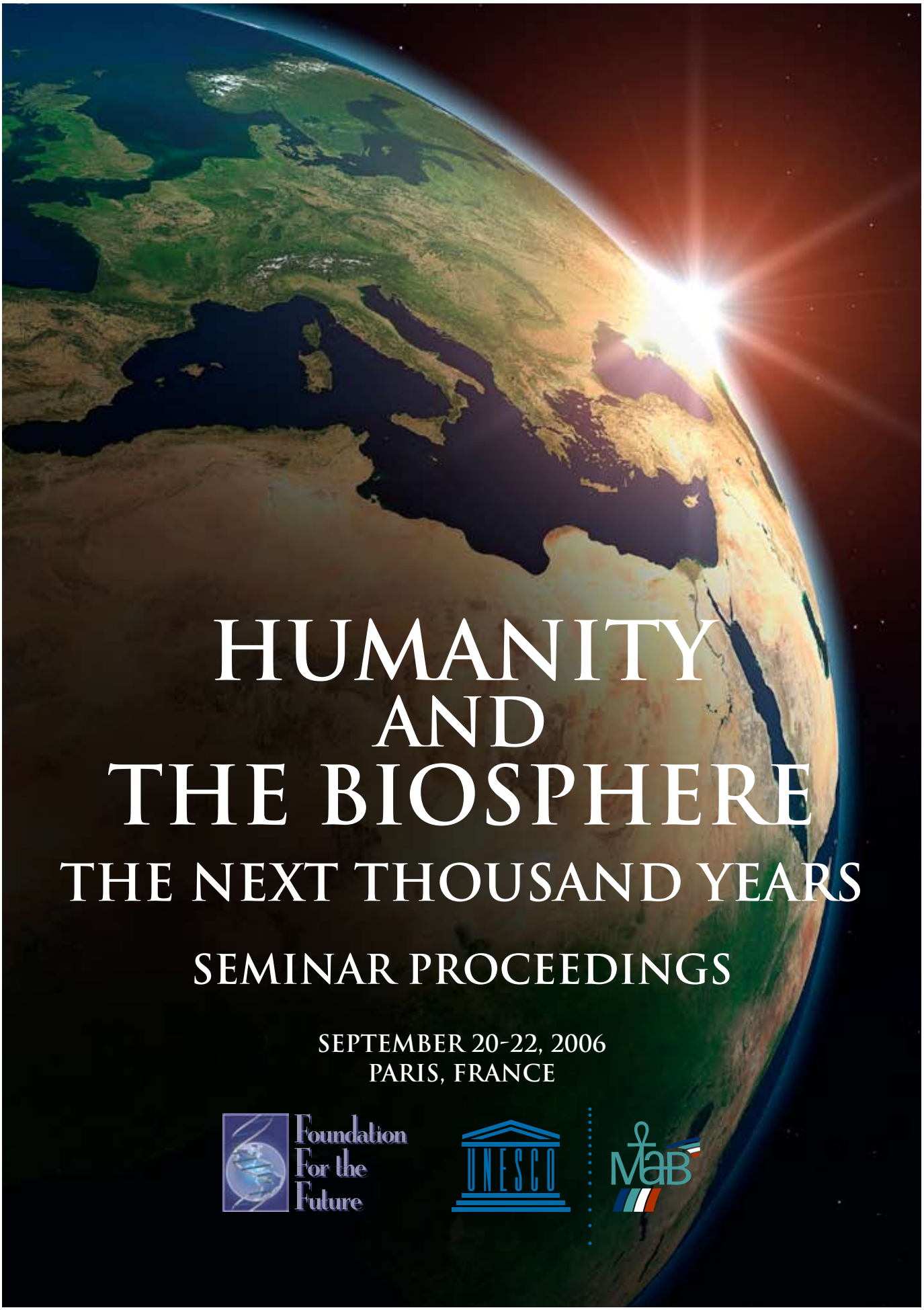

HUMANITY AND THE BIOSPHERE

THE NEXT THOUSAND YEARS

SEMINAR PROCEEDINGS

SEPTEMBER 20-22, 2006
PARIS, FRANCE

Foundation For the Future

UNESCO

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"Humanity and the Biosphere: The Next Thousand Years" Proceedings

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www.unesco.org/mab

ISBN 978-0-9794081-0-6
1. Future – humanity.
2. Millennium – Year 3000.
3. Biosphere – futurology.
I. Title.

