INGENUITY: NEXTGEN'S VISION

Facilitating conservation

We asked young scientists from a variety of fields to address this issue: **The changes required to preserve Earth's ecosystems and biodiversity (and human population) depend on human behavior and values, yet often conflict with current lifestyles. Describe one way that your field can improve conservation efforts and implementation.** Several of those who responded addressed ways in which they and their labmates could personally reduce their carbon footprints, including reducing their use of paper, remotely attending meetings to minimize travel, ordering supplies from vendors committed to green practices, and adhering to strict guidelines to prevent environmental contamination from laboratory waste. Multiple respondents expressed frustration with the limits of plastic recycling, given the necessity of plasticware in their work, and urged more research into creative ways to break down plastics. Others offered ways to apply the work in their fields to conservation, including some success stories to emulate. Here, we have printed excerpts of these suggestions. Do you have ideas to add? Follow NextGen's InGenuity surveys and add your thoughts on Twitter with hashtag #NextGenSci.—**Jennifer Sills**

Empowerment

Phylogenetic systematics helped us convince fewer people to eat caviar, which has helped to save the rarest species of sturgeons from extinction. Once the term "caviar" was restricted to just the eggs of sturgeons (previously eggs of many fish species could be labeled "caviar"), all of which are endangered, people better understood that caviar are the eggs of rare animals. No matter how appetizing the taste, few people feel good about eating the eggs of an endangered species. Through DNA testing, we can determine whether eggs marketed as caviar are the real thing, and if they belong to the extremely rare species from Russia or if they are from better-managed stock.

Prosanta Chakrabarty

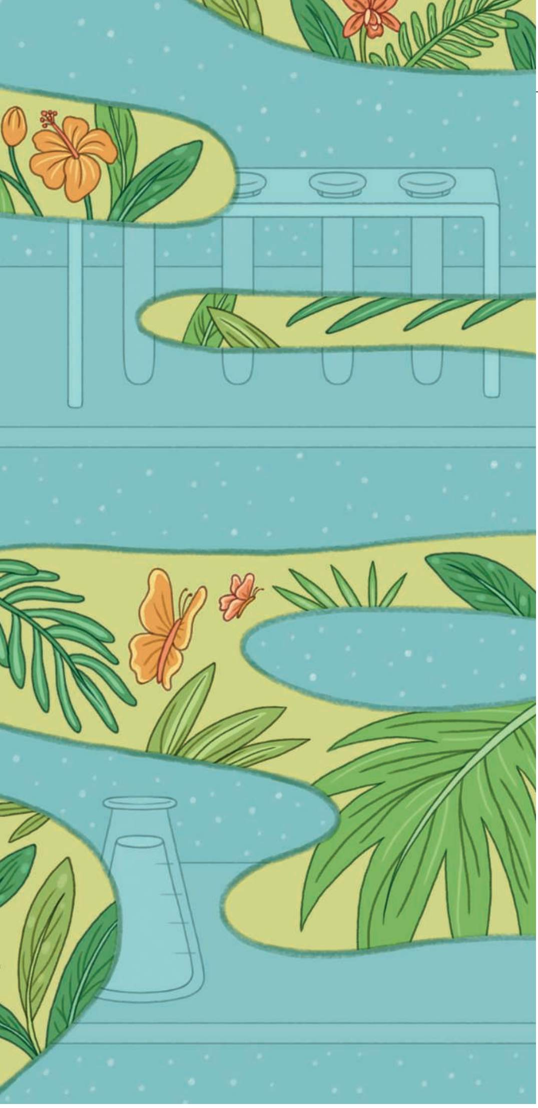
Museum of Natural Science, Louisiana State University, Baton Rouge, LA 70803, USA. Email: prosanta@lsu.edu

During my fieldwork in Nepal, I came across communities that not only are sustainable in their use of natural resources, especially forests, but also share a grounded, ecosystem-friendly mindset.

CREDIT: GABY D'ALESSANDRO

Downloaded from http://science.sciencemag.org/ on May 24, 2017

Published by AAAS



With more people belonging to "supermarket societies," there is decreased understanding of consumption. One way to bring back balance in society is to put local needs first when designating power, rights, and responsibilities regarding the use of natural resources.

Swati Negi
Department of Environmental Systems Science, Swiss Federal Institute of Technology (ETH, Zürich), Zurich, 8092, Switzerland.
Email: swati.negi@usys.ethz.ch

A major problem in conservation is that people refuse to believe that the disappearance of a plant or animal species is a problem. In Morelos, Mexico, researchers addressed this by persuading local people to take ownership of their environment. Once people felt responsible for the plants and animals around them, they were more receptive to steps they could take to protect them.

Rigoberto Medina Andrés
Instituto de Investigación en Ciencias Básicas y Aplicadas, Universidad Autónoma del Estado de Morelos, Cuernavaca, Morelos, 62209, Mexico.
Email: rigoberto.medinaa@uaem.edu.mx

Global collaboration

Diversity and outreach must be built into the fabric of the scientific enterprise. For every scientist who has risen to greatness, there are likely a thousand people with equal potential who never had the chance to practice research due to a lack of financial opportunity or the presence of crushing institutional and societal discrimination. As long as that is true, solutions to the climate and biodiversity crises will continue to elude humanity.

