From: Ryan Phelan
Subject: [Geneticrescue] Welcome to the new Genetic Rescue Listserv
Date: November 21, 2017 at 5:49:05 PM CST
To: geneticrescue@reviverestore.org

Hello again —

This message is to let you know the transition to the new Genetic Rescue listserv is complete.

Please send all future posts to our listserv using this email: geneticrescue@reviverestore.org.
And do add this email to your contacts/address book.

REMINDER – when you hit reply to — geneticrescue@reviverestore.org — you reply to the entire list of 188 participants.
For your reference, I've attached our complete list of all participants to this email.

--
You received this message because you are subscribed to the Google Groups "Genetic Rescue" group.
To unsubscribe from this group and stop receiving emails from it, send an email to geneticrescue+unsubscribe@reviverestore.org.
To post to this group, send email to geneticrescue@reviverestore.org.
Visit this group at https://groups.google.com/a/reviverestore.org/group/geneticrescue/.

Ryan Phelan
Executive Director and Co-founder
Revive & Restore
415-710-9409 cell

--
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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

Genetic Rescue Listserv Participants as of November 21, 2017

Christina Agapakis, Creative Director, Ginkgo Bioworks
Omar Akbari, Assistant Professor in the Department of Entomology, University of California at Riverside
H. Resit Akcakaya, Professor in the Department of Ecology and Evolution, Stony Brook University
Luke Alphey, Group Leader, Vector-Borne Viral Diseases Programme, The Pirbright Institute, UK
Michael Archer, Professor Biological, Earth & Environmental Sciences, University of New South Wales (Thylacine & Lazarus Projects)
Michelle Baker, Ph.D., Research scientist with the Commonwealth Scientific and Industrial Research Organisation
(CSIRO)
Soraia Barbosa, joint PhD candidate at Porto University (Portugal) and Cornell University in Biodiversity, Genetics & Evolution.
Joel Berger, Senior Scientist, Wildlife Conservation Society & Professor, Colorado State University
Eric J Bishop-von Wettberg, professor in the Biology department at Florida International University
Jack Bobo, Chief Communications Officer, Intrexon
Hilary Bok, Associate Professor of Philosophy, Johns Hopkins University
Stewart Brand, Co-founder, Revive & Restore
Michael Bruford, Professor / Research Division Leader, Organisms and Environment group, Cardiff School of Biosciences, Cardiff University
Joanna Buchthal, MIT masters student and research assistant in Kevin Esvelt's lab
Stanley Burgiel, Assistant Director with the National Invasive Species Council Secretariat
David Burney, Professor of Conservation Paleobiology, National Tropical Botanical Garden
Alejandro Camacho, Director, Center for Land, Environment & Natural Resources, UC Irvine School of Law
Claudio Campagna, Wildlife Conservation Society Marine and Argentina Programs; Adjunct Professor, UC Santa Cruz; Steering Committee member, IUCN Species Survival Commission

Earl Campbell, Ph.D., Invasive Species Program Manager for the U.S. Geological Survey
Karl Campbell, Project Director Island Conservation, Galapagos
Rob Carlson, Principal, Biodesic
Tom Chase, Executive Director of conservation strategies, Massachusetts's chapter of The Nature Conservancy.
Marc Chevrette, Head of Experimental Genomics, Warp Drive Bio**.**
George Church, Director of the Center for Computational Genetics, Harvard Medical School
John Clark, Director of Plant Conservation at San Diego Zoo Global and President/Executive Director, Center for Plant Conservation
Larry Clarke, Ph.D., Director, National Wildlife Research Center, USDA-APHIS-WS
Jeremy Coleman, National White-Nose Syndrome Coordinator; Northeast Regional Wildlife Disease Coordinator, U.S. Fish and Wildlife Service
James Collins, Virginia M. Ullman Professor of Natural History and the Environment, School of Life Sciences, Arizona State University
Pierre Comizzoli, Reproductive Physiologist, Center for Species Survival, National Zoo, Smithsonian Conservation Biology Institute
Bob Cook, Program Director of the Conservation Program and the Basic Medical Research Program, Helmsley Charitable Trust
Bobby Dhadwar, postdoctoral fellow in the George Church Lab (Woolly Mammoth)
Andrew Digby, Science Advisor, New Zealand's Department of Conservation
Josh Donlan, Founder and Director, Advanced Conservation Strategies
Tim Doran, Senior Research Scientist and Group Leader for Advanced RNA Technology, CSIRO Biosecurity Flagship
Steve Dowdy, Professor, Department of Cellular & Molecular Medicine, UC San Diego School of Medicine
David Duffy, Ph.D., Postdoctoral research fellow at the University College Dublin
Jack Dumbacher, Ornithology and Mammalogy Curator, California Academy of Sciences
Owain Edwards, Program Leader, Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Sylvia Earle, Oceanographer, National Geographic Explorer
Sara Edge, Genetic Rescue consultant, Revive & Restore

John D. Eisemann, Technology Transfer Program Manager, USDA APHIS Wildlife Services
Drew Endy, Assistant Professor, Bioengineering Stanford University
Kevin Esvelt, Assistant Professor and Sculpting Evolution Group leader, MIT Media Lab, Massachusetts Institute of Technology
Chris Farmer, Hawai‘i Program Director, American Bird Conservancy
Paula Feldmeier, Environmental attorney for U.S. Army Corps of Engineers
Alberto Fernández-Arias, Head of the Service of Hunting, Fishing and Aquatic Medium Wetlands, Aragon Government, Spain (Pyrenean ibex)
Joshua Fisher, Hawaii Aquatic Invasive Species Coordinator, U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office
Gary Fitt Ph.D., Science Director, Commonwealth Scientific and Industrial Research Organisation (CSIRO)
John Fitzgerald, Policy Director, Society for Conservation Biology
Tim Flannery, Mammalogist, Macquarie University, Sydney
Rob Fleischer, Center Head, Center for Conservation and Evolutionary Genetics, Smithsonian Conservation Biology Institute
Amy Fletcher, Undergraduate Coordinator and Senior Lecturer, Department of Social and Political Sciences, Associate Dean of Postgraduate Arts, University of Canterbury, New Zealand.
Meghan Foley, Executive Administrative Assistant, Revive & Restore
Ezra Frager, Doctor of Veterinary Medicine Candidate at Tufts University and Visiting Graduate Student in George Church’s Harvard Lab
Andrew French, A/Prof. at the Centre for Animal Biotechnology, University of Melbourne (Lazarus Project)
Ken Gage, Chief, Entomology and Ecology Activity, CDC Fort Collins
Neil Gemmel, Professor and Gemmel Lab Lead, Department of Anatomy, University of Otago
James Gibbs, Professor and Director, Roosevelt Wildlife Station, State University of New York’s College of Environmental Science and Forestry
Tom Gilbert, Professor of Paleogenomics, University of Copenhagen (Ancient DNA)
Daniel Gluesenkamp, Executive Director of the California Native Plant Society
John Godwin, Neurobiologist North Carolina State University
Fred Gould, Professor**,** Department of Entomology, North Carolina

State University
Hank Greely, Professor, Director of the Center for Law and the Biosciences, Stanford Law School
Joel Greenberg, Project Passenger Pigeon
Harry Greene, Professor of Ecology and Evolutionary Biology, Faculty Curator of Amphibians and Reptiles, Cornell University
Tim Harvey-Samuel, Senior PDRA, Arthropod Genetics Group, The Pirbright Institute, UK
Cliff Hague, Entrepreneur, conservationist, currently on the San Diego Zoo Global's Board of Directors and Chair of SDZG's Conservation Council.
Susan Haig, President, American Ornithologists' Union and Supervisory Wildlife Ecologist, USGS
Bruce Hay, Professor of Biology, California Institute of Technology
Sean Hoban, Tree Conservation Biologist, The Morton Arboretum
Ben Hoffman, Principal Research Scientist, Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australia
Michael Hofreiter, Professor, Evolutionary Adaptive Genomics, University of Potsdam.
Nick Holmes, Director of Science at Island Conservation
Chris Hoving, Adaptation Specialist, Wildlife Division, Michigan Department of Natural Resources
Gregg Howald, North America Regional Director, Island Conservation, Canada
Insung Hwang, Researcher, Sooam Biotech Research Foundation (Woolly mammoth)
David Iorns, private individual interested in bringing back the moa
Alicia Jackson, Chief Technology Officer, Drawbridge Health, Inc.
Jeff Johnson, Associate Professor, Department of Biological Sciences, Institute of Applied Sciences, University of North Texas
Kate Jones, Professor of Ecology and Biodiversity, University College London and Zoological Society of London
Makaala Kaaumoana, Executive Director, Hanalei Watershed Hui
Durrell Kapan, Senior Research Fellow, Institute for Biodiversity Science and Sustainability, California Academy of Sciences
Peter Kareiva, Chief Scientist, The Nature Conservancy
Billy Karesh, Executive Vice President for Health and Policy at EcoHealth Alliance
Jason Kelly, co-founder Ginkgo BioWorks, a synthetic biology company

Henri Kerkdijk-Otten, Uruz Project, Chair, True Nature Foundation
Isabella Kirkland, Artist, Research Associate at California Academy of Sciences
Wendy Kiso, Research and Conservation Scientist, Ringling Bros. Center for Elephant Conservation
Michael Kjelland, founder and owner of Conservation, Genetics & Biotech, LLC.
Todd Kuiken, Senior Program Associate with the Science and Technology Innovation Program, The Wilson Center
Jennifer Kuzma, Co-director, Genetic Engineering and Society Center, North Carolina State University
Garrie Landry, instructor of biology, University of Louisiana, Project Passenger Pigeon website
David Lang, Co-founder, OpenROV
Robert Lanza, Chief Scientific Officer, Advanced Cell Technology (Gaur and Bucardo)
Caroline Leitschuh, Phd candidate at North Carolina State University, focused on genetic biocontrol for invasive rodents on islands.
Elaine Leslie, Biological Resources Chief, Natural Resource Stewardship and Science, National Park Service
Erez Liberman-Aiden, Center for Genomic Architecture, Baylor College of Medicine
Paul Ling, Department of Molecular Virology and Microbiology, Baylor College of Medicine
Jeanne Loring, Professor of Developmental Neurobiology, Director of the Center for Regenerative Medicine
Edy MacDonald, Social Science Manager of the New Zealand Department of Conservation - Te Papa Atawhai
Michael Mace, Curator of Birds, San Diego Zoo Safari Park
Ross MacPhee, Curator & Professor, American Museum of Natural History (Ancient DNA)
Tom Maloney, Director of Conservation Science, Revive & Restore
John Markoff, Science Journalist, *The New York Times*
Paul Marini retired commercial geneticist, advisor on band-tailed pigeon captive breeding, Revive & Restore
Claire Marris, Senior Research Fellow in the Department of Social Science, Health and Medicine, King’s College London
Bryce Masuda, Conservation Program Manager, San Diego Zoo Global

Douglas McCauley Ph.D., Assistant Professor of Ecology, Evolution, and Marine Biology at U.C. Santa Barbara's Marine Science Institute
Michael McGrew, Professor of Developmental Biology, The Roslin Institute, University of Edinburgh
Jacob Metcalf, Assistant Director of the Science & Justice Research Center, UC Santa Cruz and lecturer in Sociology and Philosophy
Ryan Monello, Program Manager for the Pacific Island Network's Inventory and Monitory Program, National Park Service
Andy Newhouse, PhD candidate at SUNY, College of Environmental Science & Forestry, focused on government and regulatory issues for transgenic blight-resistant American chestnut trees
Jack Newman, Chief Scientific Officer, Amyris
Ben J. Novak, Avian Engineering, Revive & Restore
David Oehler, Curator of Ornithology at the Bronx Zoo, Wildlife Conservation Society
Heath Packard, Director of Communications, Island Conservation
Clare Palmer, Cornerstone Fellow & Professor of Philosophy at Texas A&M University
Angus Parker, conservationist and board member for Island Conservation, business and strategy consultant to Revive & Restore
Mike Parr, Vice President, American Bird Conservancy
Eleonore Pauwels, Public Policy Scholar, Science and Technology Innovation Program, Woodrow Wilson Center
Chandran Pfitzner, PhD candidate at the University of Adelaide, researching mouse gene drive Research in Paul Thomas's laboratory
Ryan Phelan, Executive Director, Revive & Restore
Toni Piaggio, Research Molecular Biologist, USDA APHIS Wildlife Services
Glenn Plumb, Ph.D., Chief Wildlife Biologist in the National Park Service's Biological Resource Division
Hendrik Poinar, Principle Investigator, Ancient DNA Centre, McMaster University (Woolly mammoth/Ancient DNA)
William Powell, Director, Council on Biotechnology in Forestry, State University of New York (American Chestnut)
Melissa Price, Postdoctoral Fellow at Kewalo Marine Laboratory and Assistant Professor, University of Hawaii at Manoa
Justin Quinn, Warp Drive Bio, Cambridge MA
Maud Quinzin, Postdoctoral Fellow at Yale University, focusing on the Evolutionary and Conservation Biology of Galapagos giant tortoises

George Rabb, President Emeritus, Chicago Zoological Society/Brookfield Zoo
Floyd Reed, Assistant professor, Department of Biology, University of Hawaii
Kent H. Redford, Principal, Archipelago Consulting
Marilyn Renfree, Professor of Zoology, University of Melbourne (Tasmanian Tiger)
Richard Rhodes, Pulitzer-winning author for *The Making of The Atomic Bomb* and in 2004 author of *John James Audubon*
Ed Rice, Ph.D. student, Paleogenomics Lab, Biomolecular Engineering Department, University of California, Santa Cruz
Tonie Rocke, Research Epizootiologist, Field & Lab Research, National Wildlife Health Center, USGS
Jean-Marie Rouillard, Co-founder and CSO, MYcroarray (genome synthesis)
Michael Russello, Professor & Associate Head, Department of Biology, University of British Columbia (Okanagan Campus)
Oliver Ryder, Director of Genetics, San Diego Zoo Institute for Conservation and Research
Royden Saah, Program Manager, Genomic Biocontrol of Invasive Rodents Program, Island Conservation
Ronald Sandler, Professor of Philosophy, Chair, Department of Philosophy and Religion, Northeastern University
Dennis Schmitt, Chair of Veterinary Services and Director of Research, Ringling Bros. Center for Elephant Conservation
Ed Schulak, Biotechnology Investor
Mary Schweitzer, Professor of Marine, Earth and Atmospheric Sciences, North Carolina State University (Ancient DNA)
Philip Seddon, Director of the Postgraduate Wildlife Management Programme, Department of Zoology, University of Otago, New Zealand
Megan Serr, Ph.D. Candidate in Zoology at North Carolina State University and NSF IGERT Fellow, Genetic Engineering & Society
Beth Shapiro, Associate Professor, Ecology and Evolutionary Biology, University of California Santa Cruz
Jo Anne Shatkin, Ph.D., President, Vireo Advisors, LLC
Rebecca Shaw, Senior Vice President and Chief Scientist at World Wildlife Fund
Jacob Sherkow, Associate professor at New York Law School, Affiliated Faculty, Institute for Information Law and Policy

Jamie Shreeve, Senior Science Editor, National Geographic Magazine
David Sischo, PhD, Snail Extinction Prevention Program Coordinator at the State of Hawaii's Division of Forestry and Wildlife
Lee Skerratt, IUCN Wildlife Health Specialist Group, Centre for Biosecurity in Tropical Infectious Diseases, James Cook University, Australia
Andrea Smidler, Ph.D student, Department of Genetics, Harvard University
Craig Smith, Associate Professor, Group Leader, Comparative Development and Evo-Devo Laboratory, Department of Anatomy and Developmental Biology, Monash University
André Elias Rodrigues Soares, biologist with a doctorate in genetics; bioinformatics, UCSC Paleogenomics Lab
Michael Specter, Staff Writer, The New Yorker
Brad Stanback, Philanthropist and Revive & Restore board member
Tammy Steeves, Senior Lecturer, Conservation and Evolutionary Genetics, University of Canterbury
Michael Steinberg, Associate Professor of Geography and Interdisciplinary Environmental Studies at the University of Alabama.
James Tate, Senior Fellow for Ecological Economics and Ethics at the Potomac Institute for Public Policy and a Research Associate at the Smithsonian Institution's Migratory Bird Center
Stanley Temple, Professor Emeritus, University of Wisconsin-Madison
David Threadgill, Director, Whole Systems Genomics Initiative, Texas A&M University
Ronald Thresher, Scientist, CSIRO, Wealth from Oceans Research Flagship, Australia
Tierney Thys, Marine Biologist, National Geographic Emerging Explorer
Mark Tizard, Genome Engineering Team, CSIRO Biosecurity Flagship, Australian Animal Health Laboratory
Dan Tompkins, Portfolio Leader, Managing Invasives, Landcare Research
Will Turner, Vice President of Conservation Priorities and Outreach, Conservation International
Marcela Uliano da Silva, Ph. D. student, Federal University of Rio de Janeiro

Alison Van Eenennaam, Ph.D. – Cooperative Extension Specialist, Animal Genomics and Biotechnology, U.C. Davis
Frans Vera, Founder, Oostvaardersplassen and Director, Foundation Natural Processes
Michelle Verant, Veterinarian, Postdoctoral Research, School of Veterinary Medicine, University of Wisconsin-Madison.
Vance Vredenburg, Associate Professor, Department of Biology, San Francisco State University
Norm Wainwright, Senior Director of Research & Development, Charles River Laboratories, Inc.
Bruce Webber, Senior Research Scientist, Team Leader for Ecosystem Change Ecology, Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Renee Wegrzyn, Program Manager, DARPA Biological Technologies Office
Bob Wiese, Chief Life Sciences Officer, San Diego Zoo Global
Evelyn Wight, Senior Communications Manager, The Nature Conservancy of Hawai'i
Margaret Wild, Chief Wildlife Veterinarian, National Park Service, Biological Resources Division, Wildlife Health Branch
Matt Winkler, Chairman & Founder of Asuragen, Revive & Restore board member
Thierry Work, Wildlife Disease Specialist, National Wildlife Health Center, USGS
Cindy Wu, Co-founder & CEO, Experiment.com
Luhan Yang, postdoc in the George Church Lab (Woolly Mammoth)
Tanja Zabka, Veterinary Pathologist, Safety Assessment Group, Genentech
Gintas Zavadzkas, Fish and Wildlife Director, Miccosukee Tribe of Florida
Guojie Zhang, Associate Director of Scientific Development, BGI-Shenzhen
Carl Zimmer, Independent journalist and author
Sergey Zimov, Director, Northeastern Science Station of Cherskii (Pleistocene Park)

From: Hank Greely <hgreely@stanford.edu>
Subject: Re: [Geneticrescue] Hank Greely's Opinion Piece
Date: December 11, 2017 at 5:54:20 PM CST
To: Tom Maloney < g>
Cc: Hank Greely <hgreely@stanford.edu>, geneticrescue@reviverestore.org

Thanks. Hard to say much in 900 words but I hope hit the right spot for most people. It's unlikely to please people who want no regulation or people who want no genetically edited organisms (or think they do), but so it goes….