The comments and deliberations of all participants are deemed very important by the sponsors of this seminar. While every attempt has been made to preserve the accuracy of dialogue in the seminar sessions, it is impossible to guarantee that no errors or omissions were made in the course of transcribing and editing the live-session recordings. All participants were afforded the opportunity prior to publication to review and amend their comments recorded in this document.

The goal in publishing the proceedings of the seminar is to encourage human minds to ponder issues that may shape humanity's future.

Printed copies of this publication are available from the Foundation For the Future. Contact the Foundation for details.

Printed in the United States of America

May 2007

Dear Readers:

I am very pleased to present to you the proceedings of the seminar "Humanity and the Biosphere: The Next Thousand Years," our first seminar co-sponsored with UNESCO. This event, which convened at UNESCO in Paris in September 2006, brought together eleven scholars representing five continents to consider the critical factors that might have the most impact on the long-term future of the biosphere. Observing and offering comment during the seminar were various members of UNESCO's Man and the Biosphere Programme.

The Foundation For the Future was established with the mission to increase and diffuse knowledge concerning the long-term future of humanity. Our Humanity 3000 Program focuses specifically on the thousand-year future. It regularly reviews, in annual seminars and workshops, the history of cultural, scientific, and technological trends along with emerging technologies to consider the basic question: "Where does humanity go from here?" This particular seminar focused attention on biospheric issues and the significant impact of one part of the biosphere, humanity, on the biospheric future.

This book is a comprehensive record of the September 2006 seminar. I hope you will enjoy reading these discussions about the major problems and opportunities related to humanity's interactions within the biosphere going forward in this millennium.

Sincerely,

Walter Kistler
Co-founder and President
Foundation For the Future

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United Nations
Educational, Scientific and
Cultural Organization

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للتربية والعلم والثقافة

联合国教育、
科学及文化组织

Man and the Biosphere
Programme

Division of Ecological and Earth Sciences

May 2007

Dear Readers:

The seminar "Humanity and the Biosphere: The Next Thousand Years" was jointly conceived and organized by the Foundation For the Future and the Division of Ecological and Earth Sciences (SC/EES) of UNESCO to target issues of sustainability, climate change, and biodiversity loss, and their social and economic ramifications on a global scale. Since 1971, the "Man and the Biosphere Programme" (MAB), which is a part of SC/EES, has worked continuously for the sustainable use and conservation of biological diversity and an improved relationship between people and their environment globally.

The seminar brought together policy and management specialists and visionaries of the long-term future. This included one individual who had been part of UNESCO Secretariat in the past. My colleagues in SC/EES and I also interacted with the invited scholars. All points of view expressed in this transcribed version of our conversations are views of the individuals concerned and should not be interpreted in any way as UNESCO or SC/EES policy. We in SC/EES and MAB appreciated the opportunity to interact with and learn from the seminar participants and to distill ideas and concepts that we can adapt to guide the Programme to better suit the needs of the future, which appears, more and more, to be quite different from times that led to the design and launch of MAB 36 years ago.

As you read this document, I hope you will appreciate the effort of the participants in arriving at the four-faceted goal recommended as the most critical issue for humanity's thousand-year journey into the future. MAB will take this goal into consideration in its current efforts to reform and reinvent its agenda in line with UNESCO mission and mandates for the new millennium.

Very truly yours,

Natarajan Ishwaran
Director of Ecological and Earth Sciences
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Humanity and the Biosphere: The Next Thousand Years

Walter Kistler, FFF

Bob Citron, FFF

Sesh Velamoor, FFF

Peter Dogsé, UNESCO

Lynn Margulis, Shekhar Singh, and David Macdonald, Participants

Seminar participants, seated at the inner tables, discuss humanity/biospheric issues, as observers listen.

Humanity and the Biosphere: The Next Thousand Years

Walter Erdelen, UNESCO

Natarajan Ishwaran, UNESCO

Miguel Clüsener-Godt, UNESCO

Malcolm Hadley and Sylvia Earle, Participants

Thomas Schaaf, UNESCO

June Marie Mow comments on how some national policies go against environmental policies.