Brett Favaro
School of Fisheries, Fisheries and Marine Institute of Memorial University of Newfoundland, St. John's, NL, A1C 5R3, Canada. Email: brett.favaro@mi.mun.ca

Conservation efforts require cross-disciplinary approaches. However, data about Earth's ecosystems and biodiversity are scattered among survey reports and research literature. This information needs to be stored in a unified global biodiversity repository that can provide global, species-wide distribution maps, allowing biodiversity assessment across the globe in near real-time.

Bipin Singh
Centre for Computational Natural Sciences and Bioinformatics, International Institute of Information Technology (IIIT), Hyderabad, Hyderabad, Telangana, 500032, India. Email: bipin.singh@research.iiit.ac.in

Adaptation

Myriad mechanisms exist throughout diverse plant and animal phyla that confer resistance mechanisms to both biotic stressors (such as bacterial, fungal, and insect pathogens) and abiotic stressors (such as drought, high salinity, and drastic temperature shifts). These mechanisms inspire us to develop modified plants that will be less vulnerable to accelerations of human-driven environmental transitions.

Richard Hilleary
Department of Botany, University of Wisconsin–Madison, Madison, WI 53706, USA.
Email: dickhilleary@gmail.com

All life forms have evolved through the development of the most efficient and effective processes, which are optimized to minimize both energy input and toxic by-products. There are many industrial processes that can be improved by using a biological model. Implementing such changes would reduce the impact on the ecosystem and allow all species to flourish.

Patrick Kobina Arthur
Department of Biochemistry, Cell and Molecular Biology, University of Ghana, Legon-Accra, Ghana.
Email: parthur14@gmail.com

Soil transplants containing microbes favoring specific plants can restore a native plant range quickly. Cover crops such as winter rye can prevent nutrient run-off and retain soil. Planting nitrogen-fixing legumes can replenish a field. Soils provide opportunities to save native plant environments and improve agriculture.

Ian H. Street
Dartmouth College, Hanover, NH 03755, USA.
Email: ih.street@gmail.com

Facilitated by the recent advances in high-throughput sequencing technologies, microbial ecologists can now examine in detail the genetic diversity of highly complex microbial communities in a timely and cost-effective manner. As a result, conservation policy-makers can now develop better and more comprehensive conservation priorities.

Man Kit Cheung
School of Life Sciences, The Chinese University of Hong Kong, Hong Kong, China.
Email: mkcheung@cuhk.edu.hk

To protect our environment, we must replace fossil fuels with cleaner energy options. One possibility, nuclear fusion, produces energy when hot hydrogen nuclei collide to form helium. At such high temperatures, hydrogen becomes a new state of matter: plasma. Plasma physicists and engineers around the world are working together to learn how to control plasmas, so that the energy produced in fusion reactions can be used to create electricity.

Matthew Parsons
Department of Nuclear, Plasma, and Radiological Engineering, University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA.
Email: msparsons73@gmail.com

Metal ion pollutants in water are toxic to human health and can be devastating to an ecosystem. Large-scale water management can also disrupt ecosystems, diverting rivers and streams, draining lakes, and risking groundwater contamination through the digging of boreholes. New materials offer solutions. Chemists are working toward using high-tech materials in low-tech filters, which can be deployed as a distributed water supply that needs no large pipelines, no dams, and no boreholes. We dream of a future in which seawater can cheaply be made into drinking water, and water can be pulled from the air, so that the water needs of humans do not damage ecosystems.

Timothy Easun
School of Chemistry, Cardiff University, Cardiff, CF10 3AT, UK. Email: EasunTL@cardiff.ac.uk

Downloaded from http://science.sciencemag.org/ on May 24, 2017

Published by AAAS

Behavior management

Behavioral economics can identify the real (and psychological) barriers people face in conservation efforts and suggest efficient ways to overcome them. People have limited attention resources and limited capacities for information processing. Behavioral economics can help find a way to capture an individual's attention, change his or her perspective, and provide the most effective type of information.

Lubomír Cingl

Department of Institutional, Environmental, and Experimental Economics, University of Economics of Prague, Prague 3, 13067, Czech Republic.
Email: lubomir.cingl@gmail.com

Norm-based persuasion messages appear to be very effective in encouraging energy-saving and environmental protection behavior. For example, many hotel chains have adopted conservation programs in which they post a sign asking guests to reuse their towels during their stay. Natural field studies have revealed that norm-based signs (such as those saying "the majority of guests join our conservation program and reuse their towels") are more effective than signs focused solely on environmental protection. Others' disapproval is also effective in decreasing littering and electricity usage and increasing recycling. Normative appeals can encourage conservation behavior, at no extra cost to organizations (such as hotels).