> On Dec 11, 2017, at 3:12 PM, Tom Maloney <t > wrote:
>
> Hi All —
>
> Here's the link to Hank Greely's opinion piece in the Washington Post As usual, Hank provides a good treatment of the need to broaden the regulatory perspectives on CRISPR and its potential outcomes. The are so many potentially transformative applications for conservation that a broader more inclusive regulatory orientation is needed.
>
> Nice work Hank.
>
> Tom.
>
> Tom Maloney
> Director of Conservation Science
> Revive & Restore
>
> (805) 602 - 2294
>
> --
> You received this message because you are subscribed to the Google Groups "Genetic Rescue" group.
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to geneticrescue+unsubscribe@reviverestore.org.
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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

Begin forwarded message:

From: Kent Redford <r >
Subject: [Geneticrescue] phenomenal set of gene drive articles
Date: January 12, 2018 at 12:54:55 PM CST
To: geneticrescue@reviverestore.org

From our colleagues at Genetic Engineering and Society at North Carolina State University:
https://research.ncsu.edu/ges/publications/faculty-publications/?table_filter=JRISpecialIssue&utm_source=GES+Center&utm_campaign=4e8cb697a4-COLLOQUIUM_2018_1_16&utm_medium=email&utm_term=0_a99bb58ca1-4e8cb697a4-73533771

And ALL available for download.
Well done!

Kent

Kent Redford
Archipelago Consulting
Portland, ME 04112, USA

Cell: ++ 914-263-6163
Skype: Kent.H.Redford

--
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College Station
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c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: Stewart Brand
Subject: [Geneticrescue] Principles for gene drive research -- in Dec.1 SCIENCE
Date: December 11, 2017 at 6:06:06 PM CST
To: Genetic Rescue listserv <geneticrescue@reviverestore.org>

Interesting engagement from gene drive sponsors:

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Visit this group at https://groups.google.com/a/reviverestore.org/group/geneticrescue/.

http://science.sciencemag.org/content/358/6367/1135.full

Comments?

--Stewart

--
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Clare Palmer
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YMCA 301
Department of Philosophy

Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: Ryan Phelan <
Subject: [Geneticrescue] Holiday Greetings and 2017 Year-End Report
Date: December 21, 2017 at 5:35:01 PM CST
To: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>

Revive & Restore would like to take this opportunity to thank all of you on this listserv for your participation throughout 2017 and share with you our highlights from this past year.
Many of you have been kind enough write wonderful testimonials for Revive & Restore — see here on our website. Any others would be greatly appreciated. (Please send to ryan@reviverestore.org).

Happy Holidays and Best Wishes to all!

— Ryan, Stewart, Tom, Ben, and Meghan

2017 Year-End Report

Expanding Operations

Since our founding five years ago, Revive & Restore has become a recognized and respected leader in guiding the responsible application of biotechnology to address conservation challenges for endangered species and ecosystems. Last year's annual report announced that Revive & Restore, then a project of The Long Now Foundation, was prepared to "fledge" and become an independent non-profit organization. We are pleased to report that we have completed that process, receiving our tax-exempt status from the Internal Revenue Service last March. As part of this process, we established our Board of Directors, with backgrounds in academia, the biotech industry, and conservation:

- **Tom Chase**, The Nature Conservancy (Massachusetts chapter)
- **Megan Palmer**, Stanford University's Center for International Security and Cooperation
- **Beth Shapiro**, University of California at Santa Cruz's Paleogenomics Lab
- **Brad Stanback**, The Foundation for the Carolinas
- **Matt Winkler**, Asuragen

We recruited Tom Maloney as Director of Conservation Science, who brings to this role twenty years of conservation experience as environmental advocate, natural resource planner, and ecologist. Tom is also an avid birder.

Meanwhile, our biotech-and-ecology scientist Ben Novak (Lead Researcher, The Great Passenger Pigeon Comeback) is working "off site," a little farther away than usual. He was invited to pursue his Ph.D. at Monash University in Melbourne, where he is now working with cutting-edge scientists from Australia's prestigious research organization CSIRO (Commonwealth Scientific and Industrial Research Organization) to advance genome-engineering techniques for pigeons and other wild birds.

Convening

We were invited early this year by CSIRO to co-host a workshop at Heron Island on the Great Barrier Reef to address "Engineering Resilience in Threatened Ecosystems," based upon a workshop format that we successfully introduced in 2015.The four-day meeting was attended by an international group of 43 scientists focused on four key areas: climate resilience, invasive species, disease resistance, and stakeholder engagement. On day one, the participants reviewed a wide range of potential challenges to address, from invasive species (cane toads, feral cats, and rodents), to amphibians with chytrid fungus and bats with White-Nose Syndrome. Each work group was then tasked with designing a research program for a specific case study using a genomic solution to address a key environmental challenge, culminating with a presentation of their work to a panel representing potential funding sources (industry, government, and philanthropy). The resulting case studies were:

- Climate Resilience: "Reefs for the future: Next generation corals for tomorrow's reef."
- Invasive Species: "Future-proofing biodiversity: Restoring indigenous cultural stories."
- Disease Resistance: "Combating rapid Ohi'a death: Saving Hawaii's forests."
- Stakeholder Engagement: "World institute for synthesizing engagement."

We are pleased to report that several new partnerships and scientific collaborations were formed at this workshop, with several of these case studies now moving forward with funding.

To help advance the emerging field of genetic rescue, Revive & Restore continues to host this private listserv discussion with the scientific and conservation communities. It has now grown to nearly 200 members including conservationists, genome engineers, social scientists, philanthropists, and science journalists.

Advancing Research & Development

Black-footed Ferret: After several years of discussion, meetings, and planning with the National Black Footed Ferret Center, Revive & Restore has applied for a Recovery Permit with the US Fish & Wildlife Service (USFWS). In collaboration with Intrexon (a leading biotech company), Revive & Restore developed the application to conduct laboratory-based experiments to increase the genetic diversity of the Black-footed Ferret and to create heritable resistance to two deadly diseases, sylvatic plague and canine distemper. Revive & Restore will also work with the USFWS to assess any potential environmental effects under the National Environmental Policy Act (NEPA).

Avian Genetic Rescue: Although the de-extinction of the Passenger Pigeon and the Heath Hen will likely take a decade, avian de-extinction research is already generating foundational science

that could transform bird conservation. Many of the same technologies are needed for endangered birds in order to restore genetic diversity, create or enhance disease resistance, and facilitate adaptation to address genomic vulnerability to a changing climate. This can only be accomplished by germ-line transmission, a process we have started to develop for Greater Prairie Chickens. The primordial germ cells of the donor bird's embryo are extracted, grown in cell cultures, and then transmitted through the reproductive organs of surrogate host parents (known as chimeras). The chimeras then foster the sperm/eggs of the germ-cell donor, meaning when bred they will lay eggs and brood offspring of the donor. This process is used in chickens but, if successfully developed for wild birds, our work will open up a whole new set of potential genomic tools to address avian conservation challenge

Cover Story in Science

Passenger Pigeon Genome Study: Four years ago, Revive & Restore's Ben Novak joined an extraordinary team of scientists at the University of California, Santa Cruz to examine passenger pigeon genomics. The team – led by Beth Shapiro, head of the UCSC Paleogenomics Lab and a Revive & Restore board member – analyzed four passenger pigeon genomes and compared them to two genomes of the band-tailed pigeon, the passenger pigeon's closest living relative. The major discovery of the study earned the cover story of the November 2017 issue of Science. Their analysis of the passenger pigeon's genome is the first study to reveal how natural selection and genetic recombination shape a genome in an abundant population, as was the passenger pigeon's before the arrival of European settlers to North America. The passenger pigeon numbered between 3 billion and 5 billion individuals before its 19th-century decline and extinction. In fact, the species was abundant for tens of thousands of years before being relentlessly hunted down to the very last bird. Scientists have long wondered why a bird with such a large population, only decades before its extinction, disappeared so quickly and so completely, without leaving even a small population behind. Generally, biologists assume that large populations have correspondingly high genetic diversity. But the team found the opposite: the passenger pigeon's strong social structure favored beneficial mutations for living at high densities, driving selection throughout the species and decreasing genetic diversity in large sections of the genome where recombination seldom occurs. This low diversity means that

passenger pigeons would have needed to be conserved as a one contiguous population, not a fragmented one. This is an important insight for declining and recovering species that also live in dense social groups. This understanding of passenger pigeon genomics will also a play a key role in Revive & Restore's efforts to build a successful program to revive the species' vital ecological role. To read more, please visit our website and check out Ben's latest blog post.

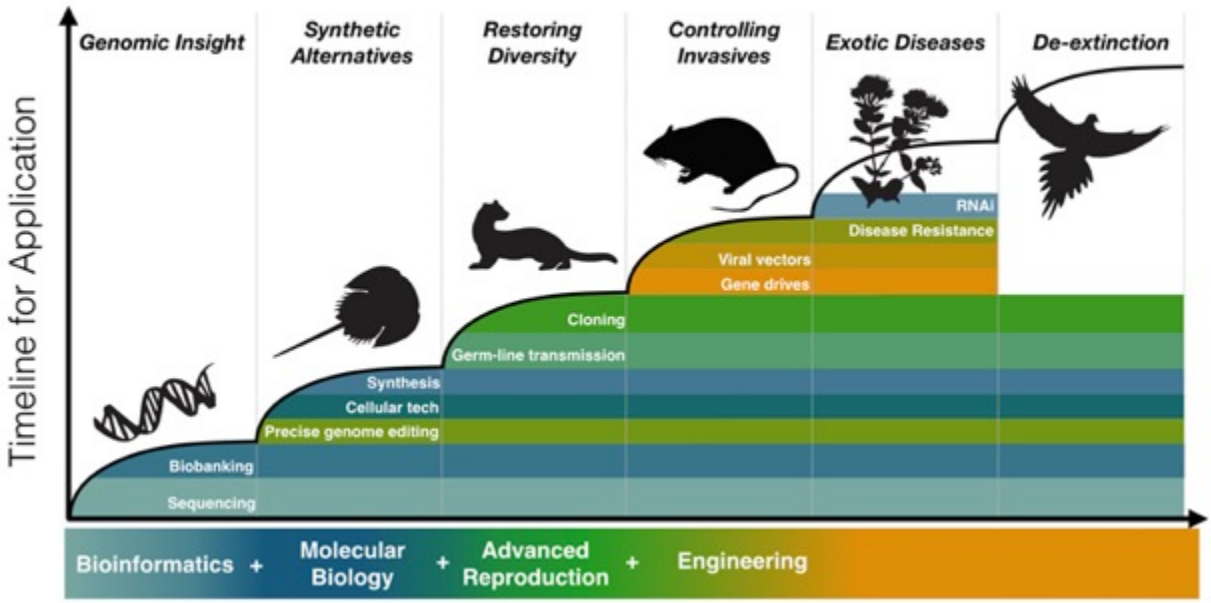
Horseshoe Crabs, which have been around for 450 million years, may not survive our era because they are captured at a massive scale and bled for the biomedical industry. Because their blue blood is ultra-sensitive to infectious bacteria, it is used to detect contamination in all vaccines and injectable drugs. It was brought to our attention last spring that an effective synthetic substitute has been developed but not deployed, so the capture of crabs continues needlessly. In Singapore, Ryan Phelan met with Dr. Ling Ding, the scientist who developed this substitute, and learned that many needless barriers have prevented its widespread adoption by the pharmaceutical industry. Revive & Restore is working to overcome industry and government inertia and to increase adoption of the synthetic alternative.

Looking Forward to 2018

Revive & Restore is working to scale up in order to help build the global consortium of players and supporters needed to accomplish the full promise of genetic rescue in the coming years and decades. We have begun creating an initial coalition of international organizations and funders eager to build an inclusive and highly effective consortium for responsibly applying new biotechnology tools to ensure ecosystem resilience and enhance biodiversity. Our goal for 2018 is to expand our work at the programmatic level, taking on projects with the capability to advance genetic rescue as a standard tool for modern conservation practice. This means our projects will push forward the science needed to make genetic rescue possible for endangered species. As proof-of-concept projects, they will engage local communities and earn the social license needed for innovative science. Our previous workshops have inspired new funding opportunities and programs within federal agencies and key conservation organizations. The National Park Service has asked us to help convene a conference in 2018 on innovative solutions for invasive species. In addition, the U.S. Fish & Wildlife Service has a designated an "innovation fund" and has asked us to help identify opportunities to target the fungal pathogen causing the devastating White-Nose Syndrome in wild bats and reduce its pathogenicity.

Catalyst Fund: Revive & Restore has come to an important realization that a key barrier to the adoption of genomic solutions by the conservation community is the lack of success stories. The success of these projects is dependent upon advancing the science; and that the barrier to scientific advancement is funding. In order to remove these barriers, Revive & Restore is raising an initial Catalyst Fund of $2 to $5 million, to invest in potentially transformative conservation science innovations that can emerge from the continuing rapid new developments in biotechnology.

Advancing the 21st century genetic rescue toolkit for conservation:



The genetic rescue toolkit includes: bioinformatics (whole genome sequencing and ancient DNA analysis), biobanking, advanced reproductive technologies, and genome engineering (from gene drives to de-extinction)

Recommended 2018 books and articles featuring Revive & Restore

Books:

– Ben Mezrich's *Woolly: The True Story of the Quest to Revive One of History's Most Iconic Extinct Creatures*. [Learn more.]
– Britt Wray's *Rise of the Necrofauna: The Science, Ethics and Risks of De-Extinction.* [Learn more.]
– Chris D. Thomas's *Inheritors of the Earth: How Nature Is Thriving in an Age of Extinction*. [Learn more.]

Articles:

– Anderson, Ross. "Welcome to Pleistocene Park," *The Atlantic*, April 1, 2014. [Read here.]
– Conniff, Richard. "Should Genetic Engineering Be Used as a Tool for Conservation?" *YaleEnvironment360*, July 20, 2017. [Read here.]
– Scharfenberg, David. "Extinction is a bummer. Let's bring back the dead," *The Boston Globe*, May 26, 2017. [Read here.]

– Yin, Steph. "We Might Soon Resurrect Extinct Species. Is It Worth the Cost?" *The New York Times,* March 20, 2017. [Read here.]
– Yong, Ed. "What DNA Says About the Extinction of America's Most Common Bird…and its possible resurrection," *The Atlantic,* November 16, 2017. [Read here.]

PS: Follow this link to listen to Stewart read the afterward he wrote for Ben Mezrich's *Woolly.*

Ryan Phelan
Executive Director and Co-founder
Revive & Restore
415-710-9409 cell

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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

Begin forwarded message:

From: Kent Redford
Subject: [Geneticrescue] phenomenal set of gene drive articles
Date: January 12, 2018 at 12:54:55 PM CST
To: geneticrescue@reviverestore.org

From our colleagues at Genetic Engineering and Society at North Carolina State University:
https://research.ncsu.edu/ges/publications/faculty-publications/?table_filter=JRISpecialIssue&utm_source=GES+Center&utm_campaign=4e8cb697a4-COLLOQUIUM_2018_1_16&utm_medium=email&utm_term=0_a99bb58ca1-4e8cb697a4-73533771

And ALL available for download.
Well done!

