

Experiences and lessons learned from the “Horizon scan of global conservation issues” and UNEP’s Foresight Process

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University of Sussex

School of Life Sciences

What's the future like?

All decisions are made to influence the future.

Extrapolation

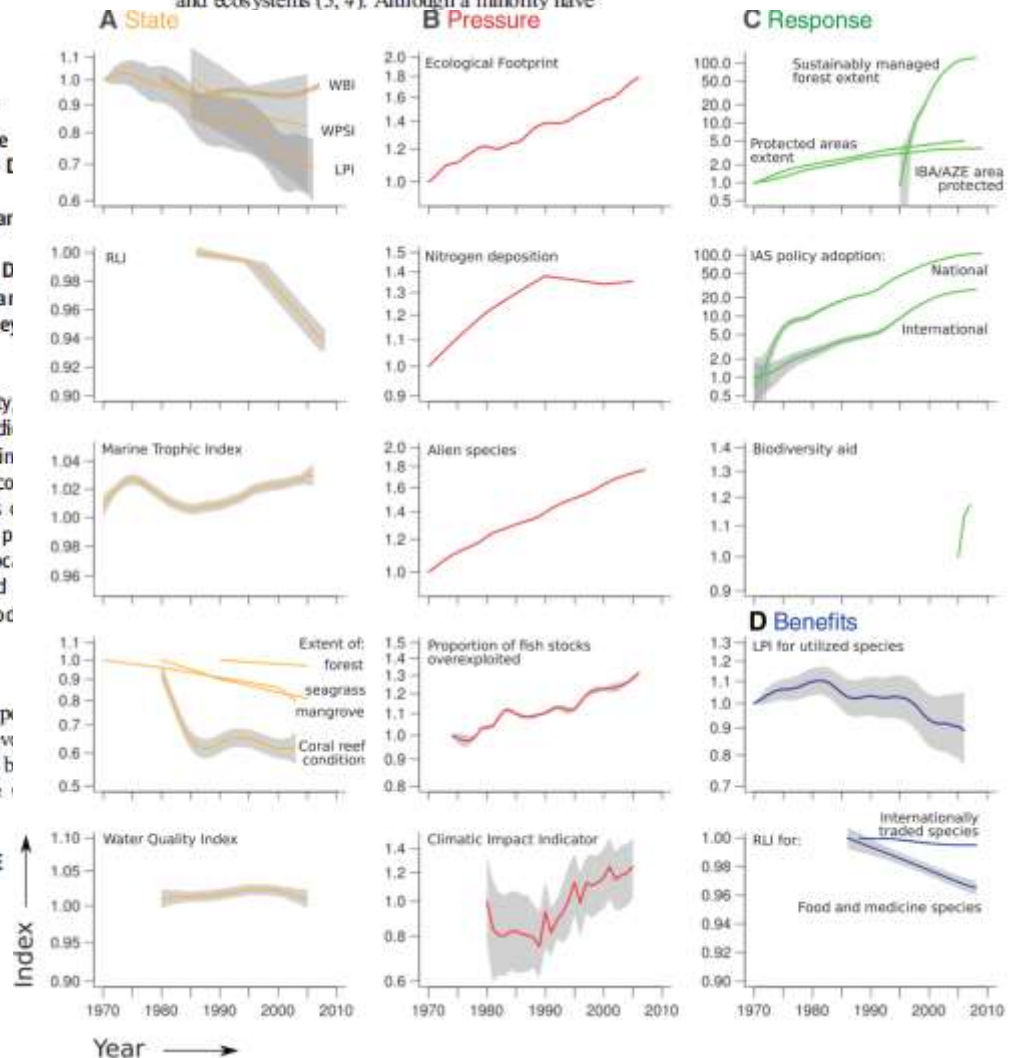
Global Biodiversity: Indicators of Recent Declines

Stuart H. M. Butchart,^{1,2*} Matt Walpole,¹ Ben Collen,³ Arco van Strien,⁴ Jörn P. W. Scharlemann,¹ Rosamunde E. A. Almond,¹ Jonathan E. M. Baillie,³ Bastian Bomhard,¹ Claire Brown,¹ John Bruno,⁵ Kent E. Carpenter,⁶ Geneviève Janice Chanson,⁸ Anna M. Chenery,¹ Jorge Csirke,⁹ Nick C. Davidson,¹⁰ Frank I. Matt Foster,¹² Alessandro Galli,¹³ James N. Galloway,¹⁴ Piero Genovesi,¹⁵ Richard D. Gregory,¹⁶ Marc Hockings,¹⁷ Valerie Kapos,^{1,18} Jean-Francois Lamar Fiona Leverington,¹⁷ Jonathan Loh,²⁰ Melodie A. McGeoch,²¹ Louise McRae,³ Anahit Minasyan,²² Monica Hernández Morcillo,¹ Thomasina E. E. Oldfield,²³ D Suhel Quader,²⁵ Carmen Revenga,²⁶ John R. Sauer,²⁷ Benjamin Skolnik,²⁸ Diar Damon Stanwell-Smith,¹ Simon N. Stuart,^{1,12,30,31} Andy Symes,² Megan Tierney, Tristan D. Tyrrell,¹ Jean-Christophe Vié,³² Reg Watson²⁴