Humanity and the Biosphere: The Next Thousand Years

Daniel B. Botkin, Participant

June Marie Mow, Participant

Malcolm Hadley, Participant

Jane Robertson, UNESCO

Host Natarajan Ishwaran, UNESCO, and Facilitator Sesh Velamoor, FFF

Ricardo Guerrero, Participant

Magnus Ngoile, Participant

Humanity and the Biosphere: The Next Thousand Years

Lynn Margulis, Participant

Eric J. Chaisson, Participant

Albert de Haan, Participant

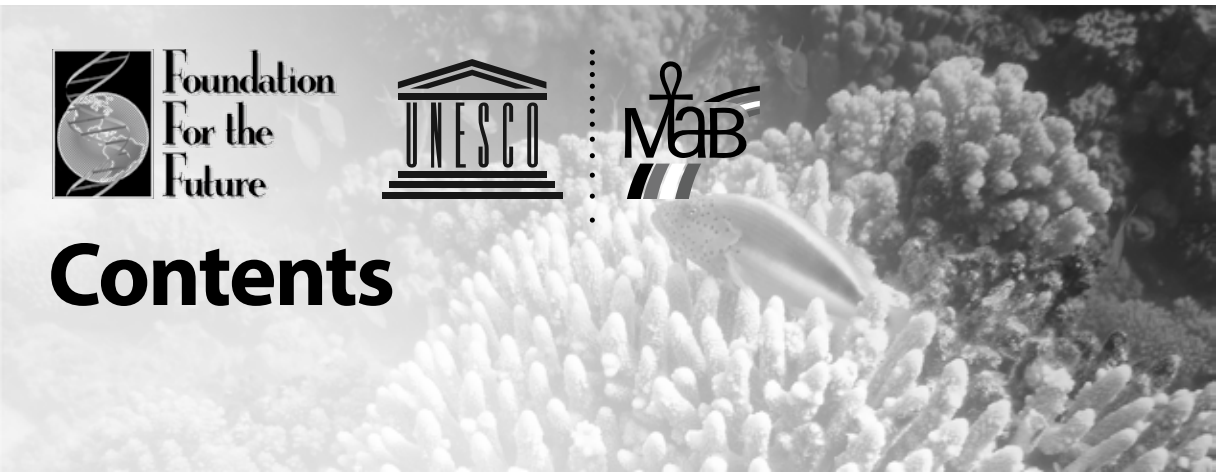
Shekhar Singh, Participant

Salvatore Arico, UNESCO

Sylvia Earle, Participant

David Macdonald, Participant

Ana Persic, UNESCO



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Acknowledgments

The Foundation For the Future (FFF) and UNESCO's Man and the Biosphere Programme (MAB) wish to acknowledge the following persons for making the co-sponsored seminar "Humanity and the Biosphere: The Next Thousand Years" a success:

The eleven participants, whose extensive backgrounds, expert perspectives, and wide experience formed the substance of the seminar and whose contributions will be valuable well into the future. These participants and their affiliations are named on Page xix of this document.

MAB personnel, for participating in the seminar with insights, observations, and questions to the participants. These personnel include Salvatore Arico, Miguel Clüsener-Godt, Peter Dogsé, Ana Persic, Jane Robertson, and Thomas Schaaf.

Natasha Lazic, MAB Programme Specialist's Assistant, for tireless dedication and continuous support throughout the planning for the seminar as well as on-site orchestration and assistance during the event.

The staff of the Foundation For the Future, for their dedication and commitment to the success of the seminar and preparation of documentation. This staff includes Kathy Carr, Special Programs Manager; Jean Gilbertson, Public Relations and Publications Manager; Jeff Holdsworth, Creative Director; Tom Price, Executive Assistant; and Mary Stroh, Executive Assistant.

Rebecca Mayse, certified real-time court reporter, for providing transcripts of the seminar.

Richard Dowling, Yves Waucampt, and Eveline Poulain for capturing the entire seminar on videotape.

Edwin Murillo Mercado and Pilar Chiang-Joo, for audiovisual support and providing a CD of all seminar presentations and discussions.