Kent

Kent Redford
Archipelago Consulting
Portland, ME 04112, USA

Cell: ++ 914-263-6163
Skype: Kent.H.Redford

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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: Ryan Phelan
Subject: [Geneticrescue] 2018 Horizon Scan of Emerging Issues for Global Conservation and Biological Diversity
Date: January 15, 2018 at 7:05:12 PM CST
To: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>

"… it is intended as an early awareness and alert system drawing attention to novel issues that, if realised, may create pivotal opportunities or threats and thus warrant further analysis in the near future."

— one of the scary ones—pathogenic bacteria and virsuses being relaesed from thawing permafrost

—a term I have not come across before "culturomics "…but good to see acknowledged here an emerging trend with "*the identification of conservation-oriented constituencies, demonstration of public interest in nature, understanding the drivers of such interest, etc….*"

I'm curious to know what if anything in this report surprised you?

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Ryan Phelan
Executive Director and Co-founder
Revive & Restore
415-710-9409 cell

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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

A 2018 Horizon Scan of Emerging Issues for Global Conservation and Biological Diversity

Introduction and Aims of Horizon Scanning

We present the outcomes of our ninth annual horizon scan. Our aim is to highlight systematically both risks and opportunities to the conservation of biological diversity that are not widely known by conservation scientists and decision makers. Collectively, our horizon scanning team has considerable expertise, experience, and perspectives on conservation science and allied disciplines. These disciplines encompass economics, policy, journalism, ecology, microbiology, conservation practice, and professional horizon scanning. Horizon scanning allows users, including but not limited to policy makers, researchers, innovators, educators, investors, and practitioners, to identify future political, environmental, technological, and societal changes and consider their possible effects. Horizon scanning can help reduce the degree for conservation biology to be a crisis discipline [1], and to be a proactive rather than a reactive science.

It is now well established that horizon scanning can support and shape local, national, and international decision making. For example, a foresight study on the detection and identification of infectious diseases by the UK Government Office for Science drove investment into new approaches [2]. We cannot easily track whether the issues we identified previously affected decisions by policy makers or conservationists because the issues are embedded within extensive political, social, and environmental changes such as urbanisation, human migration, and population growth. The potential opportunities and threats associated with each issue, and the response of the global conservation community will be affected considerably by the trajectory of these global drivers. In some scenarios, the issues are likely to mature into trends, whereas in others they are not. However, several issues that we highlighted in previous scans gained broader attention that resulted in action, suggesting at the least that some of our issues were at the cusp of emergence.

In 2015, we discussed the underground gasification of coal and its potential to contaminate groundwater and produce greenhouse gases [3]. After publication of the scan, the UK Government commissioned an independent review of underground gasification of coal [2]. In November 2015, that review suggested that the technology could be responsible for a substantial increase in greenhouse gas emissions. Scotland banned underground gasification of coal in October 2015 [4] and the UK Department for Business, Energy and Industrial Strategy stated that it was 'minded not to support' the technology in 2016. In 2017, we noted that the growing demand for sand and gravel was outstripping sustainable supply [5]. This same issue since has been the subject of media investigation and reporting in major outlets in the US, Europe, and Asia [6], and an editorial on this issue [7] referenced our scan when identifying this topic as an emerging issue.

As the basis for the scan reported here, we compiled 117 issues. Participants and their colleagues suggested the issues on the basis of at least 444 sources that were referenced in descriptions of the issues: 178 articles from a total of 109 scientific journals, 138 online news articles, and an assortment of web pages, press releases, reports, surveys, blogs, videos, and radio programmes. Most references were in English, but some were written in Chinese, Spanish, Icelandic, or Portuguese. Content producers were affiliated with, among others, universities, government, research institutions, national newspapers, and agricultural or industrial sectors.

Identification of Issues

The methods we used during this horizon scan were consistent with those used during our previous annual scans [3,5,8–14]. The 24 core participants in the horizon scan (the authors) used a modified version of the Delphi technique that is repeatable, inclusive, and transparent [15–17].

We consulted our professional networks by person-to-person communication and through targeted Facebook groups, Twitter (e.g., six participants tweeted the same message to their 22 377 followers), the BiodivERsA network, and a project on ResearchGate. We communicated directly with 357 people in person, electronically, or via social media. Each coauthor then submitted at least two issues. Criteria for consideration of these issues by the group were that they must be related to conservation of nature or natural resources, relevant at regional or global scales, and emergent among the global community of researchers, practitioners, and policy makers. The resulting list of 117 issues was circulated to the participants.

Participants gave each issue a unique score in the range from 0 to 1000, with higher scores for issues that were not well known and likely to have considerable environmental effects. The scores were converted to ranks. Separately, participants also indicated whether they had heard of the issue, and the proportion of participants' awareness was used to indicate wider awareness or novelty of the issue, and hence to influence the final scoring. To counteract the possibility of scoring fatigue, or unconscious differences in scoring of issues near the start and end of a long list [18], we developed two versions of the list in which the order of issues was changed, and distributed each version to half of the participants. We retained the 35 issues with the highest median ranks across all participants for further consideration.

Next, two or occasionally three participants were assigned to each of 35 issues to investigate further their novelty, apparent likelihood of occurrence or implementation, and likely magnitude of positive or negative effects. The participants then convened in Cambridge, UK, during September 2017 and discussed each of the 35 issues. The proponent of each issue was not one of the first three people to contribute to discussion on that topic. During our discussion, the emphasis of some issues was adjusted. Following discussion, participants again independently and confidentially ranked the issues, and the 15 with the highest median ranks across all participants were selected for inclusion in the scan. During our subsequent research on these issues, it became clear that two were substantially better known than we originally thought. We removed these two issues and replaced them with the next two highest-ranked issues. The duration of the formal process, from original submission to final selection of the 15 issues with the highest ranks, was ~4 months, although participants gather issues throughout the year. The issues below are grouped thematically rather than presented in rank order.

Emerging Issues

Thiamine Deficiency as a Possible Driver of Wildlife Population Declines

Evidence is increasing that a range of taxonomic groups, including bivalve molluscs, ray-finned fish, and birds across the Northern Hemisphere, are deficient in thiamine (vitamin B1) [19,20]. Thiamine is required for basic cellular metabolism and functioning of neuronal membranes. Thiamine deficiency rarely is a direct cause of mortality, but impairs health and can cause immunosuppression or leads to behavioural and reproductive problems that ultimately could cause population decline or extirpation. Days of thiamine deficiency may present long-lasting sublethal effects, which makes recognition of the extent of thiamine deficiencies more complex. The deficiencies likely are caused by insufficient dietary intake, which may be related to shifts in thiamine-producing algal populations. A recent and extensive survey along the northwest coast of the US found evidence of thiamine depletion in the water column [21]. Additionally, exposure to environmental pollutants may interfere with thiamine uptake. The extent to which thiamine deficiency may pose a substantial long-term risk to a range of species remains unclear.

Geographic Expansion of Chronic Wasting Disease

Chronic wasting disease is a progressive and fatal neurodegenerative disease in cervids. It is a prionic disease similar to scrapie and bovine spongiform encephalitis. Transmission appears likely to occur from animal to animal, with the infectious agent being passed in faeces, urine, or saliva and from mothers to offspring. The prions associated with chronic wasting disease are highly resilient, and contaminated pasture soils may become sources of infection. First discovered in mule deer (*Odocoileus* hemionus) in the US in 1967, the disease subsequently was found in other deer species – white-tailed deer (*Odocoileus virginianus*), elk (*Cervus* canadensis), and moose (*Alces alces*) – in 23 US states and two Canadian provinces. Chronic wasting disease may cause annual, population-level mortality of ~10% in white-tailed deer, and may be constraining population growth [22]. There is a risk that chronic wasting disease will become epidemic in other continents, potentially inducing ecological cascades if key herbivore populations suddenly decline. Chronic wasting disease recently was discovered in captive elk in South Korea and in two individual reindeer (*Rangifer tarandus*) in Southern Norway; its first confirmed presence in Europe [23]. Infection later was detected in three additional reindeer in Central Norway, prompting the decision to cull a herd of 2000 animals [24]. Further emergence of chronic wasting disease in Norwegian reindeer may have substantial effects on vegetation structure, ecological succession, and prey availability for top predators in tundra ecosystems [25], and on the culture and livelihoods of Arctic herding communities.

Breaks in the Dormancy of Pathogenic Bacteria and Viruses in Thawing Permafrost

Some viruses and bacteria can survive freezing for thousands of years [26]. Permafrosts (frozen soils usually held together by ice) that have persisted for millennia are now thawing because of recent and continuing climate changes. As permafrosts thaw, embedded viruses and bacteria, some of them pathogens of humans or other living organisms, may be released and break dormancy, with cascading ecological effects. During the 2016 heat wave in Siberia, for example, a release of anthrax bacteria (*Bacillus anthracis*) led to infections that resulted in one human fatality, the hospitalisation of 20 people, and the death of 2000 reindeer [27]. The anthrax bacterium is thought to have emerged from the thawing carcass of a reindeer that died some 75 years previously. Pathogen viability may be far longer than 75 years, however. Following thawing in a laboratory, a virus (*Pithovirus sibericum*) that had been frozen in Siberian permafrost for 30 000 years was able to infect and kill amoebae [28]. If the pathogens are released in a given area from which they have been absent for a long period, then the pathogens could result in population-threatening epidemics. The extent and speed of fast-thawing permafrost may be further increased by mining for minerals and drilling for oil and gas that is facilitated by melting of Arctic Sea ice.

RNA-Based, Gene-Silencing Pesticides

Topical application of double-stranded RNA (dsRNA) is emerging as a novel method to control insects and viruses considered to be plant pests. The ingested dsRNA triggers enzymes within insect cells, stopping production of proteins that correspond to the dsRNA sequence. This process mimics the natural defence mechanism of RNAi; consumption of dsRNA sequences alters genetic expression in some species [29] and halts expression of genes that strongly affect survival or reproduction of the pests. dsRNA delivered via the vascular system of several crop plants killed sap-feeding insects [30] and a single application of dsRNA protected tobacco plants against a virus for 20 days [31]; albeit both studies were laboratory based. Diverse applications of dsNRA are being developed. For example, one company is developing an RNAi spray that kills *Varroa destructor*, a mite that threatens some honey bee populations (*Apis* cerana and *Apis mellifera*). Because gene silencing does not result in a heritable change, this approach may be more publicly acceptable than others that modify organismal genomes. Similarly, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services pollinator report identified RNAi gene silencing specifically as a promising technology for controlling viruses in honey bees [32]. In addition, dsRNA could be regulated as a chemical pesticide rather than a genetically modified product. Little is known about the potential effects of gene silencing on nontarget organisms with the same gene sequences. Although some studies [33,34] found no measurable effects on survival, condition, or gene expression of nontargeted organisms, these studies were conducted on relatively few species. Ensuring the species specificity of gene-silencing methods is challenging, as is creation of effective, integrated pest management with fewer undesirable environmental effects [35].

Genetic Control of Mammal Populations

Gene editing and self-replicating gene drive technologies, which can spread a deleterious allele to provoke a population crash, are developing rapidly [36]. A global partnership of scientists from diverse organisations, including the governments of the US and New Zealand, is fostering development of the technologies, and their accompanying regulations and ethics, to control non-native invasive rodents on islands. The programme aims for applications within 10 years (Genetic Biocontrol of Invasive Rodents; http://www.geneticbiocontrol.org/). Controlling or eradicating invasive mammals on islands could reduce the likelihood of projected future extirpations of threatened vertebrates by 41–75% [37]. New Zealand aims to eradicate rats, possums, and stoats on all its land by 2050, and is investing NZ$6 million (~US$ 4.3 million) per year in this effort (Predator Free 2050; http://www.doc.govt.nz/predator-free-2050). Laboratories worldwide are developing gene drive systems in mice (*Mus musculus*), although rats are responsible for a greater proportion of extinctions on islands than mice. The projections of individual-based models [38] suggest that some methods based on CRISPR-Cas9 (clustered regularly interspaced short palindromic repeats) gene editing could reduce the mouse population of an island from 50 000 to zero in 4–5 years [38]. Larger populations of mice, and populations of black rats (*Rattus rattus*) or rabbits (*Oryctolagus cuniculus*), also could be eradicated with these methods, although more slowly. Widespread use of these methods to manipulate the demography of mammal populations, however, raises ethical and ecological questions, such as the cascading effects of the eradication of the targeted populations and the potential consequences if an eradication trait spreads into nontarget regions or species within their native range.

Use of Lasers in Commercial Deep Water Fishing

An alternative to bottom trawling has been developed by the Innovation Center Iceland and Icelandic Marine Research Institute [39]. Currently one-third of the value of wild seafood landed in Europe is caught by bottom trawling, a fishing method that generates considerable bycatch [40], causes extensive and enduring damage to benthic ecosystems [41], and results in substantial carbon emissions [42]. Emissions of greenhouse gases and bycatch generated by trawling for shrimp, for example, are especially high; fuel use may approach 4 l of oil per kilogram of edible catch. The new method replaces the conventional trawl with a rigid frame and a small tapered net that corresponds to the cod end of a traditional trawl. Automated height control allows the frame to glide above the sea floor, and target species are herded with directed laser beams, leaving nontarget species and other elements of the benthic ecosystem undisturbed. Lasers also can be used to extend the effective size of the trawl without introducing additional drag [39]. Tests on caridean shrimp (*Pandalus borealis*) indicated that the volume of catch from the laser-based gliding trawl is greater than from bottom trawling. If the new technology proves viable, it may be a realistic alternative to traditional bottom trawls, causing much less sea-bed damage and substantially reducing the volume of fossil fuel used per catch. However, the potential for unsustainable catch levels and other undesirable effects have not yet been widely discussed.

Use of Metal–Organic Frameworks (MOFs) for Harvesting Atmospheric Water

A new technique is being developed to capture atmospheric water in a wide range of ambient conditions, including in low humidity. It involves MOFs (a form of porous crystals) [43,44] or use of solar power. MOFs capture 2–5 l of water daily per kilogram of MOF. MOFs currently use expensive metals such as zirconium, but frameworks that are based on other materials are under development [45]. MOFs could reduce the time necessary to collect water and reduce displacement of humans or wildlife from arid ecosystems or during drought, increasing well-being of humans and reducing ecological effects of environmental migration or land abandonment. Conversely, capture of atmospheric water might make farming in marginal lands feasible, with adverse environmental and social effects. Future refinements might allow collection of sufficient water for plant growth in semi-arid areas, perhaps focusing on drought-tolerant species. Whilst this technique creates new opportunities for human and wildlife communities, its implementation across large areas could lead to major land-use or land-cover changes, with potentially widespread effects on local ecological communities. Effects of capture of atmospheric water in areas with low humidity are unclear, but across extensive areas, further reduction in local atmospheric humidity might exacerbate existing water stress in nonirrigated plant communities in arid areas.

Aquaporins Engineered to Increase Plant Salt Tolerance

While certain plant species, including some crops, have high salt tolerance [46], increasing salinity of agricultural soils threatens crop production in many locations worldwide [47]. Recent advances in understanding of plant responses to salt stress suggest possible methods to increase salt tolerance in crops and thus expand their possible cultivation ranges. Aquaporins, for example, are proteins in the plasma membrane that transport water, and can transport solutes and ions in plants and animals. Rarely has transport of ions by aquaporins been reported in plants [48]. Nevertheless, it is becoming apparent that certain aquaporins in plants, such as AtPIP2;1, may transport sodium ions. Accordingly, genetic engineering of aquaporins may increase salt tolerance in plants [49]. Treatment of plants with silicon may increase tolerance of salt further through regulation of aquaporin gene expression [50]. If plants with these aquaporins can be selectively bred or engineered, it may be possible to increase the agricultural capacity of soils that currently are relatively saline or that may become more saline due to subsidence related to ground water extraction or sea level rise. The extent to which salt tolerance in native plants or crops might be increased via such aquaporins remains unclear. Should this, or other methods of increasing plant salt tolerance, become commercially viable, the positive or negative effects on biological diversity may be considerable. Increases in the extent of arable land may lead to loss or fragmentation of habitat for native species. Additionally, salt-tolerant agricultural plants may colonise natural ecosystems and out-compete native plants. An increase in salt-tolerant crops, however, may allow use of abandoned croplands, and reduce food shortages and human displacement, reducing pressure to convert presently nonfarmed land to agriculture or settlements.