In 2002, world leaders committed, through the Convention on Biological Diversity, a significant reduction in the rate of biodiversity loss by 2010. We compiled 31 indicators on progress toward this target. Most indicators of the state of biodiversity (covering population trends, extinction risk, habitat extent and condition, and community composition) showed declines, with no significant recent reductions in rate, whereas indicators of pressure on biodiversity (including resource consumption, invasive alien species, nitrogen pollution, overexploitation, and climate change impacts) showed increases. Despite some local and increasing responses (including extent and biodiversity coverage of protected areas, sustainable forest management, policy responses to invasive alien species, and biodiversity aid), the rate of biodiversity loss does not appear to be slowing.

In 2002, world leaders committed, through the Convention on Biological Diversity (CBD), “to achieve by 2010 a significant reduction of the current rate of biodiversity loss” (1), and this “2010 target” has been incorporated into the United Nations Millennium Development Goals in recognition of the impact of biodiversity loss on human well-being (2). The

framework of indicators to measure biodiversity loss at the level of genes, populations, species, and ecosystems (3, 4). Although a minority have



Modelling

REVIEW

Scenarios for Global Biodiversity in the 21st Century

Henrique M. Pereira,^{1,2,3,4} Paul W. Leadley,^{5,6} Vânia Proença,⁷ Rob Alford,⁸ Jón P. W. Sutherland,⁹ Juan F. Fernandez-Manjarrés,¹⁰ Miguel B. Araújo,^{1,4} Patricia Balvanera,¹¹ Keesette Biggs,¹² William W. L. Cheung,¹³ Louise Chini,¹⁴ H. David Cooper,¹⁵ Edic L. Gilman,¹⁶ Sylvie Guénette,¹⁷ George C. Hart,^{18,19} Henry P. Huntington,²⁰ Georgina M. Mace,²¹ Thierry Oberdorff,²² Carmen Revenga,²³ Patricia Rodrigues,²⁴ Robert J. Scholes,²⁵ Ümit Rashid Seneviratna,²⁶ Matt Walpole²⁷

Quantitative scenarios are coming of age as a tool for evaluating the impact of future socioeconomic development pathways on biodiversity and ecosystem services. We analyse global terrestrial, freshwater, and marine biodiversity scenarios using a range of measures including extinctions, changes in species abundance, habitat loss, and distribution shifts, as well as comparing model projections to observations. Scenarios consistently indicate that biodiversity will continue to decline over the 21st century. However, the range of projected changes is much broader than most studies suggest, partly because there are major opportunities to intervene through better policies, but also because of large uncertainties in projections.

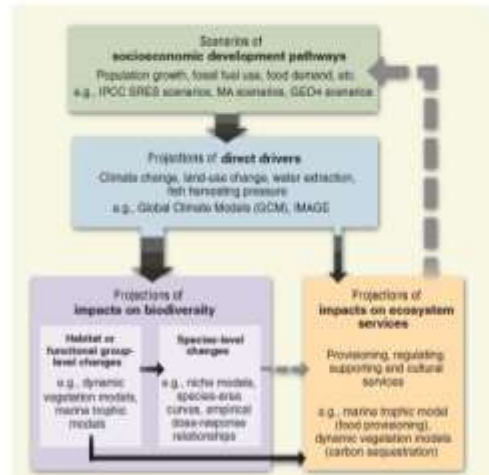


Fig. 1. Overview of methods and models commonly used for constructing biodiversity scenarios. Some models include several components of this figure, such as the integrated assessment model IMAGE (2) or the marine trophic model 'Oceanic with Ecosystem' (25). Each arrow indicates key linkages treated in biodiversity scenarios. Dashed grey arrows indicate linkages that are absent in current biodiversity scenarios. In some cases, impacts on ecosystem services may be mediated by changes in the abiotic condition of ecosystems (this arrow from direct drivers to ecosystem services).

Quantitative estimates of the future trajectories of biodiversity, which we broadly refer to as biodiversity scenarios, are typically based on the coupling of several complex components (Fig. 1). Socioeconomic scenarios with trajectories of key indirect drivers of ecological change, such as human population growth and greenhouse gas emissions, are developed under different assumptions regarding society's development, often associated with 'storylines' (1). These trajectories are then fed into models that project changes in direct drivers of ecosystem change, such as climate and land-use change, in different regions of the world (1, 2). Finally, the projected drivers are used as inputs to biodiversity models (Table 1). In some cases, associated changes in key ecosystem services are also modelled, although quantifying the link between biodiversity and ecosystem services remains a major scientific challenge (3, 4). Thus, we review recent model-based biodiversity scenarios, which have grown rapidly in number over the last five years owing to major advances in modelling and data availability.

