. Charo & H. T. Greely *Am. J. Bioeth.* 15, 11–17; 2015).

The reality is that the techniques and

expertise needed to create a deadly insect or virus are far beyond the capabilities of the typical DIY biologist or community lab. Moreover, pursuing such a creation would go against the culture of responsibility that DIY biologists have developed over the past five years. In fact, when it comes to thinking proactively about the safety issues thrown up by biotechnology, the global DIY-biology community is arguably ahead of the scientific establishment.

EASY ACCESS

The equipment and reagents that are needed to use CRISPR–Cas9 are already readily available to DIY biologists. Members of the teams that participated in the 2015 International Genetically Engineered Machine (iGEM) competition — including high-school students and users of community labs around

the world — received CRISPR–Cas9 plasmids in their starting kits. These kits contain more than 1,000 standard biological parts known as BioBricks, the DNA-based building blocks that participants need to engineer a biological system for entering into the competition. Other components of the CRISPR–Cas9 system are also available from the iGEM registry (<http://parts.igem.org/CRISPR>).

Yet few DIY biologists seem to be using the technology. Both Tom Burkett, founder of the Baltimore Under Ground Science Space in Maryland, and Ellen Jorgensen, executive director of Genspace — a community lab in Brooklyn, New York — say that their users are interested in CRISPR–Cas9, and Genspace will be offering a workshop on it in March. But none of the projects currently being pursued in these spaces require it. Users of the La Paillasse community lab in Paris are similarly focused on projects that do not need CRISPR–Cas9.

The materials might be available, but the knowledge and understanding needed to make edits that have the desired effects



<http://www.nature.com/news/governance-learn-from-diy-biologists-1.19507>

Open Insulin Foundation

We're a team of biohackers with a variety of backgrounds, and skills, and relationships to insulin and diabetes from many cities and countries around the world, including Oakland, California; Baltimore, Maryland; Paraiba, Brazil; Dakar, Senegal; Yaounde, Cameroon; and Puerto Rico. We're working to develop the first practical, small-scale, community-centered model for insulin production to make insulin accessible to all. We envision a world in which communities in need have local sources of safe, affordable, high-quality insulin, and where people living with diabetes and their communities can own and govern the organizations that produce the medicine they depend on to survive.

[Join Us](#)

387

Million people

There are currently 387 million people worldwide living with diabetes.

2^x

Insulin price increase from 2012-2016

The few suppliers of insulin have been raising prices in near-synchrony for decades.