Effect of Culturomics on Conservation Science, Policy, and Action

Culturomics analyses word frequencies and associations in large, digital sets of data to better understand human culture and behaviour. The methods are not new, but their applications to conservation are emerging [51]. Culturomics may affect the success of conservation strategies that depend on public support and the demonstration of societal and cultural impacts of conservation. Proposed applications of culturomics in conservation science, practice, and policy include identification of conservation-oriented constituencies, demonstration of public interest in nature, understanding the drivers of such interest, and assessing the effects of conservation interventions. Internet searches, Twitter and WeChat traffic can, for instance, be used to quantify public perception and interest in wetlands or bird species [52,53], or changes in public interest in biological diversity over time [54]. Culturomics could inform efforts to enhance conservation and guide decision-making. While originally applied exclusively to text-based sources, culturomics is becoming feasible for analysing video and audio files [55] and sentiments [56]. Advances in machine learning may enable the classification and use of new information sources, thus allowing further characterization of human–nature interactions that may increase support for conservation. It is probable, however, that culturomics also will be applied by organisations seeking to counteract or prevent conservation policy and actions.

Changes in the Global Iron Cycle

The global iron cycle is changing in response to accelerating ocean acidification, stratification, warming, and deoxygenation and is predicted to change further [57]. Changes in the iron cycle affect the aqueous chemistry, sources and sinks, recycling, particle dynamics, and bioavailability of iron [58]. Iron limitation constrains productivity of phytoplankton in many open ocean areas, which may affect entire ocean ecosystems. Iron is supplied to the oceans by wind-deposited particulates, anthropogenic sources, biological recycling, hydrothermal and riverine inputs, and upwelling. In polar regions, major sources include glacial runoff from scoured rock, resuspension of sediments from iceberg scour, and sea-ice cycles; all of which are predicted to change substantially as climate changes [57]. Available iron may increase in the short-term as a result of increases in iceberg scour. However, in the longer term, as glaciers retreat to their grounding lines, a considerable decrease is likely to occur. The trade-off between iron bioavailability and use also is likely to change as the oceans warm and phytoplankton growth rates increase [58]. Increasing levels of iron limitation might further be used to justify ocean-fertilisation efforts, either simply to enhance or to maintain previous CO_2 draw-down from the atmosphere, or possibly to support offshore fisheries [59].

Underestimation of Soil Carbon Emissions

Soil organic carbon contains most of the terrestrial carbon. The decomposition of this carbon stock as global temperatures increase represents a potentially large climate feedback mechanism, and is a major source of uncertainty in climate models. The loss of carbon from the upper soil layer in response to warming is well recognised [60], but emissions of soil carbon from deeper layers have not yet been systematically considered. A deep-warming (to 100 cm) experiment detected a previously unobserved response at all depths, with CO_2 production increasing by 34–37% given a 4°C increase [61]. Kauffman and colleagues reported losses in mangrove soil carbon stocks at depths >1 m following conversion to pasture [62]. Other research has indicated that soil volume change has been underestimated as a soil forming process, leading to errors of up to −87% to +54% in calculations of soil carbon change over longer time frames [63] and reinterpretation of soil organic matter transport between layers [64]. If a substantial proportion of the soil carbon, emitted through a feedback mechanism in response to increased temperatures, is missing from current climate projections, global warming could be more rapid than expected, with substantial effects on ecosystems, humans, and other species.

Rapid Climatic Changes on the Qinghai–Tibet Plateau

The Qinghai–Tibet plateau in Asia covers 2.5 million km^2, with an average elevation of more than 4000 m, and contains the third largest reservoir of ice in the world. From 1980 to 1997, temperatures on the plateau increased by an average of 0.21°C per decade, accelerating to 0.25°C per decade since 1997; precipitation has increased by 3.8 mm per decade since 1961 [65,66]. Glacial melt and increasing plateau temperatures will cause lakes on the plateau to overflow; the loss of permafrost will increase emissions of soil carbon and also have substantial effects on vegetation, hydrology, and species throughout and beyond the plateau [67]. Changes in the climate of the plateau also may affect Eurasian weather systems. Summer snow cover on the Qinghai–Tibet plateau affects atmospheric winds that modulate the El Niño–Southern Oscillation and in turn influence the East Asian Monsoon, which generates summer rain between the Yangtze and Yellow River basins [68,69]. Snow cover on the Qinghai–Tibet plateau also has been linked to the onset of the summer monsoon on the Indian subcontinent and Indochina, and to heat waves in Southern Europe and Northern China [70,71]. As the plateau continues to warm and snow cover decreases or becomes more variable, its effects on climate and hydrology in Asia and Europe may become more pronounced, with potentially major effects on species and ecosystems.

International Collaborations to Encourage Marine Protected Area Expansion in the High Seas

Areas beyond any national jurisdiction (the high seas) cover 44% of surface of the Earth, and <1% are protected. New designations and advances in international policy frameworks suggest that the expansion of marine protected areas (MPAs) in the open ocean is increasingly possible. The challenges of legally protecting biological diversity in the high seas are considerable [72]. The first high seas MPAs included the South Orkney Islands Southern Shelf MPA (2009) and several sites in the North Sea (from 2010). These MPAs sometimes are criticised because they are in areas with few other human demands [73] or because regulatory controls are insufficient to achieve conservation objectives [74]. The Ross Sea MPA in the Southern Ocean, was scheduled to come into force in December 2017 as the largest MPA (1.55 million km^2) in the world. Members of the Commission for the Conservation of Antarctic Marine Living Resources (which include most of the G20 Group of nations) unanimously agreed to establishment of the MPA. In parallel, a preparatory commission established by the United Nations General Assembly in 2015 has drafted key elements of potential legislation to protect the biological diversity of the high seas, including novel mechanisms for establishing MPAs. This legislation would be managed under the International Convention for the Law of the Sea [75]. The lack of permanence of the Ross Sea MPA, which will expire after 35 years, has been regarded as a core weakness. However, the foundational agreement for the MPA, and the potential for a clearer international framework for management intervention, could lead to rapid increases in high seas conservation.

Belt and Road Initiative in China

In 2013, Chinese President Xi Jinping unveiled a strategic infrastructure programme that would support development of six major land transport corridors across central Asia. The corridors would link China to Europe (the belt) and link Chinese ports to Indonesia, ports around the Indian Ocean, and, through the Red Sea, Southern Europe (the road). The cost of completing the corridors, estimated to be $1.25 trillion by 2025 [76,77], will deliver economic development, supported by considerable scientific and technological development, across Eurasia to Africa. Nearly 70 countries have agreed to cooperate in the plan [78]. Given the growth of ecologically informed policies in China [14], it may be possible to develop the corridors in an environmentally sustainable manner [79]. President Xi stated his ambition to create a big-data service platform for environmental protection, and to support climate change adaptation projects internationally [78]. However, official documents currently do not appear to emphasise environmental assessment, and there are concerns that the investors may push such big infrastructure projects through quickly at the expense of safeguards, with a cascade of negative environmental impacts [80]. For example, the proposed routes overlap protected areas supporting snow leopards (*Panthera* unica), Amur tigers (*Panthera tigris altaica*), and Far Eastern leopards (*Panthera pardus orientalis*) [81]. The anticipated and extensive industrial and infrastructure development across central Asia, exacerbated by resulting human immigration to the region, would compound the undesirable ecological changes that are anticipated as climate changes [79]. Furthermore, any growth in trade throughout the region is likely to increase the risk of trade in endangered species and transport of non-native invasive species.

Potential Effects on Wildlife of Increases in Electromagnetic Radiation

Understanding the potential effects of nonionising radiation on wildlife could become more relevant with the expected adoption of new mobile network technology (5G), which could connect 100 billion devices by 2025. During use, mobile telephones and other smart devices generate radiofrequency electromagnetic fields (RF-EMFs), a form of nonionising radiation, which may change biological processes such as neurotransmitter functions, cellular metabolism, and gene and protein expression in certain types of cells, even at low intensities [82]. The notion of risk to human health remains controversial, but there is limited evidence of increased tumour risk in animals [83]. 5G uses the largely untapped bandwidth of the millimetre wavelength, between 30 and 300 GHz on the radio spectrum, which uses smaller base stations than current wireless technology. As a result, wireless antennae may be placed densely throughout neighbourhoods on infrastructure such as lamp posts, utility poles, and buildings. This could expose wildlife to more near-field radiation. Although some studies reported negative associations between electromagnetic field strength (radiofrequencies and microwaves: 1 MHz–3 GHz range) and species, for example the density and abundance of house sparrows (*Passer domesticus*) [84,85], these studies have not yielded clear empirical evidence that the observed effects are due to RF-EMFs. The potential effects of RF-EMFs on most taxonomic groups, including migratory birds, bats, and bees, are largely unknown. The evidence to inform the development of exposure guidelines for 5G technology is limited, raising the possibility of unintended biological consequences [86].

Discussion

Identifying issues that are truly on the horizon of current scientific thinking entails trade-offs. If there is little evidence that a phenomenon is emerging, it is difficult to gauge whether it is likely to become a major threat or opportunity. If there is considerable evidence, an issue no longer is novel. RF-EMFs are an example of the former. Discussions about the potential effects of RF-EMFs are unresolved and controversial [83]. However, the likely considerable global expansion in the use of RF-EMFs, and recognition that new technologies may allow radiation to use higher frequencies of the electromagnetic spectrum than previously were feasible, led us to include this issue among our 15. In contrast, we also discussed the impending global hydropower boom, but later decided it was no longer an emerging issue [87–89].

Another challenge in horizon scanning is evaluating the degree to which the possible influence of an issue is exaggerated by news media, commercial interests, or individual scientists. Emerging environmental issues that are controversial are typically characterised by active campaigning voices, which can report or reference biased or misleading sets of research results and inferences [90]. When there is little evidence, the quality and provenance of that evidence is crucial to deciding whether an issue plausibly is emerging or whether it more likely represents a campaign mounted by one or more interest groups. We had discussions of this nature about EMFs, thiamine deficiency, and laser light trawling. We also debated the timeline along which we should judge emerging issues, and in many cases, we agreed that some required short-term action.

This year, two of our issues relate to emerging or returning disease. Previous horizon scans highlighted the re-emergence of rinderpest [9], snake fungal disease [13], and coral diseases [3]. These issues reflect growing evidence that emerging, or returning diseases are affecting native species and populations around the world, and, in some cases, leading to population declines or extirpations in once-common species [91,92]. Animal and plant diseases pose a serious and continuing threat to food security, food safety, national economies, biological diversity, and the environment (UK Animal and Plant Health Agency and Department for Environment, Food & Rural Affairs; Protecting plant health: topical issues; https://www.gov.uk/guidance/protecting-plant-health-topical-issues). For example, plant health is a growing focus for governments and country risk registers [93]. Horizon scans can contribute substantially to focused research and its effects on government actions. Given the continued global transport of biological material and cumulative effects of stressors that increase the susceptibility of wild animals and plants to disease [94], we suspect that future horizon scans will continue to highlight novel, emerging, or returning pathogens and diseases.

As we discussed in our 2017 horizon scan, biotechnology continues to yield transformational developments, many enabled by new and relatively cheap gene editing methods such as CRISPR-Cas9 [5]. Two of the issues we identified this year, gene-silencing pesticides based on RNAi and genetic biocontrol of mammals, are being considered as solutions to the challenges of invasive non-native species and the need for increased food production. Both technologies may have major, positive effects on species and ecosystems through highly targeted control of unwanted species. However, both also represent technological interventions in natural populations and ecosystems that previously have not been attempted across extensive areas and could have long-term and unintended ecological or environmental consequences. As new biotechnologies develop, ethical considerations and careful assessment of possible negative effects are usually given a high profile in the scientific literature and by regulators and governments (e.g., [95,96] on CRISPR-Cas9). Nevertheless, these processes do not always stop the development of promising technologies that indeed have unintended consequences that are considered unacceptable by some sectors of society.

The horizon scanning process is not intended to draw attention to phenomena that are widely understood to affect societal needs or values, including those related to all aspects of biological diversity. Instead, it is intended as an early awareness and alert system drawing attention to novel issues that, if realised, may create pivotal opportunities or threats and thus warrant further analysis in the near future. It supports the capabilities of organizations to deal better with an uncertain and complex future [97]. We hope that our annual scans highlight issues of relevance not only to biological conservation but also to the wider environment and, by extension, to human well-being.

Acknowledgements

This is an exercise coordinated by the Cambridge Conservation Initiative, funded by both the Natural Environment Research Council (NERC) and the Royal Society for the Protection of Birds (RSPB). We are grateful to the large numbers of people who engaged with this process and submitted issues. For suggesting issues that appeared in this paper, we thank Ricardo Correia (culturomics), Silviu Petrovan (chronic wasting disease), Lewis Spurgin (RNAi pesticides), Steffen Oppel (electromagnetic radiation) and Nancy Ockendon (genetic control of mammals). W.J.S and R.A.G are funded by Arcadia. L.V.D is funded by The Natural Environment Research Council (NE/N014472/1).

From: Todd Kuiken <tkuiken@ncsu.edu>
Subject: [Geneticrescue] peer-review of the CBD AHTEG Report
Date: January 23, 2018 at 8:21:46 AM CST
To: GeneticRescue <geneticrescue@reviverestore.org>

Hi Everyone,

The CBD AHTEG report on synthetic biology is now available for peer-review. I have copied the official email below. Some of the links to the CBD website are not working so I have also attached the AHTEG report and the form you will need to use if you want to make submissions.

Todd

P.S. If you are wondering when you get towards the end of the report, it is not a typo, we did indeed finish at 3:05am.

NOTIFICATION

No. 2018-013

Dear Madam/Sir,

In decision XIII/17, the Conference of the Parties to the Convention on Biological Diversity extended the mandate of the Ad Hoc Technical Expert Group (AHTEG) on Synthetic Biology, with new terms of reference as contained in the annex to the decision, and requested that the AHTEG meet at least once face to face prior to the fourteenth meeting of the Conference of the Parties.

The face-to-face meeting of the AHTEG on Synthetic Biology was convened in Montreal, Canada, from 5 to 8 December 2017. I am, therefore, pleased to invite Parties, other Governments, relevant organizations and indigenous peoples and local communities to peer review the report of the meeting, which is available at http://bch.cbd.int/synbio/peer-review.

National Focal Points to the Convention are kindly requested to coordinate views nationally prior to submission on behalf of Parties and other Governments. Only submissions by National Focal Points to the Convention and heads of organizations, as appropriate, will be accepted. Submissions must be sent to the Secretariat, via e-mail to synbio@cbd.int using the template accessible in the annex to this notification, no later than **28 February 2018**.

All submissions received through this peer-review process will be made available online and, along with the AHTEG report and other relevant documentation, will be taken into account by the Secretariat in preparing the relevant documents for consideration by the twenty-second meeting of the Subsidiary Body on Scientific, Technical and Technological Advice to be held in Montreal, Canada from 2 to 7 July 2018.

The text of this notification is also available on the CBD website at:
http://www.cbd.int/doc/notifications/2018/ntf-2018-013-synthetic-biology-en.doc

Please accept, Madam/Sir, the assurances of my highest consideration.

Cristiana Paşca Palmer, PhD

Executive Secretary

Secretariat of the Convention on Biological Diversity

United Nations Environment Programme

413 Saint-Jacques Street, Suite 800

Montreal, Quebec, Canada

H2Y 1N9

Tel: +1 514 288 2220

Fax: +1 514 288 6588

E-mail: secretariat@cbd.int

Web: http://www.cbd.int

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Todd Kuiken, Ph.D.
Senior Research Scholar
Genetic Engineering & Society Center
North Carolina State University
Campus Box (or CB) 7565
Raleigh, NC 27695 -7565
Phone: 919-515-2593
email: tkuiken@ncsu.edu
@drtoddoliver
Program Website: https://research.ncsu.edu/ges

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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

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9 December 2017

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REPORT OF THE AD HOC TECHNICAL EXPERT GROUP ON SYNTHETIC BIOLOGY

MONTREAL, CANADA, 5-8 DECEMBER 2017

INTRODUCTION

1. In decision XIII/17, the Conference of the Parties to the Convention on Biological Diversity commended the work of the online forum and the Ad Hoc Technical Expert Group on Synthetic Biology (AHTEG) and welcomed the conclusions and recommendations of the report of the AHTEG as a basis for further discussion. The Conference of the Parties also considered the operational definition useful as a starting point for the purpose of facilitating scientific and technical deliberations under the Convention and its Protocols and took note of the conclusion of the AHTEG that living organisms developed through synthetic biology are similar to living modified organisms (LMOs) as defined in the Cartagena Protocol. The Conference of the Parties noted that the general principles and methodologies for risk assessment under the Cartagena Protocol and existing biosafety frameworks provide a good basis for risk assessment of living organisms developed through synthetic biology, but such methodologies might need to be updated and adapted.

2. In the same decision, the Conference of the Parties (a) extended the mandate of the current AHTEG in accordance with the terms of reference contained in the annex to the decision; (b) extended the open-ended online forum to support the work of the AHTEG; (c) invited Parties, other Governments, relevant organizations and indigenous peoples and local communities and other relevant stakeholders to submit information and supporting documentation on topics relevant to the work of the AHTEG, as outlined in paragraph 10 of the decision; and (d) requested the Executive Secretary, among other things, to continue to facilitate moderated discussions under the open-ended online forum on synthetic biology through the Biosafety Clearing House.