François Jacob and Josh Citron, for extensive photographic coverage.

The Trustees and Executive Director of the Foundation, and UNESCO's Assistant Director-General for Natural Sciences, for reposing their trust and confidence in all of us.

Natarajan Ishwaran
Director
Division of Ecological and Earth Sciences
UNESCO

Sesh Velamoor
Deputy Director, Programs
Foundation For the Future

Donna Hines
Deputy Director, Administration
Foundation For the Future

Introduction

The seminar "Humanity and the Biosphere: The Next Thousand Years," which was jointly sponsored and conducted by Foundation For the Future and UNESCO, was intended to provide a forum for dialogue amongst academics, scientists, conservationists, resource managers, and practitioners in international environment relations to explore a critical component of the human-environment relationship with significant implications for the future of Planet Earth. The seminar was held at UNESCO in Paris, France, in September 2006.

Though the participants were encouraged to address the themes and issues suggested to them from any perspective they considered appropriate, the UNESCO Division of Ecological and Earth Sciences (SC/EES) prepared guidelines to inform the speakers and panelists of certain perspectives of interest. SC/EES hoped to draw insights and ideas from the seminar and integrate them into planning its future work as part of the next UNESCO Medium Term Strategy that is scheduled to be launched in 2008.

The Foundation's goal in its program activities is not to create a vision or develop a decisive set of guidelines for the future, nor does the Foundation advocate any particular cause or position. Rather, its effort is to create forums for scholarly discussions about the future and to distribute the results and records of those discussions widely in the anticipation that an informed, bottom-up process of choice and decision-making will affect the long-term future.

"Humanity and the Biosphere: The Next Thousand Years" followed five Humanity 3000 seminars; knowledge workshops on humans and space, nanotechnology, and the status of humanity's search for extraterrestrial intelligence; and two bidecadal Humanity 3000 symposia. Proceedings of previous Humanity 3000 events may be downloaded from the Foundation's website [www.futurefoundation.org].

Provided in this document are the transcripts of the seminar presentations plus commentaries and all plenary dialogic sessions.

The Proceedings Sections

Summarized below are the contents of each Section and Appendix of "*Humanity and the Biosphere: The Next Thousand Years*" *Proceedings*.

SECTION 1 cites the four themes that formed the basis of thinking for the seminar "Humanity and the Biosphere: The Next Thousand Years."

SECTION 2 summarizes the seminar, providing details on goals, design and process, selection of participants, and key outcomes.

SECTION 3 contains statements prepared by participants, describing their pre-seminar thoughts about the three most critical issues pertaining to humanity and the biosphere.

SECTION 4 provides transcripts of the presentations, commentaries, and all dialogic sessions that composed the core of the seminar. Included are two speeches given at the opening reception by Walter R. Erdelen, Assistant Director-General for Natural Sciences, UNESCO, and Walter Kistler, Co-founder and President, Foundation For the Future.

APPENDIX 1 is the seminar agenda, noting key activities from the opening reception to a group dinner following the closing remarks.

APPENDIX 2 provides biographical information on the eleven participants in the seminar, along with partial bibliographies of recent, relevant publications.

APPENDIX 3 includes two PowerPoint presentations given at the seminar by Bob Citron: "The Human Journey on Planet Earth" and "The Human Impact on Planet Earth."

List of Participants

Dr. Daniel B. Botkin
Founder
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Director
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Tufts University
Medford, MA USA

Mr. Albert de Haan
Commercial Director
European Climate Exchange
Amsterdam, The Netherlands

Dr. Sylvia Earle
Chairman
DOER Marine
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Ms. June Marie Mow
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Dr. Magnus Ngoile
Team Leader
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Dar es Salaam, Tanzania, Africa

Dr. Shekhar Singh
Convenor
National Campaign for People's Right to Information
New Delhi, India

Critical Themes and Issues

The following themes and issues were of particular interest to UNESCO SC/EES in discussions at the seminar. However, the speakers and panelists were not limited to these themes in their topics of presentation and panel intervention.