Biodiversity change has many metrics (5). Here we group these metrics into five classes: species extinctions, species abundance and community structure, habitat loss and degradation, and shifts in the distribution of species and biomes. Scenarios of species extinction risk (6, 7) address

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COMMENT

COMMENTARY Sally Rockley **ECOLOGIST** Zoological travelogue tracks rare species worldwide **300**
WOMEN Calls to root out sexism in journals, conferences and experiments **305**
BIOMATHS Rita Levi-Montalcini, nerve-growth factor pioneer and science advocate **306**



A hyena surveys a flock of flamingos in South Africa.

Time to model all life on Earth

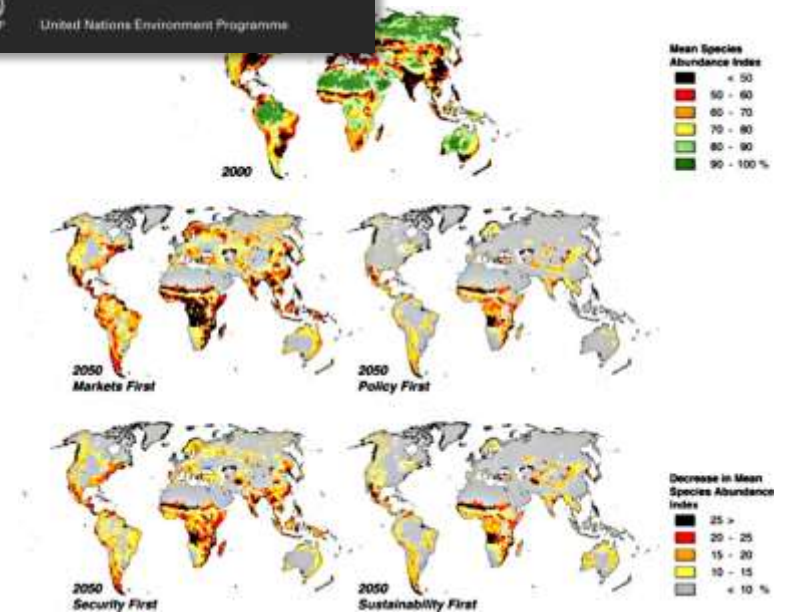
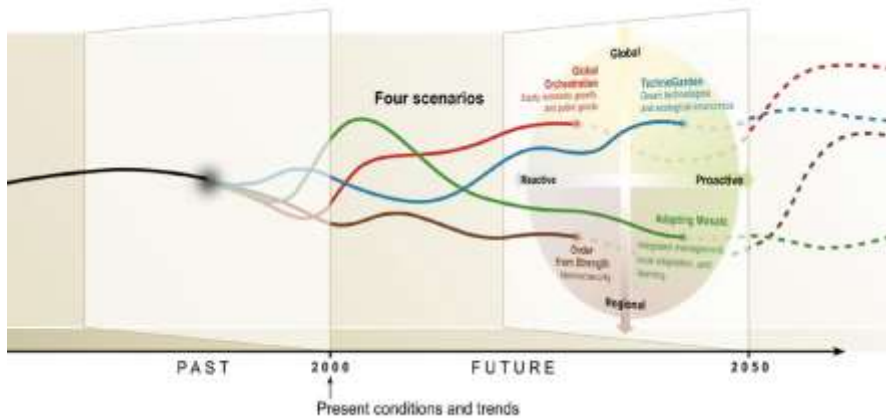
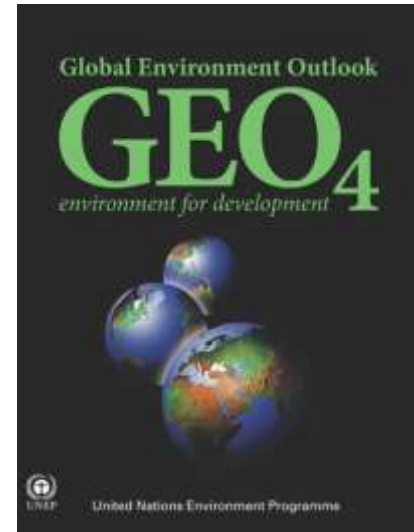
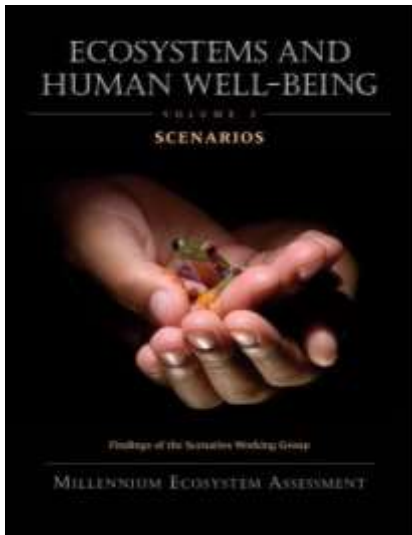
To help transform our understanding of the biosphere, ecologists — like climate scientists — should simulate whole ecosystems, argue Drew Purves and colleagues.