3. In response to this decision, with a view to supporting the work of the AHTEG, the Secretariat has taken the following actions:

(a) It issued a notification[1] inviting the submission of information and documentation, as outlined in paragraph 10 of the decision. A total of 29 submissions were received, of which 15 were from Parties, 1 from a non-Party and 13 from organizations;[2]

(b) It convened a series of moderated online discussions of the open-ended online forum on synthetic biology from July to October 2017;[3]

[1] Notification SCBD/SPS/DC/DA/MW/86375, available at https://www.cbd.int/doc/notifications/2017/ntf-2017-025-bs-en.pdf.

[2] Submissions are available through the Biosafety-Clearing House at http://bch.cbd.int/synbio/submissions/2017-2018.shtml.

[3] The discussions under the Open-ended Online Forum on Synthetic Biology are available at https://bch.cbd.int/synbio/open-ended/discussion/.

(c) It compiled and synthesized the outputs of the activities referred to in subparagraphs (a) and (b) above in CBD/SYNBIO/AHTEG/2017/1/2 to facilitate the deliberations of the AHTEG.

4. In working towards fulfilling its mandate as per decision XIII/17, the AHTEG held its face-to-face meeting in Montreal, Canada, from 5 to 8 December 2017. The list of participants is contained in the annex.

ITEM 1. OPENING OF THE MEETING

5. The meeting was opened at 9:50 a.m. on Tuesday, 5 December 2017, by Mr. David Cooper, Deputy Executive Secretary on behalf of Ms. Cristiana Pasça-Palmer, Executive Secretary of the Convention on Biological Diversity.

6. The Deputy Executive Secretary welcomed the members of the AHTEG and thanked them for bringing their expertise to the meeting and to the online discussions that had preceded the meeting. He emphasized the importance of the work of the AHTEG, emphasizing the scientific and technical nature of its work, and elaborated on the need to achieve the outcomes outlined in the terms of reference. He noted that the outcomes of the meeting would be considered by the Subsidiary Body on Scientific, Technical and Technological Advice at its twenty-second meeting, to be held in Montreal, Canada, from 2 to 7 July 2018. Mr. Cooper also thanked the European Union and Switzerland for generously providing funds to support the participation of experts from developing country Parties and representatives of indigenous peoples and local communities.

7. Following his opening remarks, the Deputy Executive Secretary invited the members of the AHTEG to briefly introduce themselves.

ITEM 2. ORGANIZATIONAL MATTERS

2.1. Election of officers

8. The AHTEG elected Mr. Nikolay Tzvetkov (Bulgaria) and Ms. Maria de Lourdes Torres (Ecuador) as co-chairs and Mr. Peter Kwapong (Ghana) as the meeting Rapporteur.

9. The co-chairs made introductory statements in which they highlighted the importance of the task at hand and the challenges before the Group.

2.2. Adoption of the agenda

10. The co-chairs invited the AHTEG to consider and adopt the provisional agenda (CBD/SYNBIO/AHTEG/2017/1/1).

11. Following a proposal from one of its members, the AHTEG agreed to consider paragraph 1(e) of its terms of reference under agenda item 5 on “Other matters”.

2.3. Organization of work

12. The AHTEG decided to proceed on the basis of the organization of work contained in annex I to the annotations to the agenda (CBD/SYNBIO/AHTEG/2017/1/1/Add.1).

ITEM 3. SUBSTANTIVE ISSUES

13. Ms. Dina Abdelhakim of the Secretariat of the Convention on Biological Diversity provided an overview of the outcomes of the work of the Open-ended Online Forum on Synthetic Biology and

introduced the background document (CBD/SYNBIO/AHTEG/2017/1/2) to assist the AHTEG in its deliberations on each of the substantive items.

3.1. Recent technological developments in the field of synthetic biology

14. In its deliberations under this agenda item, the AHTEG acknowledged that technological developments within the field of synthetic biology were advancing at an accelerated rate, resulting in an increasing number of organisms that had been engineered using various tools and techniques.

15. In reviewing the recent technological developments of synthetic biology, the AHTEG noted, inter alia, the following:

(a) Some recent synthetic biology techniques expand the range of organisms that can be modified;

(b) Synthesis of whole genomes and chromosomes is now possible and can have significant implications on the way modification of organisms is done;

(c) The development of various gene editing tools enables the simultaneous targeting of multiple sites, or multiplexing, within a genome in one step;

(d) Engineered gene drives are being developed in a range of sexually reproducing organisms, such as some insects and rodents;

(e) Biotechnology tools have become increasingly available in some countries to the "do-it-yourself" (DIY) community and the public at large outside of formal laboratory facilities;

(f) Some recent developments in synthetic biology have advanced to the point at which organisms might be considered for introduction into the environment at an accelerated rate;

(g) Approaches such as machine learning, artificial intelligence, robotics and those related to "big data" are being applied with a view to constructing and engineering genomes and genetic circuits, and are expected to enable rapid prototyping and testing of highly novel organisms;

(h) Combining new biotechnology tools and automation allows the more rapid production of modified organisms;

(i) Modified algae, being used for the production of chemical substances, might require relatively "open" production ponds/facilities due to the need for sunlight;

(j) The development of whole-cell and cell-free sensors is being pursued with a potential for use inside and outside laboratories;

(k) External genome regulation methods are being developed, such as RNA interference vectors or reagents being applied in the form of sprays.

16. The ever increasing speed of development within the field of synthetic biology might pose a challenge to the capacity to conduct risk assessments in some countries.

17. The recent developments in synthetic biology and the continued pace of development might pose challenges to the ability to understand the possible impacts on biodiversity and human health. There might be a need to consider more thoroughly the potential benefits and potential adverse effects at the ecosystem level, particularly for some developments, such as engineered gene drives.

18. The development and implementation of well-designed strategies, including physical containment and built-in systems to effectively limit the survival or spread, might be needed to prevent or minimize the exposure of the environment to organisms, components and products of synthetic biology

under contained use.[4] These strategies should be commensurate to the risk posed by the organisms, components and products.

19. The potential dual use nature of some advances in synthetic biology might raise biosecurity concerns in relation to the three objectives of the Convention.

20. The AHTEG noted that regular horizon scanning, monitoring and assessing of developments in the field of synthetic biology could be useful for reviewing new information regarding the positive and negative impacts of synthetic biology vis-à-vis the three objectives of the Convention and its Protocols.

21. The AHTEG also noted that most synthetic biology research and development took place in developed countries and in a limited number of developing countries, and that many developing countries as well as indigenous peoples and local communities might need capacity development to stay abreast of developments in that field. The AHTEG highlighted the need to explore ways to facilitate, promote and support capacity-building and knowledge sharing regarding synthetic biology, risk analysis and related matters, to meet the needs of developing countries and of indigenous peoples and local communities, including through necessary funding, and the co-design of programmes, with training provided in the official languages of the United Nations and, where possible, in local languages.

3.2. Evidence of benefits and adverse effects of organisms, components and products of synthetic biology vis-à-vis the three objectives of the Convention

22. Under this agenda item, the AHTEG recalled the conclusion reached at its previous meeting that the organisms, components and products of synthetic biology were expected to have similar types of positive and negative impacts on biological diversity as classical genetic engineering. However, it considered that the potential positive and negative impacts of synthetic biology might be broader and more wide-ranging due to the potential for synthetic biology to produce organisms and biological systems with ranging levels of complexity for use in a range of applications.

23. The AHTEG noted that, beyond the experience gained from LMOs already released into the environment, to date, there was limited direct empirical evidence of the benefits and adverse effects on biodiversity resulting from the organisms, components and products of synthetic biology.

24. However, the AHTEG also noted the availability of other types of information and knowledge that were of scientific value in informing an assessment of the potential benefits or adverse effects of organisms, components and products that had been developed through synthetic biology techniques. That could include information based on modelling and scenarios, data from experiments performed under contained use, such as in laboratories, and experience gained through the management of pests and invasive alien species, including biological control, as well as from the use of LMOs that had been released into the environment. Information gathered from traditional animal and crop breeding, forestry, aquaculture and other human interventions in the environment, including knowledge, innovations and practices of indigenous peoples and local communities, could also be useful in exploring possible positive and negative impacts of organisms resulting from synthetic biology.

25. The AHTEG noted that consideration of the potential benefits and adverse effects of organisms produced through synthetic biology could be particularly relevant and urgent for those organisms that had been developed to contain engineered gene drives, in the light of the impacts that such organisms might have on the conservation and sustainable use of biological diversity, as well as the knowledge, innovations and practices of indigenous peoples and local communities, particularly if they were released into the environment. Uncertainties related to the efficacy and safety of engineered gene drive systems, as

[4] Insofar as they are consistent with Conference of the Parties decision V/5, para. 23.

well as the relative risks that could be posed by the different applications of engineered gene drive systems (for example, for population replacement or suppression) were noted. Furthermore, while there could be potential benefits to the development of such organisms, it was noted that additional research and guidance were needed before any organism containing engineered gene drives could be considered for release into the environment, including into lands and territories of indigenous peoples and local communities. The AHTEG also noted the potential for the unintended transboundary movements and geographic spread of organisms released into the environment. Given the current uncertainties regarding engineered gene drives, a precautionary approach and cooperation with all countries and stakeholders that could be affected, taking into account the need for the free, prior and informed consent of indigenous peoples and local communities, might be warranted in the development and release of organisms containing engineered gene drives, including experimental releases, in order to avoid potential significant and irreversible adverse effects to biodiversity.

26. The discussion under this agenda item also considered the possible impacts of synthetic biology on the traditional knowledge, innovation, and practices of indigenous peoples and local communities, as well as how synthetic biology would impact the relationship of indigenous peoples and local communities with Mother Nature. The development of such technologies should be accompanied by the full and effective participation of indigenous peoples and local communities with a view to creating a vision that would further guide advances and understanding in the field of synthetic biology and to integrating the concerns and needs of indigenous peoples and local communities in decision-making.

3.3. Living organisms developed through synthetic biology that may not be regarded as living modified organisms as per the Cartagena Protocol on Biosafety

27. The AHTEG discussed this item on the basis of the contributions of the online forum and further analysed whether and how organisms developed through synthetic biology fulfilled the criteria of the definition of LMOs as per Article 3 of the Cartagena Protocol.

28. As a result of its deliberations, the AHTEG concluded that most living organisms already developed or currently under research and development through techniques of synthetic biology, including organisms containing engineered gene drives, fell under the definition of LMOs as per the Cartagena Protocol.

29. Techniques involving cell-free systems did not result in the development of living organisms. Likewise, to date, protocells that were capable of replicating genetic material did not exist and, as such, were not living organisms. In the future, however, protocells that were capable of transferring or replicating genetic material might be developed and those might be regarded as LMOs.

30. Furthermore, there were different interpretations as to whether or not organisms modified through epigenetic engineering contained novel combinations of genetic material and, therefore, those organisms might or might not be regarded as LMOs.

31. The AHTEG also noted that indigenous peoples and local communities regarded all components of Mother Nature as living entities.

3.4. Tools to detect and monitor the organisms, components and products of synthetic biology

32. The AHTEG noted that most tools that were currently in use for the detection, identification and monitoring of LMOs could also be used for organisms developed through synthetic biology, but those tools might need to be updated and adapted.

33. The AHTEG also noted that challenges might arise in the case of organisms that might not have a suitable target marker(s) and when the resulting LMO was indistinguishable from a naturally occurring or conventionally bred counterpart. In such cases, the development of additional detection, identification and monitoring tools might be needed.

34. With regard to detecting and monitoring products of synthetic biology, it was noted that analytical techniques could be used to distinguish between products of synthetic biology and naturally occurring or chemically synthesized counterparts. However, further development in that area might be needed.

35. The AHTEG further noted that relying on traceability and documentation for identity preservation were also useful and cost-effective tools for identification and monitoring. In addition, regulatory tools, reporting and auditing mechanisms, as well as the use of online databases, such as the Biosafety Clearing-House and the Food Safety platform of the Food and Agriculture Organization of the United Nations, were useful for sharing information on the detection and monitoring of organisms, components and products of synthetic biology.

36. It was suggested that the Network of Laboratories for the Detection and Identification of LMOs,[5] among others, might be able to contribute to the assessment of the availability of tools for the detection of organisms developed through synthetic biology techniques and the identification of best practices as well as any gaps and challenges in existing methodologies that might need to be addressed. It was also suggested that the Network could be expanded to bring together experts in the field of analytical chemistry in order to facilitate the assessment of the availability of tools for the detection and monitoring of components and products of synthetic biology.

37. It was noted that, while tools for the detection, identification and monitoring of organisms, components and products of synthetic biology might be available, some countries might not have access to such tools due to insufficient technical infrastructure and technical capacity, and legal barriers. Capacity-building and legal and technological cooperation were therefore needed.

38. It was also suggested that developers of organisms resulting from synthetic biology that were intended for introduction into the environment or for placing on the market could be made responsible for providing validated tools, relevant sequence data and reference materials, in an accessible manner, that would facilitate the detection, identification and monitoring of such organisms and products thereof, as was already the case for LMOs under some frameworks.

3.5. Risk management measures, safe use and best practices for safe handling of organisms, components and products of synthetic biology

39. The AHTEG took the view that it would be important to consider risk assessment as well as risk management in the discussion on this agenda item.

Risk assessment

40. The AHTEG reiterated that the general principles and methodologies for risk assessment under the Cartagena Protocol and existing national biosafety frameworks, as well as voluntary guidance, could provide a good basis for risk assessment of organisms developed through synthetic biology. These methodologies might need to be periodically updated and adapted.

41. Updates and adaptations might be needed to account for:

[5] Accessible through http://bch.cbd.int/onlineconferences/portal_detection/lab_network.shtml.

(a) The lack of suitable comparators in cases whereby organisms developed through techniques of synthetic biology contain features that are significantly different from existing organisms;

(b) Knowledge gaps in assessing unintended effects that might result from complex changes and novel traits;

(c) Knowledge gaps in assessing interactions of combinatorial and cumulative effects of multiple organisms developed through synthetic biology being released in the same environment;

(d) Lack of experience with the introduction of organisms containing engineered gene drives into natural populations.

42. The AHTEG also noted the existence of voluntary guidance documents that could be taken into account in the risk assessment of organisms developed through synthetic biology.[6]

43. In addition, the AHTEG noted the need to develop and conduct assessments of the potential positive and negative impacts of synthetic biology on the three objectives of the Convention, taking into account the continuing loss of biodiversity, including species extinctions and degradation of ecosystems, the relationship between indigenous peoples and local communities and Mother Nature, and the rights recognized by the United Nations Declaration on the Rights of Indigenous Peoples.

44. The AHTEG further noted that existing risk assessment considerations and methodologies might not be sufficient or adequate to assess and evaluate the risks that might arise from organisms containing engineered gene drives due to limited experience and the complexity of the potential impacts on the environment. The development or further development of guidelines on risk assessment of organisms containing engineered gene drives by the Convention, other international organizations, national governments and professional bodies would be useful in that regard.

45. Some experts noted that a stepwise approach might be appropriate in order to gather information that is needed to fill knowledge gaps and avoid adverse effects or minimise the likelihood of them occurring. However, the step of release into the environment might be irreversible and, therefore, a precautionary approach might be warranted.

46. The AHTEG noted the need to promote and support capacity-building and knowledge-sharing on synthetic biology, risk analysis and related matters in order to meet the needs of developing countries and of indigenous peoples and local communities, taking into account traditional knowledge, innovation, culture, free, prior and informed consent, customary practices and community protocols in the context of articles 8(j) and 10(c) of the Convention and the Akwé: Kon guidelines.

Risk management

47. The AHTEG noted that risk management measures should be imposed to the extent necessary to prevent adverse effects, taking into account uncertainties and lack of knowledge, and in accordance with national legislation and the customary law of indigenous peoples and local communities.

48. Current strategies for risk management and monitoring of LMOs might provide a good basis for managing the risks and monitoring potential impacts of organisms developed through synthetic biology. These strategies might need to be adapted and complemented in order to address specific characteristics of organisms developed through synthetic biology.

[6] Such as the Guidance on Risk Assessment developed by the AHTEG on Risk Assessment and Risk Management and other relevant guidance documents as per decision CP VIII/12.

49. Cooperation with international organizations and other relevant stakeholders could assist in identifying best practices within other frameworks that were relevant for risk management and monitoring of organisms, components and products of synthetic biology, and that were consistent with the objectives of the Convention.

50. The AHTEG discussed the appropriateness of current containment measures and noted the existence of guidelines for various levels of containment, ranging from laboratory settings to outdoor facilities. The AHTEG also noted that the requirements for the implementation of these containment measures varied among countries.