7.6

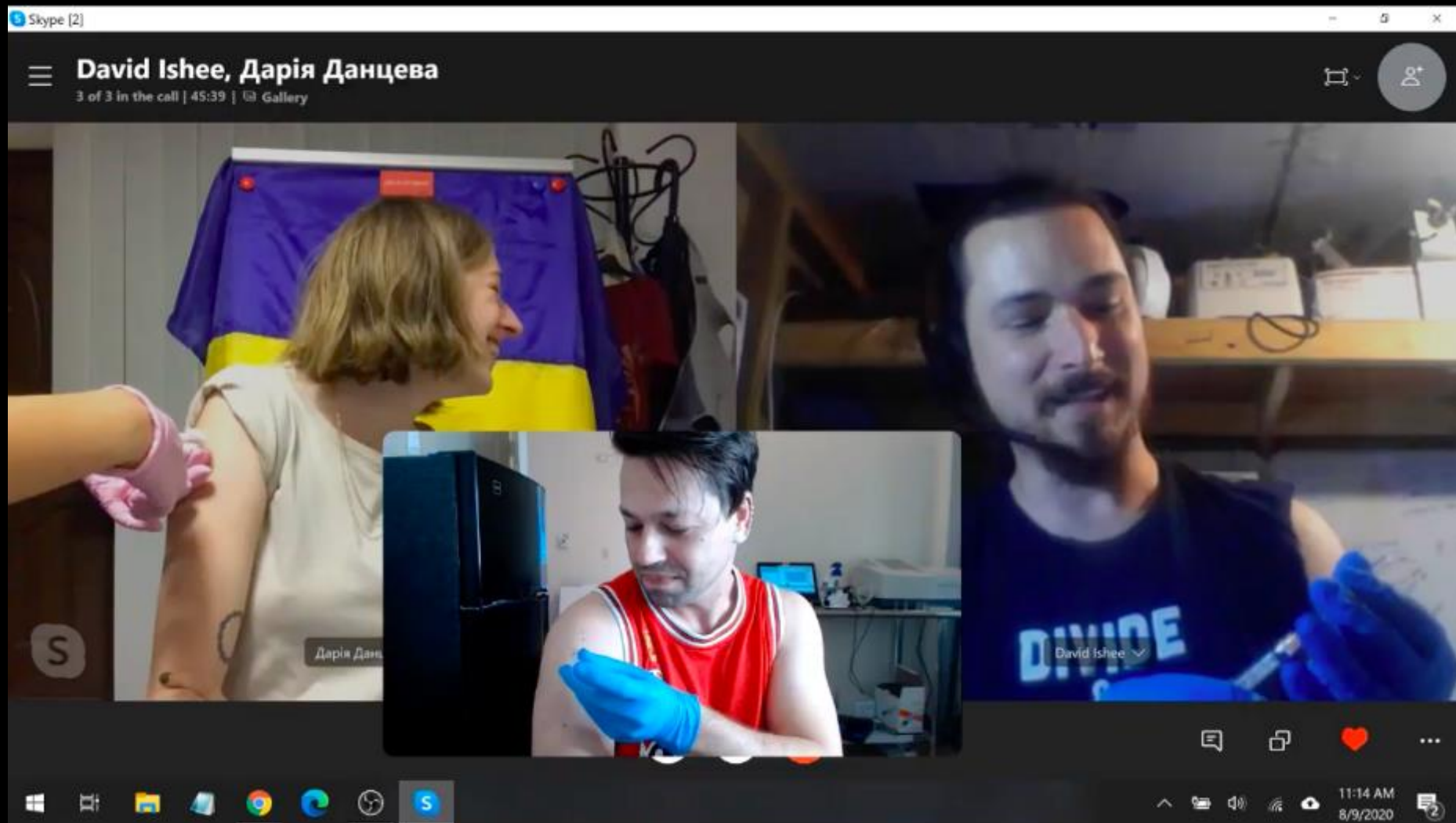
million

Hospitalizations in 2016

These price increases lead to long-term health and consequences and deaths.

<https://openinsulin.org/>

How about amid a
global pandemic?



Screenshot of Josiah Zayner's YouTube channel, August 9, 2020

Slide courtesy of Alex Pearlman @Lexikon1 or alexpearlman.com



<https://radvac.org/>

Image courtesy Alex Hoekstra,
Radvac

Slide courtesy of Alex Pearlman @Lexikon1
or alexpearlman.com

Open Covid Ethics Study



Hello! We are researchers who have received NSF funding for an IRB-approved study to look at research ethics in the DIYbio community. By observing the discussions on Slack and within the JOGL platform, we hope to understand the challenges and innovations related to research ethics in the Open Science community.

Research Team



PI
Anna Wexler, PhD
University of Pennsylvania



Co-PI
Lisa Rasmussen, PhD
University of North Carolina at Charlotte



Clinical Research Coordinator
Rebekah Choi, MPH
University of Pennsylvania



Digital Ethnographer
Alex Pearlman, MA
University of Pennsylvania

All the data we collect will be totally anonymized, including names, usernames, and personally identifying information. But, if you would like to fully “opt out” and have all your data excluded from our study, please [fill out this form](#).