Biosphere in the 21st century

The 21st century will see the peaking of global human population at about 9 million and then, it is to be hoped, stabilizing and perhaps even falling. In addition, human populations may also become more and more concentrated around urban areas. At the end of the 20th century humanity recognized a global biodiversity crisis. The international community has set itself an agenda to demonstrate ways and means of significantly minimizing biodiversity loss by 2010. Is that target feasible? Is it possible that humanity may take a turn toward better ways of sustaining biodiversity? Under what conditions could that happen and how can better incentives and options for biodiversity be made more appealing for the general public?

Information, expert knowledge, and biosphere futures

Do scientific information and expert knowledge make a difference in enabling the enactment of biosphere-friendly policies and legislation and their effective implementation? Particularly during the global environmental decades that began in the 1970s with the establishment of the United Nations Environmental Programme (UNEP) in 1972 and of MAB in 1971, has science done all that it could do to better conserve and use biosphere resources? If yes, what are the good examples? If not, what could be done in the future?

Climate change and biosphere futures: threats and opportunities

Climate change will cause environmental, ecological, social, and political changes during the next century, the impacts of which are difficult to predict. In the meantime, climate change has opened the door for carbon-denominated financial instruments to enter global markets. Is this an opportunity or a threat? Many environmentalists and some economists question the ethics behind assigning quotas and permits for carbon trading to industries that created the problem in the first place! But could carbon financing and trading help biosphere causes like biodiversity conservation? What are the prospects and how do we move forward in these fronts?

Conservation and extinctions

As the global biodiversity crisis appears set to worsen during the 21st century, what would be prudent ways to choose conservation targets? Should we prioritize our efforts and investments into conserving large charismatic species, keystone species, ecosystems services, or a mix of these targets? What would determine political and policy choices in specific places around the world of our conservation priorities? Will the 21st century see all large animals and extensive areas of remaining, legally unprotected ecosystems vanish, leaving only legally protected islands of parks and reserves as refugia? What are the chances for biodiversity outside of legally protected areas surviving into the 22nd century?

These critical themes and issues became keynote and panel topics for the structuring of the seminar "Humanity and the Biosphere: The Next Thousand Years."

Seminar Summary

This summary provides an overview of the seminar "Humanity and the Biosphere: The Next Thousand Years," sponsored, organized, and conducted jointly by UNESCO Division of Ecological and Earth Sciences and Foundation For the Future. The seminar, held September 20–22, 2006, at UNESCO in Paris, France, was documented by video footage and still photography, in addition to this published proceedings document.

Background and Purpose

This seminar was the first of a number of scientific events the Foundation plans to co-host with United Nations agencies and other international organizations. It was a Foundation "Humanity 3000 Program" seminar.

Humanity 3000, one of the major program components of the Foundation For the Future, is an international seminar and symposium series launched in 1999. The purposes of Humanity 3000 are to use a multidisciplinary approach to assess the current status of humanity, to identify the most significant factors that may affect the life of the people of the Earth now and into the thousand-year future, to map the territory (past and present) of these factors and suggest trajectories, and to outline the problems and opportunities related to these factors for the long-term future.

The Man and the Biosphere (MAB) Programme is part of UNESCO's Division of Ecological and Earth Sciences. Since 1971, MAB has worked continuously for the sustainable use and conservation of biological diversity and an improved relationship between people and their environment globally. It is a pioneer international program for co-operation on research, training, education, and information- and knowledge sharing on all problems that straddle the human-environment interface.

The purpose of the seminar in Paris was to provide a forum for dialogue amongst academics, scientists, conservationists, resource managers, and practitioners in international environment relations to explore critical components of the human-environment relationship with significant implications for the future of Planet Earth.

Seminar Goal

The goal of the seminar was to identify issues critical to the long-term future of humanity and the biosphere.

Participants

Scholars from five continents participated in the seminar "Humanity and the Biosphere: The Next Thousand Years." UNESCO and Foundation For the Future developed their own lists of invitees to ensure a participant roster of experts from diverse affiliations and activities that bear on the biosphere. Ultimately, eleven participants were convened.

Observing and offering occasional comment throughout the seminar were various representatives of the UNESCO Division of Ecological and Earth Sciences, particularly those who are directly tasked with the implementation of the MAB Programme.