51. Regarding the containment of organisms containing engineered gene drives, the following points were raised:

(a) Best practices for effective containment of LMOs should be adapted and applied for organisms containing engineered gene drives;

(b) Islands are not ecologically fully contained environments and should not be regarded as fulfilling the conditions in the definition of contained use as per Article 3 of the Cartagena Protocol unless it is so demonstrated;

(c) Internationally agreed standards for effective containment of organisms containing engineered gene drives might be useful in order to avoid accidental releases from laboratory facilities.

52. The AHTEG noted that horizon scanning of synthetic biology under the Convention could also keep track of progress in the adaptation of risk assessment and risk management of organisms developed through synthetic biology.

53. The AHTEG highlighted the need to take into account the socio-economic impacts, perspectives, rights and lands of indigenous peoples and local communities when considering the possible release of organisms developed through synthetic biology into the lands and territories of indigenous peoples and local communities.

ITEM 4. CONCLUSIONS AND WAYS FORWARD

54. The outcomes of the deliberations of the AHTEG in response to paragraphs 1(a) to (d) of its terms of reference in decision XIII/17 are set out in paragraphs 14 to 53 above.

55. The AHTEG recommended that the Subsidiary Body on Scientific, Technical and Technological Advice at its twenty-second meeting consider the outcomes of this meeting to facilitate future discussions and actions on synthetic biology under the Convention.

ITEM 5. OTHER MATTERS

56. The AHTEG noted that the Subsidiary Body on Scientific, Technical and Technological Advice at its twenty-first meeting, to be held in Montreal, Canada, from 11 to 14 December 2017, would consider how to apply the criteria, as set out in paragraph 12 of decision IX/29, for the selection of new and emerging issues relating to the conservation and sustainable use of biological diversity. The AHTEG decided to defer the analysis requested in paragraph 1(e) of its terms of reference until further guidance was provided.

57. The importance of addressing the potential socio-economic impacts of the commercialization of products of synthetic biology that replaced naturally occurring products was noted.

58. The participation of representatives of indigenous peoples and local communities at the meeting was acknowledged. The Secretariat was encouraged to continue facilitating their full and effective participation in all meetings that were relevant to the three objectives of the Convention.

ITEM 6. ADOPTION OF THE REPORT

59. The draft report was introduced to the AHTEG by the Rapporteur. The co-Chairs invited the AHTEG to consider the report. The report was adopted as orally amended.

ITEM 7. CLOSURE OF THE MEETING

60. The meeting closed on Saturday, 9 December 2017, at 3:05 a.m.

Annex

LIST OF PARTICIPANTS

PARTIES

Antigua and Barbuda

1. Ms. Ruth Spencer
National Coordinator
UNDP-GEF Small Grants Program
Country Club Rd, Hodges bay, Box 846
St. John's
Antigua and Barbuda
Email:

Austria

2. Mr. Helmut Gaugitsch
Head of Unit
Department of Land Use and Biosafety
Environment Agency Austria
Spittelauer Lände 5
Vienna A-1090
Austria
Tel.: +43 1 31 304 3133
Fax: +43 1 31 304 3700
Email:
Web: h

Belarus

3. Ms. Maryna Bahdanava
Leading Researcher
National Coordination Biosafety Centre
Laboratory of Genetics and Cell Engineering
Institute of Genetics and Cytology, National Academy of Sciences of Belarus
27 Akademicheskaya Street
Minsk 220072 Belarus
Tel.: +375 297706871
Email:

Brazil

4. Ms. Luciana Pimenta Ambrozevicius
Ministry of Agriculture, Livestock and Food Supply
Vila Gianetti, 38
Campus DA VFV Vicosa
CEP 36570-000
Brazil
Tel.: +55-31-3899 2722
Email:

Bulgaria

5. Mr. Nikolay Tzvetkov
Senior Expert on GMOs
Biodiversity Department, National Nature Protection
Ministry of Environment and Water
22 Maria Luisa Blvd.
Sofia 1000
Bulgaria
Tel.: +359 29406123
Fax: +359 29406127
Email: n
n

Canada

6. Mr. James Louter
Manager, Biotechnology Section, Science and Technology Branch
Environment and Climate Change Canada
Place Vincent Massey, Annex 6th Floor
351 St Joseph Blvd
Gatineau, QC, K1A 0H3
Canada
Tel.: +1 819 938 5057
Email:

China

7. Mr. Yongbo Liu
Institute of Ecology
Chinese Research Academy of Environmental Sciences
8 Dayangfang Beiyuan Road Chaoyang District
Beijing 100012
China
Tel.: +86 10 84910906
Email: l

Cuba

8. Mr. Lazaro Regalado
Department of Authorizations, National Centre for Biological Safety, Office of Environmental Regulation and Nuclear Safety
Ministerio de Ciencia, Tecnología y Medio Ambiente
Calle 28 No 502 e/5ta y 7ma, Miramar Playa
Havana 11300 Cuba
Tel.: +53 7 2023281
Email:

Ecuador

9. Ms. Maria de Lourdes Torres
Director of Biotechnology Center
Universidad San Francisco Quito
Francisco Salazar 360 y Coruña Complejo Vistaleste, Casa 5
Quito Pichincha
Ecuador
Tel.: +593 9 99826522; +593 2 2971746
Fax: +593 2 289 0070
Email:

Estonia

10. Mr. Mart Loog
Institute of Technology, University of Tartu
Nooruse 1
Tartu 50411
Estonia
Tel.: +372 5175698
Email:

Ethiopia

11. Mr. Taye Birhanu
Genetic Resource Access & Benefit Sharing Directorate
Ethiopian Biodiversity Institute
Kebena Road
P.O. Box 30726, Addis Ababa
Ethiopia
Tel.: +251- 116512028; +251-918812388
Email:

European Union

12. Ms. Ilaria Ciabatti
DG Sante
European Commission
Brussels
Belgium
Tel.: +32 22967452
Email:

Germany

13. Ms. Margret Engelhard
Integrated Nature Conservation and Sustainable Use, GMO Regulation
Federal Agency for Nature Conservation (Bonn)
Konstantinstrasse 110
Bonn 53179
Germany
Tel.: +49 228 84911860
Email:

Ghana

14. Mr. Peter Kwapong
Department of Conservation, Biology and Entomology, School of Biological Sciences, College of Agriculture and Natural Sciences
Department of Entomology and Wildlife
University of Cape Coast
Cape Coast
Ghana
Tel.: +233209764697
Email:

India

15. Mr. Syed Shams Yazdani
Synthetic Biology and Biofuels Group
International Centre for Genetic Engineering and Biotechnology
Aruna Asaf Ali Marg
New Delhi 110067
India
Tel.: +919818992403; +91 11 26742357 ext 460
Fax: +91 11 26742316
Email:

Japan

16. Mr. Ryo Kohsaka
Professor
Graduate School of Environmental Studies
Tohoku University
468-1 Aramaki Aoba-ku, Sendai, 980-0845
Japan
Tel.: 81-76-264-5508
Fax: 81-76-234-4100
Email:

Kenya

17. Mr. Benson Mburu Kinyagia
National Commission for Science, Technology and Innovation
Ministry of Education, Science and Technology
Biological Science Department
P.O BOX 30623, Nairobi 100
Kenya
Email:

Madagascar

18. Mr. Jean Roger Rakotoarijaona
Directeur des Informations environnementales
Office National pour l'Environnement
BP. 822, Antaninarenina
Antananarivo101
Madagascar
Tel.: +261 20 22 259 99
Fax: +261 20 22 206 93
Email:

Mexico

19. Ms. Maria Andrea Orjuela Restrepo
Coordinación de Análisis de Riesgo y Bioseguridad
Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO)
Mexico DF
Mexico
Tel.: +525550043165
Fax: +525567085427
Email:
c

Namibia

20. Mr. Filemon Nghitilanganye Shindume
Agricultural Scientific Officer
Ministry of Agriculture, Water and Forestry
Luther Street, Government Office Park
Private Bag 13184
Windhoek
Namibia
Tel.: +264 61 2087074
Fax: +264 61 2087038
Email:

Netherlands

21. Ms. Boet Glandorf
GMO Office, dept. of Gene Technology and Biological Safety
National Institute of Public Health and Environment
Antonie van Leeuwenhoeklaan 9, PO Box 1
Bilthoven 3720 BA
Netherlands
Tel.: 31646860741
Email:

Norway

22. Mr. Casper Linnestad
Senior Adviser
Ministry of Climate and Environment
P.O. Box 8013 DEP. Kongens GT.20
Oslo N-0030
Norway
Tel.: +47 22 24 58 95
Email:

Pakistan

23. Ms. Romana Iftikhar
National Institute for Biotechnology and Genetic Engineering
Government College Women University
University Road, Sargodha
Faisalabad, 38000
Pakistan
Tel.: 0092 335 0061689
Email:

Philippines

24. Mr. Elpidio Peria
Legal Advisor on Access and Benefit Sharing
Biodiversity Management Bureau
Department of Environment and Natural Resources
Quezon Avenue, Diliman
Quezon City 1104
Philippines
Tel.: +632 922 6710/433 7182, 433 2067
Fax: +632 922 6710
Email:

Republic of Moldova

25. Ms. Angela Lozan
Head of Biosafety Office
Ministry of Environment
9, Cosmonautilo Str.
Chisinau, MD-2005
Republic of Moldova
Tel.: +373 22 226874
Fax: +373 22 226874
Email:

Slovakia

26. Ms. Zuzana Sekeyova
Senior Scientist, Expert on Synbio
Laboratory for Diagnosis and Prevention of Rickettsial and Chlamydial Infections, Department of Rickettsiology
Biomedical Research Center
Institute of Virology, Slovak Academy of Sciences
Dubravska cesta 9
Bratislava 84505
Slovakia
Tel.: +421259302433
Email:

Slovenia

27. Mr. Martin Batic
Head of Biotechnology Unit
Ministry of Environment and Spatial Planning
Dunajska 48
Ljubljana 1000
Slovenia
Tel.: +386 1 478 7402
Fax: +386 1 478 7425
Email:

Thailand

28. Ms. Chalinee Kongsawat
Manager, Biosafety Section
National Center for Genetic Engineering and Biotechnology, National Science and Technology Development Agency
Ministry of Science and Technology
113 Thailand Science Park, Phaholyothin Road, Klong Luang
Pathum Thani 12120
Thailand
Tel.: 662 564 6700
Fax: 662 564 6703
Email:

Other Governments

United States of America

29. Ms. Jennifer Shinen
Life Science Specialist
Office of Conservation and Water
Bureau of Oceans, International Environmental and Scientific Affairs
U.S. Department of State
2201 C Street N.W.
Washington DC 20520-4333
United States of America
Tel.: +1 202 647 6811
Email: shinenjl@state.gov

Indigenous Peoples and Local Community Organizations

Indigenous Knowledge and Peoples Network (IKAP)

30. Mr. Kamal Kumar Rai
Chair Person
IPs Kirant Sampang Association
Indigenous Knowledge and Peoples Network
P.O. Box 12476
Kathmandu
Nepal
Tel.: +977-9841322054
Email:

Andes Chinchasuyo

31. Ms. Maria Yolanda Terán Maigua
Coordinadora de Educación y Cultura
Avenida Real Audiencia y de los Cerezos,
Barcino 1
Pasaje C, Casa #12
Quito, Ecuador
Tel.: 1-505- 242 35 42
Email:

Organizations

Canadian Friends Service Committee (Quakers) (CFSC)

32. Mr. Frederic Bass
Canadian Friends Service Committee (Quakers)
Consultant in Preventive Medicine
#307-6026 Tisdall Street
Vancouver, BC, V5Z 3N3
Canada
Tel.: +1 604 559-7143; +604 657 1481
Email:

ETC Group

33. Mr. Jim Thomas
Co-Executive Director
ETC Group
1262 Chemin de la Rivière
Val-David, QC, J0T 2N0
Canada
Tel.: +1 514-5165759; +1 819 322 5627
Email:

Federation of German Scientists

34. Ms. Ricarda Steinbrecher
Working Group on Agriculture and Biodiversity, including Biotechnology
Federation of German Scientists
P.O. Box 1455
Oxford OX4 9BS
United Kingdom of Great Britain and
Northern Ireland
Tel.: +44 1 865 724 951
Email:

J. Craig Venter Institute (JCVI)

35. Mr. Robert M. Friedman
Vice President for Public Policy
J. Craig Venter Institute
4120 Capricorn Lane
La Jolla, CA 92037
United States of America
Tel.: +1 858 200 1810
Email:

Public Research and Regulation Initiative (PRRI)

36. Ms. Lucia de Souza
Executive Secretary
ANBio
Public Research and Regulation Initiative
IIC/Ugent
Technologiepark 3B
9052 Zwijnaarde, Belgium
Tel.: +41792074659
Email:

Third World Network (TWN)

37. Ms. Li Ching Lim
Researcher
Third World Network
B-05-03, 3 Two Square, No. 2, Jalan 19/1
Petaling Jaya, 46300
Malaysia
Tel.: +603 7955 5220
Fax: +603 7955 3220
Email:

European Association for Bioindustries

38. Ms. Ana Atanassova
EUROPABIO
European Association for Bioindustries
Avenue de l'Armée 6
Brussels 1040
Belgium
Tel.: 32 (0) 9 250 83 44
Email:

European Network of Scientists for Social Environmental Responsibility (ENSSER)

39. Christoph Then
Biosafety Expert
European Network of Scientists for Social Environmental Responsibility
Frohschammerstr 14
München 80807
Germany
Tel.: + 49 151 54638040
Email:

The Royal Society

40. Mr. Paul Freemont
The Royal Society
6-9 Carlton House Terrace
London SW1Y 5AG
United Kingdom of Great Britain and
Northern Ireland
Tel.: 2075945327
Email:

NC State University

41. Mr. Todd Kuiken
Senior Research Scholar
Genetic Engineering and Society Center
NC State University
Campus Box 7565
Raleigh, North Carolina, 27695-7565
United States of America
Tel.: +1 919 515 2593

SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY

42. Ms. Manoela Miranda
Biosafety Division
Secretariat of the Convention on Biological Diversity
413 St. Jacques Street, Suite 800
Montréal, QC, H2Y 1N9
Canada
Tel.: +1 514 764 6355
Fax: +1 514 288 6588
E-mail:

43. Ms. Dina Abdelhakim
Biosafety Division
Secretariat of the Convention on Biological Diversity
413 St. Jacques Street, Suite 800
Montréal, QC, H2Y 1N9
Canada
Tel.: +1 514 287 8703
Fax: +1 514 288 6588
E-mail:

44. Ms. Melissa Willey
Biosafety Division
Secretariat of the Convention on Biological Diversity
413 St. Jacques Street, Suite 800
Montréal, QC, H2Y 1N9
Canada
Tel.: +1 514 287 6689
Fax: +1 514 288 6588
E-mail:

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Annex

TEMPLATE FOR COMMENTS ON THE REPORT OF THE AD HOC TECHNICAL EXPERT GROUP ON SYNTHETIC BIOLOGY

Contact information:	
Surname:	
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(if applicable):	
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Comments on the draft documentation for SBSTTA-21:		
Page #	**Para #**	**Comment**
0	0	This is an example of an entry of a general comment
3	6	This is an example of a specific comment on Page 3, Paragraph (or line) 6
		Additional rows can be added to this table by selecting “Table” followed by “insert” and “rows below”

From: Philip Seddon
Subject: [Geneticrescue] Reintroduction Conference Nov 2018
Date: January 25, 2018 at 6:19:20 PM CST
To: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>

The 2nd International Wildlife Reintroduction Conference will be held at Lincoln Park Zoo, Nov 13-16 2018

Among the topics to be convered are several of potential interest to those involved in all aspects of the restoration of species, including ecosystem effects, social values and cultural contexts, and future opportunities.

https://www.reintro.org/

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****

Prof. Philip Seddon
Director / Kaiwhakahaere
Postgraduate Wildlife Management Programme
Department of Zoology / Te Tari o Mātai Kararehe
University of Otago / Te Whare Wānanga o Otāgo
Dunedin / Ōtepoti
New Zealand / Aotearoa

Postal: Department of Zoology, P.O. Box 56, Dunedin 9054
Courier: 340 Great King Street, Dunedin 9016
Phone: +64-3-479-7029
Fax: +64-3-479-7584

Research and Teaching
http://www.otago.ac.nz/Zoology/staff/otago008934.html

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IUCN/SSC Re-introduction Specialist Group
http://www.iucnsscrsg.org/organization_structure.php

New publication
De-extinction and Barriers to New Conservation Tools
free download from:
http://onlinelibrary.wiley.com/doi/10.1002/hast.745/abstract

Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

FOR IMMEDIATE RELEASE
EDITOR'S NOTE: Photos and captions available for download **HERE.**

Lincoln Park Zoo Hosts Second International Wildlife Reintroduction Conference

Zoo Partners with International Union for the Conservation of Nature to Save Species

Chicago (January 11, 2018) – Lincoln Park Zoo in partnership with the International Union for the Conservation of Nature's (IUCN) Reintroduction Specialist Group (RSG) will host the 2nd International Wildlife Reintroduction Conference from Nov. 13-16, 2018. After a successful conference at the zoo in 2008, reintroduction biologists and managers from around the globe will again convene in Chicago to share information, triumphs and tribulations from experiences restoring wildlife back into the wild.