No report from the Intergovernmental Panel on Climate Change would fail to mention global climate models and shaping policies. We think that analogous general ecosystem models (GEMs) could actually improve understanding of the biosphere and inform policy decisions about biodiversity and conservation. Currently, decisions in conservation are based on disparate correlational studies, such as those showing that the diversity of local species tends to decline in deforested landscapes. GEMs could provide a way to base conservation policy on an understanding of how ecosystems actually work.

General circulation models, which simulate the physics and chemistry of Earth's land,

ocean and atmosphere, embody scientists' best understanding of how the climate system works and are crucial to making predictions and shaping policies. We think that analogous general ecosystem models (GEMs) could actually improve understanding of the biosphere and inform policy decisions about biodiversity and conservation. Currently, decisions in conservation are based on disparate correlational studies, such as those showing that the diversity of local species tends to decline in deforested landscapes. GEMs could provide a way to base conservation policy on an understanding of how ecosystems actually work.

Scenarios



Horizon scanning

systematic examination of potential threats, opportunities and likely developments including but not restricted to those at the margins of current thinking and planning.

exploration of novel and unexpected issues as well as persistent problems or trends.

Two horizon scanning processes

Cambridge Conservation Initiative

transforming the landscape of biodiversity conservation



collaboration between
University of Cambridge and
9 biodiversity conservation
organisations clustered in and
around Cambridge, UK

voice for the environment
within the United Nations
system



Aims

Cambridge **Conservation** Initiative

transforming the landscape of biodiversity conservation



Identify emerging issues in time to *initiate research and develop policy and practical responses.*

Identify technological advances, environmental changes, novel ecological interactions, changes in society that could have impacts on the conservation of biodiversity.

International *consensus* and *priority* list of most important emerging issues related to the global environment.

Inform UN and wider international community, feed into UNEP's PoW.

Definitions of “emerging issues”

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Unknown to participants

Globally important, or local effect on species, ecosystem or regions of global interest

Not prioritised, but issues sufficiently important to warrant new research, policy consideration or pre-emptive, cost-effective action.

Already recognized by scientific community, insufficiently attended to by policy community

Newness of issue because of

- new scientific knowledge
- new scales or accelerated rates of impacts
- heightened level of awareness
- new ways to respond

Global, continental or ‘universal’

Priority over next 1-3 years

Process

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Process informal,
transparent & democratic,
briefly summarised in
papers

18-25 academic and NGO
scientists, horizon scanning
experts, journalist

3 months

Repeated annually

Process more complex,
described in detail
Ensure legitimacy through
wide consultation

Regional, gender and
subject representation

22 academic scientists

8 months

Repeated every 2 years

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Gather issues within organisations

Preliminary list
score (known: y/n, 1-1000),
consolidate

Panel meeting (1 day)
discuss, score & shortlist

Publication in *TREE*

Canvass UNEP community

Preliminary list
scoring, consolidating

1st Panel meeting (3 days)
discuss & shortlist

Electronic consultation
score 1-10 + add/remove

2nd Panel meeting (3 days)
refine & rank

Final report

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Gather issues within organisations
158-253