Consultants to the Research



Sarah Ware, PhD
BioBlaze Community Bio Lab



Todd Kuiken, PhD
North Carolina State University



Christi Guerrini, JD, MPH
Baylor College of Medicine



Joanna Kempner, PhD
Rutgers University

[Home](#)


From: OpenCovid19 Initiative

Dear community,

<https://app.jogl.io/program/opencovid19>

Art/Design as a Tool for Societal/Ethical Discussions

The Competition

Biodesign Challenge is an education program and competition that is shaping the first generation of biodesigners. We partner high school and university students with scientists, artists, and designers to envision, create, and critique transformational applications in biotech.

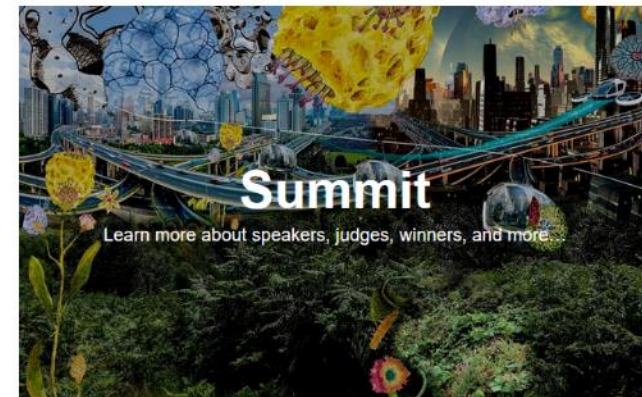
See the list of [2021 participating schools](#).



<https://biodesignchallenge.org/>

Biodesign Challenge 2021

BDC Summit 2021 was broadcast online for an entire week from **June 21st - 25th** during which featured student videos, live Q & A's with judges, speakers, and more.





PROJECTS | 2021

Sub·ver·sive /səb'vərsiv/ - BioFashion for Black Lives

MIKA CAMPBELL, GRACE BURCH, ABIGAIL GORDON, SAVANNAH ADAMS

This project attempts to change the social narrative around wearing hoodies as a Black person in America. A biodesigned reimagining of the garment, this project imbues modular biosensors and protective spider silk into the fabric to provide comfort and protection to the wearer.

Finalist Team



<https://www.biodesignchallenge.org/spelman-college-2021>



As you walk through the neighborhood you live in, you've probably encountered a bank of wildflowers covered in neon blue bruises. What you are seeing is the result of the world's first gene-drive as protest, which utilized the agency of living things to propagate through their environment as a means of spreading a political message.