From deep sea coral to green-winged macaws, reintroduction biologists are tirelessly working to restore native populations of endangered wildlife. Many wildlife populations throughout the world are experiencing dramatic declines in size or are already extirpated in what scientists have deemed the sixth mass extinction. An established conservation strategy to enhance the restoration of locally extinct populations is the reintroduction of in-situ and ex-situ animals.

"This is a challenging time for many species," said Lincoln Park Zoo's Executive Vice President Megan Ross, Ph.D., "Lincoln Park Zoo is excited to gather the greatest minds in reintroduction science to discuss how we can best increase our impact to preserve the natural world"

The second International Wildlife Reintroduction Conference will bring together top experts in the field to focus on the evolving science of reintroduction and discuss "lessons learned," identify scientific processes that improve effectiveness and build a culture of innovation of theoretical and applied research on wildlife reintroduction and other conservation translocations.

"The health of the natural world depends on us, as much as we depend on it," said University of Otago Prof. and Chair of the Conference's Scientific Advisory Group, Phil Seddon "By developing the science and the practice of reintroduction biology we can restore lost species and the ecosystems in which they live."

While there have been several high-profile successful reintroductions over the past decades including Puerto Rican parrots, California condors, black-footed ferrets and golden lion tamarins, wildlife reintroduction is inherently challenging. More than 40 speakers, including many notable wildlife experts, will present new research findings to foster collaborations and improve the success rates of future reintroduction programs.

Keynotes for the 2018 conference include renowned conservationists including the original founder of the Reintroduction Specialist Group **Mark Stanley Price, Ph.D.** who successfully reintroduced Arabian oryx to their native habitat after being extinct in the wild for 20 years. Indianapolis Prize winner **Prof. Carl Jones**, who is credited with bringing several species native to the Isle of Mauritius and Rodrigues Island back from the brink of extinction, including the Mauritius kestrel, pink pigeon, echo parakeet, Mauritius fody, Rodrigues warbler, Rodrigues fody, and Rodrigues fruit bat. Western Australia's Scientist of the Year winner for 2011, **Prof. Richard Hobbs** who has contributed extensively to the areas of vegetation dynamics and management, ecosystem fragmentation, rehabilitation, and restoration as well as landscape ecology.

The International Wildlife Reintroduction Conference runs Nov. 13-16 at Lincoln Park Zoo in Chicago. Registration is now open at www.reintro.org with entry beginning at $450 for students and $650 for professionals. A pre-conference workshop "IUCN Reintroduction Specialist Group Training for Effective Conservation Translocations" will take place Nov. 10-13 with limited entry and separate registration ($500).

The International Wildlife Reintroduction Conference is also made possible by Calgary Zoo and Saint Louis Zoo.

###

Media Contacts:	**Jillian Braun** **312-742-5791** **JBraun@lpzoo.org**	**Emily Altimari** **312-742-2236** **EAltimari@lpzoo.org**

ABOUT LINCOLN PARK ZOO

Lincoln Park Zoo inspires communities to create environments where wildlife will thrive in our urbanizing world. The zoo is a leader in local and global conservation, animal care and welfare, learning, and science. A historic Chicago landmark founded in 1868, the not-for-profit Lincoln Park Zoo, is a privately-managed, member-supported organization and is free and open 365 days a year. Visit us at lpzoo.org.

From: Ryan Phelan
Subject: [Geneticrescue] Should some species be allowed to die out?
Date: March 18, 2018 at 11:39:50 PM CDT
To: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>

https://www.nytimes.com/2018/03/13/magazine/should-some-species-be-allowed-to-die-out.html

As the list of endangered animals worldwide grows longer, society may soon be faced with an impossible decision: which ones to take off life support.

By JENNIFER KAHNMARCH 13, 2018

> .....Whether we regard conservation as an ethical or an economic issue, we're still faced with the question of how we decide what to save. In an ideal world, Michael Scott told me, conservation science would have the resources to study this question, rather than being stuck reacting to the latest crisis. "Figuring out which species and ecosystems are the most important to protect is a complicated project," Scott says. "At this point, just coming up with a list of qualities we want to investigate would be a good start."
>
> But for such an approach to take hold, the conservation movement would have to undergo a profound shift — away from triage mode and toward a more coherent and deliberate plan for global conservation. And such a shift would most likely require more resources and more political support than currently exist. The question is whether it will happen in time to shelter us from some of the more significant changes that climate change and development are likely to bring."

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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: Ryan Phelan
Subject: [Geneticrescue] Why the High-Tech Plan to Bring Back the Northern White Rhino Matters
Date: March 28, 2018 at 12:19:20 PM CDT
To: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>

Thoughtful piece with input from Oliver Ryder and Barbara Durant at SDZG — and some good news here on NWR genetic diversity :

"...Excitingly, DNA sequencing has revealed a high level of genetic diversity within the last northern whites—"as much or more" than what is contained in the entire 20,000-strong population of southern white rhinos, according to Barbara Durant, a biologist at the San Diego Zoo who is leading assisted reproduction efforts for the project."

https://earther.com/why-the-high-tech-plan-to-bring-back-the-northern-white-1823912420

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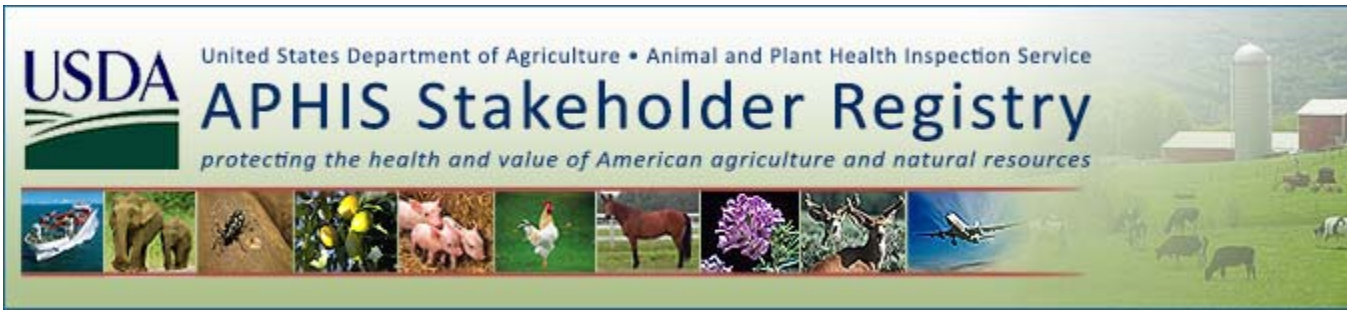
Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: Ryan Phelan <
Subject: [Geneticrescue] U.S. Department of Agriculture's (USDA) oversight of plants produced through genome-editing
Date: March 28, 2018 at 9:55:51 PM CDT
To: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>
Cc: "William A. Powell"

Seems like good news here at first glance. Eager to hear what others think about this announcement today?



(Washington, D.C., March 28, 2018) – U.S. Secretary of Agriculture Sonny Perdue today issued a statement providing clarification on the U.S. Department of Agriculture's (USDA) oversight of plants produced through innovative new breeding techniques which include techniques called genome editing.

Under its biotechnology regulations, USDA does not regulate or have any plans to regulate plants that could otherwise have been developed through traditional breeding techniques as long as they are not plant pests or developed using plant pests. This includes a set of new techniques that are increasingly being used by plant breeders to produce new plant varieties that are indistinguishable from those developed through traditional breeding methods. The newest of these methods, such as genome editing, expand traditional plant breeding tools because they can introduce new plant traits more quickly and precisely, potentially saving years or even decades in bringing needed new varieties to farmers.
"With this approach, USDA seeks to allow innovation when there is no risk present," said Secretary Perdue. "At the same time, I want to be clear to consumers that we will not be stepping away from our regulatory responsibilities. While these crops do not require regulatory oversight, we do have an important role to play in protecting plant health by evaluating products developed using modern biotechnology. This is a role USDA has played for more than 30 years, and one I will continue to take very seriously, as we work to modernize our technology-focused regulations."

"Plant breeding innovation holds enormous promise for helping protect crops against drought and diseases while increasing nutritional value and eliminating allergens," Perdue said. "Using this science, farmers can continue to meet consumer expectations for healthful, affordable food produced in a manner that consumes fewer natural resources. This new innovation will help farmers do what we aspire to do at USDA: do right and feed everyone."
USDA is one of three federal agencies which regulate products of food and agricultural technology. Together, USDA, the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA) have a Coordinated Framework for the Regulation of Biotechnology that ensures these products are safe for the environment and human health. USDA's regulations focus on protecting plant health; FDA oversees food and feed safety; and EPA regulates the sale, distribution, and testing of pesticides in order to protect human health and the environment.
USDA continues to coordinate closely with its EPA and FDA partners to fulfill oversight responsibilities and provide the appropriate regulatory environment. This ensures the safety of products derived from new technologies, while fostering innovation at the same time.

USDA Statement Regarding Plant Breeding Innovations

USDA is committed to helping farmers produce healthy, affordable food in a sustainable manner that protects this country's natural resources and offers more choices for consumers. Through innovative methods, plant scientists can now create new plant varieties that are indistinguishable from those developed through traditional breeding methods. These new approaches to plant breeding include methods like genome editing and present tremendous opportunities for farmers and consumers alike by making available plants with traits that may protect crops against threats like drought and diseases, increase nutritional value, and eliminate allergens.
In keeping with our responsibility to protect plant health, USDA has carefully reviewed products of these new technologies to determine whether they require regulatory oversight.
As USDA works to modernize its biotechnology regulations, the vision and direction of this Department will be to continue to focus regulatory initiatives on the basis of risk to plant health.
Under its biotechnology regulations, USDA does not currently regulate, or have any plans to regulate plants that could otherwise have been developed through traditional breeding techniques as long as they are developed without the use of a plant pest as the donor or vector and they are not themselves plant pests. This can include plant varieties with the following changes:

- **Deletions—**the change to the plant is solely a genetic deletion of any size.
- **Single base pair substitutions**—the change to the plant is a single base pair substitution.
- **Insertions from compatible plant relatives**—the change to the plant solely introduces nucleic acid sequences from a compatible relative that could otherwise cross with the recipient organism and produce viable progeny through traditional breeding.
- **Complete Null Segregants**—off-spring of a genetically engineered plant that does not retain the change of its parent.

USDA will continue working with other Executive Branch Departments, our domestic stakeholders, trading partners and international organizations to advance this science-based and practical approach that protects plant health while allowing for technological advancements in accordance with the Report of the Interagency Task Force on Agriculture and Rural Prosperity.
You are subscribed to BRS - Press releases, stakeholder announcements, factsheets, Q&A's, brochures, etc. for USDA Animal and Plant Health Inspection Service. This information has recently been updated, and is now available.

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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy

Texas A&M University
4237 TAMU
College Station
TX 77843-4237

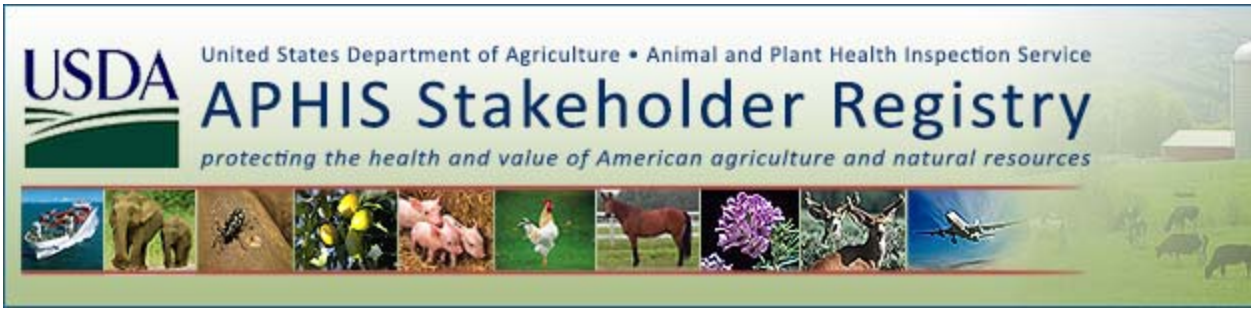
c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: Brad Stanback
Subject: Re: [Geneticrescue] U.S. Department of Agriculture's (USDA) oversight of plants produced through genome-editing
Date: March 29, 2018 at 10:03:24 AM CDT
To: Ryan Phelan
Cc: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>, William Powell

Bill Powell gave us an update on this process at our American Chestnut Foundation board meeting last week.
My reading of this is that it doesn't quite cover the case of Bill's transgenic chestnut, but I'd be interested to hear Bill's take on it.
Brad Stanback

On Mar 28, 2018, at 10:55 PM, Ryan Phelan wrote:

Seems like good news here at first glance. Eager to hear what others think about this announcement today?



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"With this approach, USDA seeks to allow innovation when there is no risk present," said Secretary Perdue. "At the same time, I want to be clear to consumers that we will not be stepping away from our regulatory responsibilities. While these crops do not require regulatory oversight, we do have an important role to play in protecting plant health by evaluating products developed using modern biotechnology. This is a role USDA has played for more than 30 years, and one I will continue to take very seriously, as we work to modernize our technology-focused regulations."

"Plant breeding innovation holds enormous promise for helping protect crops against drought and diseases while increasing nutritional value and eliminating allergens," Perdue said. "Using this science, farmers can continue to meet consumer expectations for healthful, affordable food produced in a manner that consumes fewer natural resources. This new innovation will help farmers do what we aspire to do at USDA: do right and feed everyone."

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In keeping with our responsibility to protect plant health, USDA has carefully reviewed products of these new technologies to determine whether they require regulatory oversight.

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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

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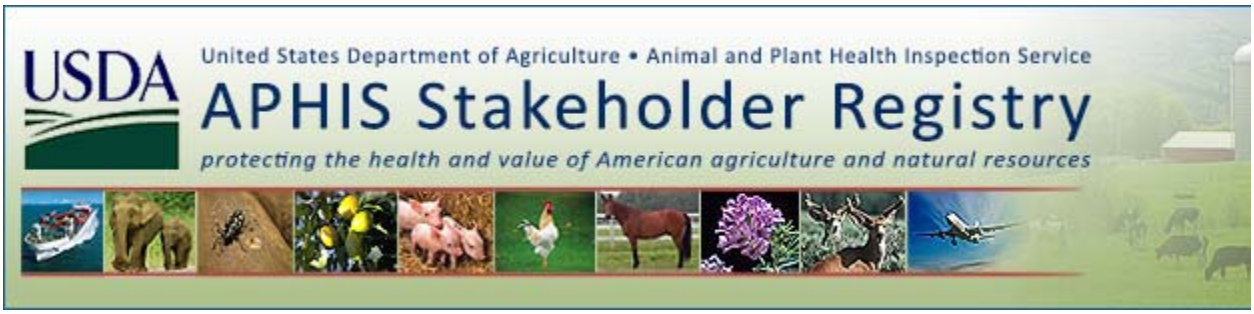
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: "William A. Powell"
Subject: [Geneticrescue] Re: U.S. Department of Agriculture's (USDA) oversight of plants produced through genome-editing
Date: March 29, 2018 at 10:17:33 AM CDT
To: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>

This is a good first step and we should welcome it. But this still leaves out the most useful tools of transgenics. Hopefully at some point they will realize that genetic engineering done properly can have less risks than many traditional breeding methods such as hybrid breeding and mutational breeding that make larger scale, and mostly unknown, changes to the plant's genome.
Just my two cents worth,
Bill

On Mar 28, 2018, at 10:52 PM, Ryan Phelan wrote:

> Seems like good news here at first glance. Eager to hear what others think about this announcement today?



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Department of Philosophy
Texas A&M University
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TX 77843-4237

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Office phone: 1-979-862-1435
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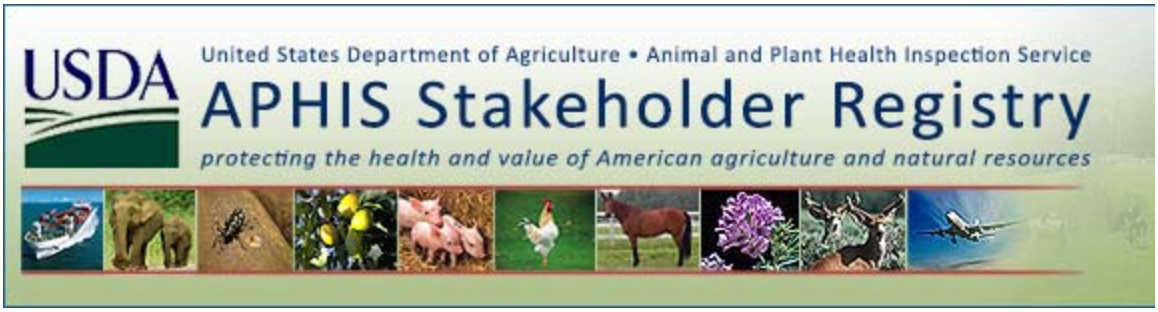
From: "William A. Powell" <
of Agriculture's (USDA) oversight of plants produced through genome-editing
Date: March 29, 2018 at 10:34:47 AM CDT
To: Brad Stanback <
Cc: Ryan Phelan "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>

Hi Brad,
This doesn't cover our current trees, but it will influence our future research.
Cheers,
Bill

On Mar 29, 2018, at 11:03 AM, Brad Stanback > wrote:

> Bill Powell gave us an update on this process at our American Chestnut Foundation board meeting last week.
> My reading of this is that it doesn't quite cover the case of Bill's transgenic chestnut, but I'd be interested to hear Bill's take on it.
> Brad Stanback
>
> > On Mar 28, 2018, at 10:55 PM, Ryan Phelan > wrote:
> >
> > Seems like good news here at first glance. Eager to hear what others think about this announcement today?