Preliminary list
score (known: y/n, 1-1000),
consolidate



Panel meeting (1 day)
discuss, score & shortlist
18-25



Publication in *TREE*



14 natural, 8 social scientists

17♂ 7♀

5 Africa, 6 Asia Pacific, 3 Latin Am., 5 Europe, 3 North America

1st Panel meeting (3 days)
discuss & shortlist
22



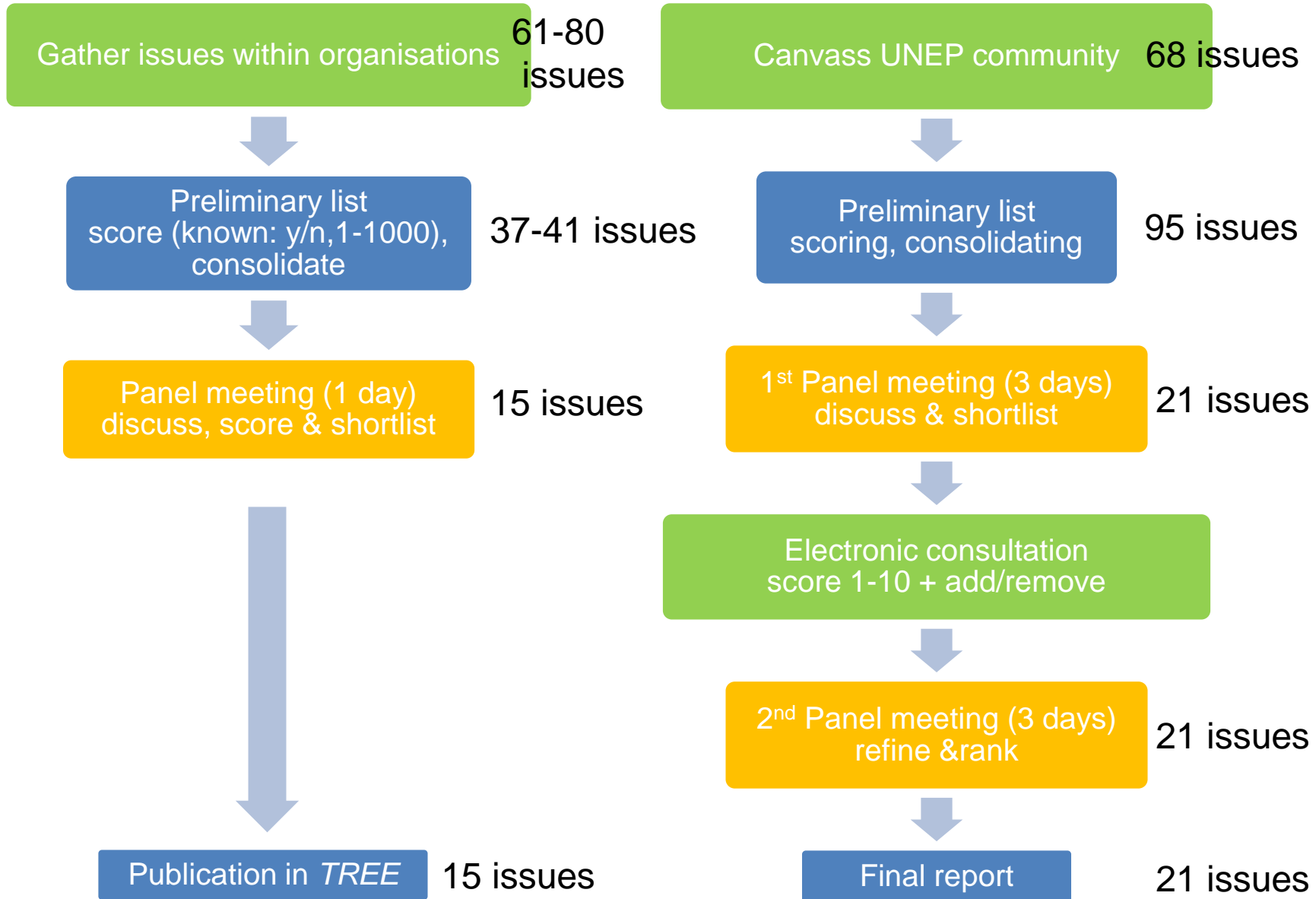
Electronic consultation
score 1-10 + add/remove
428



2nd Panel meeting (3 days)
refine & rank
22



Final report



Outputs

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A horizon scan of global conservation issues for 2010
 William J. Sutherland¹, Mick Clout², Isabelle M. Côté³, Peter Drazak⁴,
 Mick Davi⁵, Lloy Lloyd⁶, and Jörn Sarn⁷

Horizon scan of global conservation issues for 2011
 William J. Sutherland¹, Sarah Bardsley², Leon Bennun³, Mick Clout⁴,
 Isabelle M. Côté⁵, Michael H. Depledge⁶, Lisa U. Doherty⁷, Andrew D. Foxon⁸,
 Liz F⁹, John Raip¹⁰, and Stepa¹¹

A horizon scan of global conservation issues for 2012
 William J. Sutherland¹, Ros Aveling², Leon Bennun³, Eleanor Chapman⁴, Mick Clout⁵,
 Liz Fe⁶, Fiona Lloyd⁷, and Mark⁸

A horizon scan of global conservation issues for 2013
 William J. Sutherland¹, Sarah Bardsley², Mick Clout³, Michael H. Depledge⁴,
 Lynn V. Dicks⁵, Liz Felton⁶, Erica Fleishman⁷, David W. Gibbons⁸, Brandon Reim⁹,
 Fiona Lickorish¹⁰, Cori Margerison¹¹, Kathryn A. Monk¹², Kenneth Norris¹³,
 Lloyd S. Peck¹⁴, Stephanie V. Price¹⁵, Jörn P.W. Scharlemann^{14,15}, Mark D. Spalding¹⁶,
 and Andrew R. Watkinson¹⁷

Why we have a system
 The paper presents the findings of our fourth annual horizon-scanning exercise, which aims to identify issues that broadly may affect conservation of biological diversity. The 15 issues were identified as a horizon-scanning process by a team of professional horizon-scanning researchers, practitioners, and a journalist. The 15 issues include the commercial use of synthetic pesticides, climate-related water power, and increases in production.

Why we have a system
 There are several methods available for horizon-scanning. This approach we use, which has been adopted widely to facilitate 30–40, is restricted to the identification of emerging issues. We do not present issues that are well known to most ecologists, environmental, and conservation scientists. Furthermore, we do not explore the potential responses to the identified issues at length but the international reader should consult Sutherland et al. (2010), where there is an attempt, possibly assessment of forthcoming legislation that may have environmental impacts.