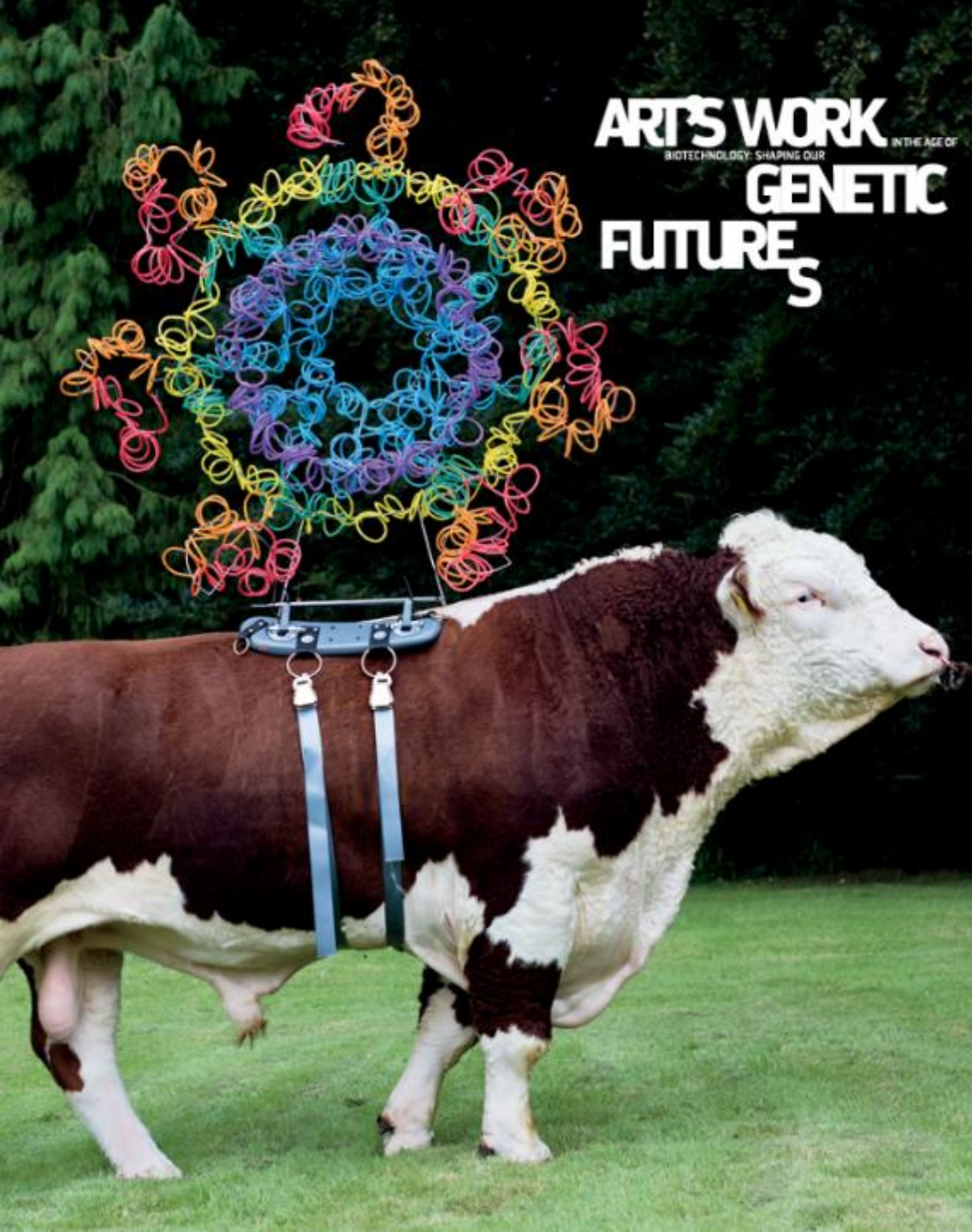
Over the past 10 years within university labs, multiple species of wildflowers have been modified to contain a genetic switch which flood their petals with mTurquoise chromoproteins when grown in soils contaminated with high levels of heavy metals. This modification was engineered to ensure its inheritance to all offspring of the flowers, allowing it to spread through existing wildflower populations.

The deliberate release of the modified flower seeds via bird-feeders was perpetrated by a renegade researcher, intending to make visible the enduring environmental legacy of industry dismantled during the 1980s, which severely impacted the welfare of working class communities. The economic benefits of these industries for the workers has gone, but its contamination remains, and continues to impact the health of the area's current population.

UK 2029: Post-Natural Artefacts from the United Kingdom of England and Wales
Curated by Eva Auer, Sean Greaves and Joseph Revans
<http://cargocollective.com/UK2029>

Accepting techno defeat (?)

- Do techno fixes resign us to the notion that we failed...in relation to biodiversity, nature conservation and environmental protection?
 - Consumerism, exploitation, population growth have taken precedence
- Or are techno-fixes part of our collective evolution of human-kind and nature as one?



ART'S WORK BIOTECHNOLOGY: SHAPING OUR IN THE AGE OF GENETIC FUTURES

Art's Work in the Age of Biotechnology: Shaping Our Genetic Futures was an art-science exhibit eliciting discussion about genetics in society through the lens of contemporary art and offers viewers new ways to think about their role in the genetic revolution.

www.go.ncsu.edu/artswork

Catalogue available here:

<https://www.uncpress.org/book/9781469659268/arts-work-in-the-age-of-biotechnology/>

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