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Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: Tierney Thys
Subject: [Geneticrescue] Coral reef refresh
Date: March 29, 2018 at 12:20:16 PM CDT
To: geneticrescue@reviverestore.org

The economist had a useful review of the recent and growing efforts afoot to save coral reefs which include bolstering microbiome immune systems and breeding in genetic robustness to combat increasing temps and dropping pH.
https://www.economist.com/news/science-and-technology/21738871-selective-breeding-and-genetic-engineering-are-both-possibilities-mass-die-offs

Sent from my iPhone

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YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: Stewart Brand >
Subject: Re: [Geneticrescue] Reversing Americas Wildlife Crisis report attached
Date: March 30, 2018 at 2:14:14 PM CDT
To: Mike Kjelland <
Cc: Ryan Phelan < >, Genetic Rescue listserv <geneticrescue@reviverestore.org>

Good report. Good emphasis on things to do.

—Stewart

On Mar 30, 2018, at 7:13 AM, Mike Kjelland < > wrote:

Hi! I came across this report by the National Wildlife Federation (NWF), American Fisheries Society (AFS), and The Wildlife Society (TWS) yesterday. I think it provides a good overview of what is happening right here in the USA concerning biodiversity and habitat loss. For example, "...researchers estimate that approximately half of the world's wild animals have been lost over the past 40 years.[17] These sobering global trends are evident here in the United States as well....."

Notably, the NWF calls for more funding to be allocated for conservation efforts.

Have a good weekend!

Mike

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<Reversing-Americas-Wildlife-Crisis.pdf>

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From: Ryan Phelan
Subject: [Geneticrescue] Please Welcome Aboard — New Genetic Rescue Listserv Participants
Date: April 2, 2018 at 8:01:28 PM CDT
To: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>

Please welcome aboard our new Genetic Rescue Listserv participants:

Jeak Ling Ding – Professor, Department of Biological Science, National University of Singapore (developed the Recombinant Factor C alternative to horseshoe crab blood (rFC)

Emma Marris – Freelance writer and Institute Fellow at the UCLA Institute of the Environment and Sustainability

Edward Perello – Revive & Restore consultant; Research Fellow at George Mason University; Co-Founder of Desktop Genetics

Paul Sisco – Former staff geneticist with The American Chestnut Foundation

Kevin Williams – Senior Scientist, Research and Development, HyGlos

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From: Ryan Phelan <
Subject: [Geneticrescue] Provocative article by Emma Marris on de-extinction
Date: April 2, 2018 at 8:07:21 PM CDT
To: "geneticrescue@reviverestore.org" <geneticrescue@reviverestore.org>

An Analysis of Potential Ethical Justifications for Mammoth De-extinction And a Call for Empirical Research
Yasha Rohwer & Emma Marris

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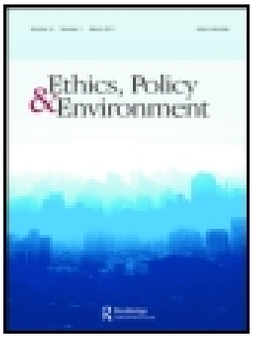

Ethics, Policy & Environment

ISSN: 2155-0085 (Print) 2155-0093 (Online) Journal homepage: http://www.tandfonline.com/loi/cepe21

An Analysis of Potential Ethical Justifications for Mammoth De-extinction And a Call for Empirical Research

Yasha Rohwer & Emma Marris

To cite this article: Yasha Rohwer & Emma Marris (2018): An Analysis of Potential Ethical Justifications for Mammoth De-extinction And a Call for Empirical Research, Ethics, Policy & Environment, DOI: 10.1080/21550085.2018.1448043

To link to this article: https://doi.org/10.1080/21550085.2018.1448043

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From: Stewart Brand
Subject: Re: [Geneticrescue] Please Welcome Aboard — New Genetic Rescue Listserv Participants
Date: April 2, 2018 at 8:50:09 PM CDT
To: Ryan Phelan
Cc: Genetic Rescue listserv <geneticrescue@reviverestore.org>

Thanks for enriching this etheric ecosystem, you five.

—Stewart

On Apr 2, 2018, at 6:01 PM, Ryan Phelan wrote:

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From: Stewart Brand <
Subject: [Geneticrescue] Interesting piece on Northern White Rhino
Date: April 7, 2018 at 7:27:51 PM CDT
To: Genetic Rescue listserv <geneticrescue@reviverestore.org>

New twist: it's not okay to play God, but it's okay to play Noah.

https://www.theverge.com/2018/4/6/17175936/northern-white-rhino-de-extinction-stem-cells-sudan

—Stewart

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From: Jeanne Loring
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino
Date: April 7, 2018 at 7:29:48 PM CDT
To: Stewart Brand <
Cc: Genetic Rescue listserv <geneticrescue@reviverestore.org>

I think this is one of the better pieces I've seen.

Jeanne

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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458

From: Gareth Sullivan
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino
Date: April 8, 2018 at 3:26:08 AM CDT
To: Jeanne Loring >, Stewart Brand
Cc: Genetic Rescue listserv <geneticrescue@reviverestore.org>

Yes I agree with Jeanne,
this is not a bad perspective!
best
gareth

From: Jeanne Loring
Sent: 08 April 2018 02:29
To: Stewart Brand
Cc: Genetic Rescue listserv
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino

I think this is one of the better pieces I've seen.

Jeanne

> On Apr 7, 2018, at 5:27 PM, Stewart Brand > wrote:
>
> New twist: it's not okay to play God, but it's okay to play Noah.
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> https://www.theverge.com/2018/4/6/17175936/northern-white-rhino-de-extinction-stem-cells-sudan
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From: True Nature Foundation >
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino
Date: April 8, 2018 at 4:19:41 AM CDT
To: Gareth Sullivan
Cc: Jeanne Loring , Stewart Brand Genetic Rescue listserv <geneticrescue@reviverestore.org>

Sure hope they also collected semen from the testicles and apply ovum pickup on the last two female NWR.
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Best wishes,

Henri

Op zo 8 apr. 2018 10:26 schreef Gareth Sullivan <g :

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> gareth
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> **Sent:** 08 April 2018 02:29
> **To:** Stewart Brand
> **Cc:** Genetic Rescue listserv
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Begin forwarded message:

From: Hank Greely < >
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino
Date: April 8, 2018 at 4:59:44 AM CDT
To: Jeanne Loring < >
Cc: Hank Greely >, Stewart Brand , Genetic Rescue listserv <geneticrescue@reviverestore.org>

Ah, I love reporters. I spoke a long time with this one, a good conversation, I thought. She asked me about the cost ("$9 million!" seemed a Dr. Evil moment) and I went on at some length about how it depends on where the money comes from and what it would otherwise be doing. She asked me about the expenditure in light of the uncertainty and I said that's true in all science, giving pharma as just one example. And that's what she quoted, setting me up for "well, looking for life saving drugs is different from messing around with de-extinction, isn't it?" responses.

Oh well. Apart from that personal annoyance, I thought it was a decent piece.

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>
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From: Mike Kjelland
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino
Date: April 8, 2018 at 11:02:42 AM CDT
To: True Nature Foundation , Gareth Sullivan

Cc: Jeanne Loring < , Stewart Brand "Genetic Rescue listserv" <geneticrescue@reviverestore.org>

I enjoyed reading that! I have a few questions as a result. If 15 oocytes could be procured from each of the existing females, I would think that the best thing to do would be to make embryos and do the transfers into synchronized SWRs without cryopreserving any of the eggs or embryos. However, that does not seem likely given the current assisted reproduction capabilities for any rhinoceros species. If the IVF/IVP system for rhinoceros has not been well developed then one could do a gamete intrafallopian transfer (GIFT) using a SWR recipient, and perhaps get better embryo production results. I have assisted doing this using goats as recips. for White-tailed deer (WTD) embryo production, and flushing those deer once later stage embryos are produced for subsequent ET into WTD. Or even better, Mule deer embryos produced in a similar manner, transferred into WTD and getting offspring, which has been done (but not published). Sure, deer and goats aren't rhinos, but I am just using that as an example of what could be done. However, if nobody has successfully done something similar with Rhino, then it sounds like a good experiment for someone to try. If the IVF/IVP and cryopreservation of rhino embryos is up and running with good results, then maybe fresh embryo production without cryopreservation isn't worth doing. Then, the next best option would be to cryopreserve any embryos that are produced from the oocytes of these two females. Has anyone successfully produced Rhino embryos, specifically morula or blastocyst stage embryos which would like;y give the highest post-thaw viability? I have not read about that but perhaps it has been done. Has anyone successfully cryopreserved immature or matured rhino eggs before, and if so with what post-thaw viability and embryo production success rates?

It would be great to have a network of zoos, reserves, and game farms established so that whenever a rhino dies, and of any rhino species, they are trained to collect the ovaries and overnight them to a lab that can perform this research. Maybe that exists now with the San Diego Zoo and I am just not aware of it?

Kind regards,

Mike

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From: True Nature Foundation <
Sent: Sunday, April 8, 2018 9:19 AM
To: Gareth Sullivan
Cc: Jeanne Loring; Stewart Brand; Genetic Rescue listserv
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino

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Best wishes,

Henri

Op zo 8 apr. 2018 10:26 schreef Gareth Sullivan < :

> Yes I agree with Jeanne,
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> **From:** Jeanne Loring
> **Sent:** 08 April 2018 02:29
> **To:** Stewart Brand
> **Cc:** Genetic Rescue listserv
> **Subject:** Re: [Geneticrescue] Interesting piece on Northern White Rhino
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Begin forwarded message:

From: Oliver Ryder
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino
Date: April 9, 2018 at 3:24:56 PM CDT
To: Mike Kjelland < True Nature Foundation >, Gareth Sullivan <
Cc: Jeanne Loring , Stewart Brand , Genetic Rescue listserv <geneticrescue@reviverestore.org>

Mike,

I can try to briefly address at least some of your questions. The pertinent reference is the open access publication:

Saragusty J, Diecke S, Drukker M, Durrant B, Friedrich Ben-Nun I, Galli C, Göritz F, Hayashi K, Hermes R, Holtze S, Johnson S, Lazzari G, Loi P, Loring JF, Okita K, Renfree MB, Seet S, Voracek T, Stejskal J, Ryder OA, Hildebrandt TB.
Rewinding the process of mammalian extinction. Zoo Biology 2016 May 3. doi:10.1002/zoo.21284

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Were any NWR ova to be obtained, they should probably be matured, fertilized - likely by ICSI - and frozen for future use.

There has been limited success at maturing and fertilizing rhino ova so far. But again, the necessary procedures are under development.

Efforts are underway to produce gametes in vitro using stem cell technology, but these are in the early stages.

Efforts are in place to collect white rhino samples and rapidly ship them to suitable labs. For reasons of timing, these efforts need to be organized within countries (or the EU), because CITES restrictions basically make it impossible to transfer samples sufficiently rapidly. San Diego Zoo has a network in place, as does the Institute of Wildlife Research in Berlin.

These are my personal comments and views, meant for this list-serve only. Any omissions or inacuracies are mine.

Oliver

Oliver A. Ryder, PhD
Kleberg Endowed Chair of Conservation Genetics
San Diego Zoo Institute for Conservation Research
15600 San Pasqual Valley Road
Escondido, CA 92027
ph: 760 291-5452
institute.sandiegozoo.org
Saving plants and animals worldwide

From: Mike Kjelland >
Sent: Sunday, April 8, 2018 9:02:42 AM
To: True Nature Foundation; Gareth Sullivan
Cc: Jeanne Loring; Stewart Brand; Genetic Rescue listserv
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino

I enjoyed reading that! I have a few questions as a result. If 15 oocytes could be procured from each of the existing females, I would think that the best thing to do would be to make embryos and do the transfers into synchronized SWRs without cryopreserving any of the eggs or embryos. However, that does not seem likely given the current assisted reproduction capabilities for any rhinoceros species. If the IVF/IVP system for rhinoceros has not been well developed then one could do a gamete intrafallopian transfer (GIFT) using a SWR recipient, and perhaps get better embryo production results. I have assisted doing this using goats as recips. for White-tailed deer (WTD) embryo production, and flushing those deer once later stage embryos are produced for subsequent ET into WTD. Or even better, Mule deer embryos produced in a similar manner, transferred into WTD and getting offspring, which has been done (but not published). Sure, deer and goats aren't rhinos, but I am just using that as an example of what could be done. However, if nobody has successfully done something similar with Rhino, then it sounds like a good experiment for someone to try. If the IVF/IVP and cryopreservation of rhino embryos is up and running with good results, then maybe fresh embryo production without cryopreservation isn't worth doing. Then, the next best option would be to cryopreserve any embryos that are produced from the oocytes of these two females. Has anyone successfully produced Rhino embryos, specifically morula or blastocyst stage embryos which would like;y give the highest post-thaw viability? I have not read about that but perhaps it has been done. Has anyone successfully cryopreserved immature or matured rhino eggs before, and if so with what post-thaw viability and embryo production success rates?

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overnight them to a lab that can perform this research. Maybe that exists now with the San Diego Zoo and I am just not aware of it?

Kind regards,

Mike

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Sent: Sunday, April 8, 2018 9:19 AM
To: Gareth Sullivan
Cc: Jeanne Loring; Stewart Brand; Genetic Rescue listserv
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino

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> **Sent:** 08 April 2018 02:29
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> **Subject:** Re: [Geneticrescue] Interesting piece on Northern White Rhino
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From: Mike Kjelland >
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino
Date: April 9, 2018 at 7:39:53 PM CDT
To: Oliver Ryder <>, True Nature Foundation , Gareth Sullivan <>
Cc: Jeanne Loring <>, Stewart Brand <>, "Genetic Rescue listserv" <geneticrescue@reviverestore.org>

Thanks for that information Dr. Ryder! I am glad to hear that many of the fundamental steps are under development and that a gamete collection network is in place.
Limited success at maturing and fertilizing rhino ova doesn't surprise me. Colleagues and I have had limited success at producing domestic goat and Bighorn sheep embryos *in vitro* so much still needs to be done in this area.

Mike

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From: Oliver Ryder <
Sent: Monday, April 9, 2018 8:24 PM
To: Mike Kjelland; True Nature Foundation; Gareth Sullivan
Cc: Jeanne Loring; Stewart Brand; Genetic Rescue listserv
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino

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Saving plants and animals worldwide

From: Mike Kjelland
Sent: Sunday, April 8, 2018 9:02:42 AM
To: True Nature Foundation; Gareth Sullivan
Cc: Jeanne Loring; Stewart Brand; Genetic Rescue listserv
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Mike

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From: True Nature Foundation >
Sent: Sunday, April 8, 2018 9:19 AM
To: Gareth Sullivan
Cc: Jeanne Loring; Stewart Brand; Genetic Rescue listserv
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino

Sure hope they also collected semen from the testicles and apply ovum pickup on the last two female NWR.
Contacted Dvur Kralove and Ol Pejeta to get tissue, but no reaction so far.

Best wishes,

Henri

Op zo 8 apr. 2018 10:26 schreef Gareth Sullivan

Yes I agree with Jeanne,
this is not a bad perspective!
best
gareth

From: Jeanne Loring <
Sent: 08 April 2018 02:29
To: Stewart Brand
Cc: Genetic Rescue listserv
Subject: Re: [Geneticrescue] Interesting piece on Northern White Rhino

I think this is one of the better pieces I've seen.

Jeanne

On Apr 7, 2018, at 5:27 PM, Stewart Brand < > wrote:

New twist: it's not okay to play God, but it's okay to play Noah.

https://www.theverge.com/2018/4/6/17175936/northern-white-rhino-de-extinction-stem-cells-sudan

—Stewart

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Clare Palmer
Cornerstone Fellow & Professor of Philosophy
YMCA 301
Department of Philosophy
Texas A&M University
4237 TAMU
College Station
TX 77843-4237

c.palmer@tamu.edu
Office phone: 1-979-862-1435
Department fax: 1-979-845-0458