Liangyan Wang

Shanghai Jiaotong University, Shanghai, 200030, China. Email: wly@sjtu.edu.cn

Neural engineering focuses on changing the brain to ameliorate disease. One branch of our field, transcranial stimulation, has started to focus on brain change in healthy individuals, helping to modulate mood or cognitive biases. A major problem in conservation is that people want to take beneficial actions (such as recycling, walking to work, or reducing energy use) but find it hard to start the habit. Perhaps noninvasive technologies could help them start those healthy habits by enhancing motivation or early learning.

Alik S. Widge

Department of Psychiatry, Harvard Medical School, Charlestown, MA 02129, USA.
Email: awidge@partners.org

Preserving Earth's ecosystems requires giving up immediate rewards (such as cheap, unregulated fossil fuels) in favor of larger benefits that are both delayed and intangible (such as clean air and protected biodiversity). Decision neuroscientists have found that people who are better at visualizing their future selves are more willing to delay gratification. In other words, we are more willing to make sacrifices to protect our future if we can vividly imagine ourselves in that future. Ever-improving virtual reality technology could make it possible for anyone, regardless of imagination skills, to immerse themselves in the future dystopias that our present actions engender, and that could prompt behavior change today that would ensure a better tomorrow.

Rosa Li

Department of Psychology and Neuroscience, Duke University, Durham, NC 27708, USA.
Email: rosa.li@duke.edu

When people learn about what they are doing through feedback, they are aware of the need for changes in behaviors. In the big data era, copious data about daily behavior can be collected, integrated, and analyzed to discover behavior patterns. Then the information can be provided in near real-time as interventions. The power of peer effect and feedback is enormous in promoting conservation behavior.

Kaile Zhou

School of Management, Hefei University of Technology, Hefei, Anhui, 230009, China.
Email: kailezhou@gmail.com

Fishermen work on China's Chaohu Lake, which is filled with cyanobacteria.

Public engagement

The potential toxicity of cyanobacteria blooms can pose health risks to humans and negatively affect ecosystem services such as drinking and recreational use of water, fishing, and irrigation. Limiting excess nutrient concentration in water can help control cyanobacteria blooms. To do this, scientists need the support of politicians and decision-makers who can invest in water treatment facilities and sewage systems and regulate the amount of fertilizers in agriculture and the types of crops planted near water bodies. Scientists also must foster awareness in the general public about the causes, consequences, and possible solutions for cyanobacteria blooms. Engaged citizens can promote the changes needed through adjustments in their lifestyle and informed votes.

Paula de Tezanos Pinto

Laboratorio de Limnología. Departamento de Ecología, Genética, y Evolución, Universidad de Buenos Aires, CONICET, Argentina.
Email: paulatezanos@ege.fcen.uba.ar

While studying the teaching and learning of science content, science education researchers have an opportunity to study the perceptions of, and interactions with, science. It is these interactions that shape the future, through personal choices, public policy, and funding for scientific research. Although content knowledge traditionally defines learning, the future of science education may emphasize multidisciplinary, socio-scientific concepts such as environmental protection, conservation, climate change, and energy technologies.

Rachel Yoho

CREATE for STEM Institute, Michigan State University, East Lansing, MI 48824, USA.
Email: yohorach@msu.edu

Scientific data is no longer just distorted through cherry-picking and misrepresentation. It is being dismissed entirely. To counter this, conservationists need society to become more receptive to science. Advances in political psychology suggest that scientific curiosity, rather than scientific literacy, makes people more open-minded to politically sensitive topics. Therefore, conservation scientists should not just produce more-detailed research to counter the post-truth tsunami. We should instead appeal to the public's curiosity by describing the way science explores and protects the undiscovered parts of nature. In short, conservation needs less advocacy and more Attenborough.

Falko Buschke

Centre for Environmental Management, University of the Free State, Bloemfontein, 9300, South Africa.
Email: falko.buschke@gmail.com

10.1126/science.aan4270

PHOTO: AFP/STRINGER/GETTY IMAGES

Downloaded from http://science.sciencemag.org/ on May 24, 2017

Published by AAAS

Facilitating conservation

Prosanta Chakrabarty, Swati Negi, Rigoberto Medina Andrés, Brett Favaro, Bipin Singh, Richard Hilleary, Patrick Kobina Arthur, Ian H. Street, Man Kit Cheung, Matthew Parsons, Timothy Easun, Lubomír Cingl, Liangyan Wang, Alik S. Widge, Rosa Li, Kaile Zhou, Paula de Tezanos Pinto, Rachel Yoho and Falko Buschke

(April 20, 2017)
Science **356** (6335), 242-244. [doi: 10.1126/science.aan4270]

Editor's Summary

This copy is for your personal, non-commercial use only.

Article Tools Visit the online version of this article to access the personalization and article tools:
http://science.sciencemag.org/content/356/6335/242

Permissions Obtain information about reproducing this article:
http://www.sciencemag.org/about/permissions.dtl

Science (print ISSN 0036-8075; online ISSN 1095-9203) is published weekly, except the last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. Copyright 2016 by the American Association for the Advancement of Science; all rights reserved. The title *Science* is a registered trademark of AAAS.

Downloaded from http://science.sciencemag.org/ on May 24, 2017