Identification of issues
 The usual methods consistent with those applied in our previous annual horizon-scanning (1, 16). The horizon-scanning process is designed to be transparent and democratic (16). Final identification of horizon issues was conducted by professional horizon-scanning specialists in multidisciplinary teams.

21 Issues for the 21st Century

Results of the UNEP Foresight Process on Emerging Environmental Issues

Outputs

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Synthetic meat

As a response to environmental pressures, ethical concerns and human health issues, a variety of research efforts worldwide are now using technologies developed for bioengineering medical tissue to grow synthetic meat in the laboratory [20]. Muscle stem cells can be taken from live animals, multiplied in a growth medium and stretched to make muscle fibres [21]. Meat cells grown in a dish obviously do not move like their real animal counterparts, so scientists use a stimuli-sensitive scaffold of collagen or alginate to add texture to the meat. Periodic stretching of this scaffold, in response to changes in temperature or pH, exercises the cells. Despite the various technological challenges, a Dutch sausage maker has developed a process that transforms pig stem cells into muscle fibres in two weeks [22]. The greatest hurdle is still price: estimates of cost per kg vary between \$10,000 [21] and \$100,000 [23]. There is a promised reward of US \$1 million for the first tasty *in vitro* chicken meat successfully sold to the public by the end of June 2012. Should synthetic meat become commonplace and protein production move from agricultural areas and oceans to factories, it could reduce livestock-produced greenhouse gases, demand for agricultural land and pressure on fish stocks. It might also have an adverse influence on those vegetation types dependent upon livestock grazing. The consequences would depend upon a range of factors, such as whether a majority of people would eat synthetic meat.

15 issues

~200 word summary, references



Issue 021 The Environmental Consequences of Decommissioning Nuclear Reactors (Ranked #17)

What we want

Most of the world's nuclear reactors are aging and will need to be decommissioned. Decommissioning involves getting a nuclear facility out of service, dismantling its decommissioning and removing or disposing of its elements. This is of course because decommissioning is a major operation which poses several technical challenges, especially the disposal of large amounts of radioactive waste, with various environmental and safety risks.

In 2010 the International Atomic Energy Agency (IAEA) noted that many of the 443 reactors operating around the world were built in the 1970s and 1980s and had an expected lifespan of around 30 years. Hence, a surge in the number of power plants going out of service and requiring decommissioning is expected soon. The IAEA projects that the peak will occur between 2020 and 2030, and that when it occurs it will present a major managerial, technological, safety and environmental challenge in those being engaged in nuclear decommissioning. How the most nuclear reactors in Fukushima, Germany and elsewhere have started to speed up the phase out of their nuclear power plants will likely in future reduce the number of plants that need to be decommissioned over the coming decade.

Important messages

Of the most challenges involved with nuclear decommissioning, particular concern is the production of high level waste (HLW) and low and intermediate level waste (LILW). These wastes need to be managed and permanently stored or disposed of. In addition IAEA experts representing various disposal or permanent storage. The IAEA (2008) estimates that the volume of waste generated during decommissioning can reach 10 to 100 times the volume generated during the operational life cycle of nuclear plants. Worldwide, nuclear power facilities annually generate about 10000 m³ of LILW, including spent fuel cladding or waste, and 100000 m³ of LILW, most of which is currently stored in intermediate storage facilities.



Photo: Wikimedia Commons



Photo: IAEA/International Atomic Energy Agency

An important health issue, generated by radionuclides and other materials, is their dispersal to the site. Decommissioning also involves handling other hazardous materials such as benzene, mercury, lead, cobalt and uranium.

Some unexpected incidents have occurred during decommissioning as reported by Chalkwasser (2010), Hatakeyama and others (2011). These include releases of radioactive elements from and their affecting storage areas and fueling up of being equipment in the Chernobyl cooling pond that can potentially spread radionuclides. Also, Laguarda (2008) and Hatakeyama (2008) have noted that decommissioning can in some cases have accidents that are significantly higher than the intended.

Another issue that an increasing number of trained nuclear professionals will be needed for decommissioning. It appears for the American Physical Society Panel on Public Policy in 2008 noted a possible shortage of workers in the US nuclear industry. Similar demands for new professionals have been identified in the European Union by the Sustainable Nuclear Energy Technology Markets (2010) and by Buck (2010) and others.

Options for action

While the decommissioning of nuclear reactors poses environmental and safety risks, there are three ways to reduce these risks. For example, more often could be given in the long term planning of decommissioning, including the provision of adequate funds to cover the costs. Issues with decommissioning could be raised from more sources, including consumer law, industry or international law.

International cooperation could help identify and plan for addressing facilities and storage sites that can handle the nuclear waste that is expected to be generated. It would also be helpful to create a wide range of stakeholders including members of the public, in the planning process for

decommissioning because this would help allow the public's concerns about the activity.

Planners and policymakers could also consider developing international guidelines and regulations aimed specifically at ensuring safety during decommissioning activities.

Cooperation for addressing the damage to nuclear personnel, as discussed by Hatakeyama and others (2011), would be to establish public-private partnerships such as the Sustainable Nuclear Education Network (SNEEN) which supports and funds the training of workers in the nuclear field.

Consequences of inaction, within 10 to 20 years

Over the next few decades the world will be confronted with a surge of nuclear power plants going out of service and decommissioning operations.

Accidents related to nuclear power, such as the Fukushima Daiichi nuclear power plant, will be a major challenge. A major challenge will be to ensure that the nuclear waste is managed safely and that the decommissioning process is carried out in a safe and effective manner.

There is a need to reduce the risk of nuclear accidents and to ensure that nuclear power is used in a safe and effective manner. This requires a combination of international cooperation and national action.

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Outputs

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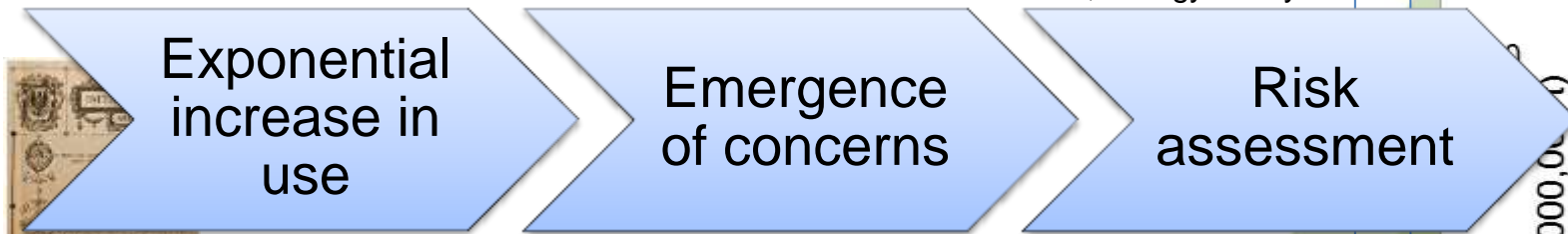
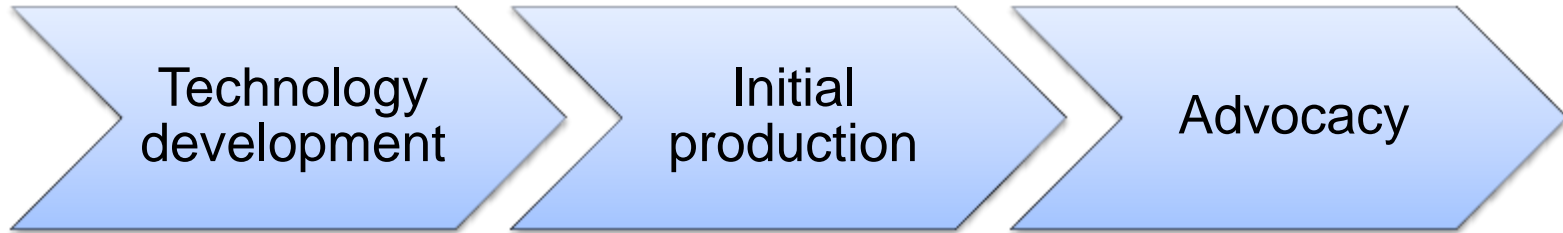
Rapid growth of concentrated solar
 Widespread development of thorium
 Seabed-located oil drilling and processing
 Accelerating water cycle
 Proliferation of hydropower in the Arctic
 Species loss as a driver of global environmental change
 Vegetarian aquaculture feed
 Rapid rise in global demand for cocoa
 Detecting aquatic species with environmental DNA
 Use of coral nurseries for reef restoration
 Forest conservation and restoration vehicles
 The 3D printing revolution
 Link between biodiversity, allergy, and climate change
 Commercial use of antimicrobial peptides
 Synthetic genetics

| Issue ID | Issue Title | Ranking* |
|---|--|----------|
| Cross-cutting issues | | |
| 001 | Aligning Governance to the Challenges of Global Sustainability | 1 |
| 002 | Transforming Human Capabilities for the 21 st Century: Meeting Global Environmental Challenges and Moving Towards a Green Economy | 2 |
| 003 | Broken Bridges: Reconnecting Science and Policy | 4 |
| 004 | Social Tipping Points? Catalyzing Rapid and Transformative Changes in Human Behaviour towards the Environment | 5 |
| 005 | New Concepts for Coping with Creeping Changes and Imminent Thresholds | 18 |
| 006 | Coping with Migration Caused by New Aspects of Environmental Change | 20 |
| Food, biodiversity and land issues | | |
| 007 | New Challenges for Ensuring Food Safety and Food Security for 9 Billion People | 3 |
| 008 | Beyond Conservation: Integrating Biodiversity Across the Environmental and Economic Agendas | 7 |
| 009 | Boosting Urban Sustainability and Resilience | 11 |
| 010 | The New Rush for Land: Responding to New National and International Pressures | 12 |
| Freshwater and marine issues | | |
| 011 | New Insights on Water-Land Interactions: Shift in the Management Paradigm? | 6 |
| 012 | Shortcutting the Degradation of Inland Waters in Developing Countries | 15 |
| 013 | Potential Collapse of Oceanic Systems Requires Integrated Ocean Governance | 13 |
| 014 | Coastal Ecosystems: Addressing Increasing Pressures with Adaptive Governance | 19 |
| Climate change issues | | |
| 015 | New Challenges for Climate Change Mitigation and Adaptation: Managing the Unintended Consequences | 7 |
| 016 | Acting on the Signal of Climate Change in the Changing Frequency of Extreme Events | 16 |
| 017 | Managing the Impacts of Glacier Retreat | 21 |
| Energy, technology, and waste issues | | |
| 018 | Accelerating the Implementation of Environmentally-Friendly Renewable Energy Systems | 7 |
| 019 | Greater Risk than Necessary? The Need for a New Approach for Minimizing Risks of Novel Technologies and Chemicals | 10 |
| 020 | Changing the Face of Waste: Solving the Impending Scarcity of Strategic Minerals and Avoiding Electronic Waste | 14 |
| 021 | The Environmental Consequences of Decommissioning Nuclear Reactors | 17 |

Lessons learned

- Aim, incl. audience & use of outputs
- Interdisciplinary
 - Participant composition/expertise
- Threats & opportunities
- Scanning of issues – link to existing databases (e.g. ministries, military)
- Discussion, panel size
- Definitions (what is emerging, scope/severity/probability/timing)

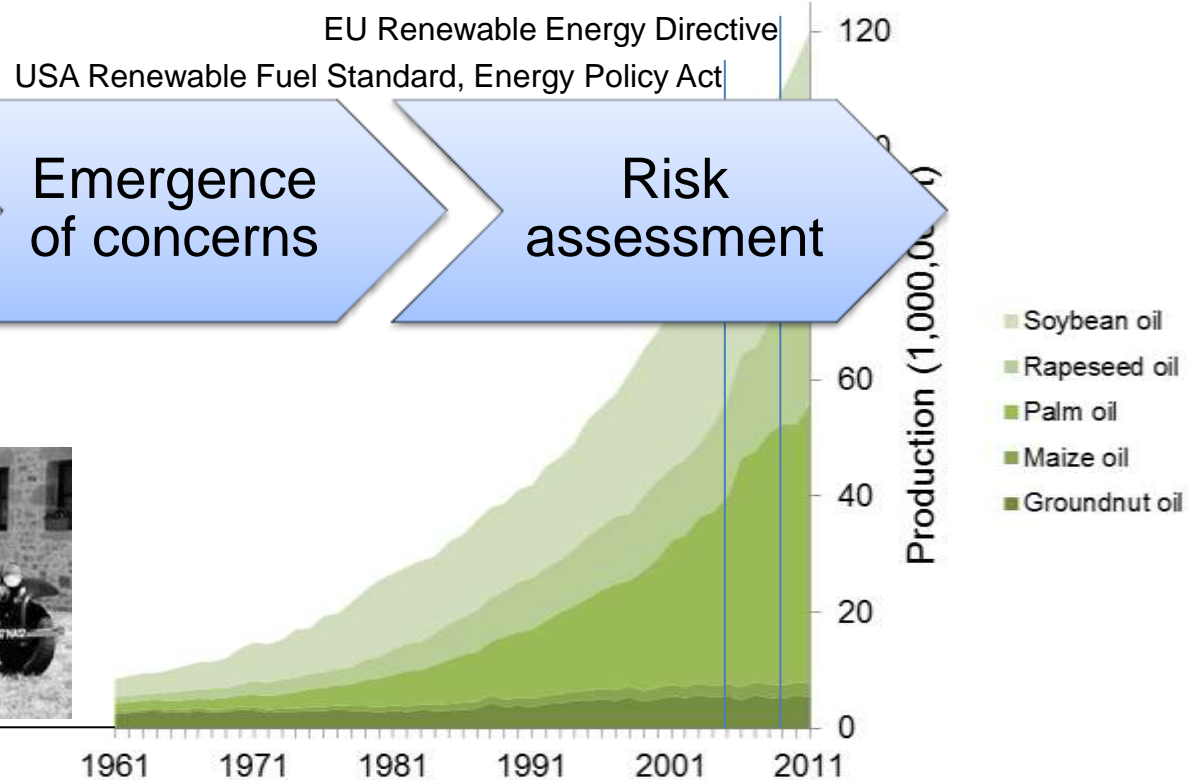
When is the right time?



1886



1933



Lessons learned

- Aim, incl. audience & use of outputs
- Interdisciplinary
 - Participant composition/expertise
- Threats & opportunities
- Scanning of issues – link to existing databases (e.g. ministries, military)
- Discussion, panel size
- Definitions (what is emerging, scope/severity/probability/timing)
- Make results accessible, follow with action
- Evolving process, flexible
- Feels uncomfortable

Experiences and lessons learned from the “Horizon scan of global conservation issues” and UNEP’s Foresight Process

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