Seminar Design and Process

The seminar combined the focus of the Man and the Biosphere Programme with the Foundation For the Future's emphasis on the long-term future of humanity.

Prior to the seminar, participants were asked to develop and submit statements identifying the three most critical issues pertaining to humanity and the biosphere. These statements, along with brief participant bios, were made available to all participants before the seminar commenced.

The seminar agenda was a blend of presentations, commentary, plenary discussion sessions, and time for more casual conversations.

Speakers

Presentations on ecological and biospheric themes were given by ecologist Dr. Daniel B. Botkin, USA; astrophysicist Dr. Eric J. Chaisson, who holds directorial and professorial posts at Tufts and Harvard universities and MIT, USA; Albert de Haan, expert in carbon emissions trading, The Netherlands; oceanographer Dr. Sylvia Earle, USA; microbiologist Dr. Ricardo Guerrero, Spain; geneticist Dr. Lynn Margulis, USA; and philosopher Dr. Shekhar Singh, India.

Commentary was provided by environmental planner June Marie Mow, Colombia; Dr. Malcolm Hadley, expert in environment and development in coastal regions and small islands, France; Dr. Magnus Ngoile, expert in marine and coastal environment management, Tanzania; and wildlife conservation expert Dr. David W. Macdonald, UK.

Most Critical Issue

The core issue determined by the scholars to be the most critical, going forward into the far future, was the overarching goal of influencing change to foster the well-being of the biosphere – a goal with four main facets: (a) evolution of consciousness, (b) exploration and research into the driving forces of change, (c) education and communication for dissemination of knowledge, and (d) ethics/equity, including intra-species equity, inter-species equity, and intergenerational equity.

MAB will take the four-faceted goal into consideration in its current efforts to reform and reinvent its agenda in line with UNESCO mission and mandates.

Participants were invited to submit alternative wording of the core issue after the seminar, and one did so. That text is also included in this proceedings.

Future Seminar

In 2008, UNESCO's Division of Ecological and Earth Sciences and the Foundation For the Future will again co-host a seminar in Paris, in connection with the UNESCO "International Year of Planet Earth."

Section 3

Participant Statements

Daniel B. Botkin

What are the three most critical issues pertaining to humanity and the biosphere?

1. Energy Supply, Civilization, and the Biosphere.

Abundant, easily available energy has large effects on civilization and human societies. Recent anthropological research suggests that when energy has been abundant and easily available, human societies have tended to move in one of two directions: to become creative and innovative, or to use the excess energy to wage wars to dominate other peoples. It is even possible to make the argument that there is some correspondence between readily available energy and democracy: When democracy has flourished, energy has been comparatively abundant and available.

As long as we continue to depend on fossil fuels, we will continue to alter climate rapidly. Therefore, the future trajectory of the biosphere and the status of civilization appear to be linked through our use of energy, and the sources of energy that we select. What I am suggesting here is a different way of viewing the energy supply problem: It is not merely one of technological convenience; it goes to the very basis of the continuation of civilization as we know it.

2. Biodiversity.

Currently, it is fashionable among conservationists to believe that it is necessary, morally right, and best for people and for the biosphere that we maximize biological diversity, and that the biosphere is quite fragile and unresilient to any loss in diversity. But there is surprisingly little scientific evidence to support this. Research during the past half-century makes clear that prokaryotic-only time during the Precambrian was not the most diverse, but was highly persistent.

Some recent ecological research also casts doubt on the ecological necessity to maximize biodiversity, and suggests that there might be instead an optimal level of biodiversity. The persistence of life – assuming one is interested only in the fact that there is life, not what kinds – does not appear to depend on maximized biodiversity. This forces the question: What kinds of life do we hope will persevere, and what level of diversity do those kinds require? At the least, in order to understand the ecological importance of biodiversity, we must open up our thoughts and our research to consideration of what an optimum level of diversity might be for a given biosphere variable of interest.

3. Pervading Cultural Beliefs about Nature and Their Consequences for the Biosphere.

In modern Western civilization, laws, policies, and actions meant to improve the environment are in the large based on a belief in the "great balance of nature," the idea that nature undisturbed achieves a permanence of form and structure that is best for all life including ourselves, and that if disturbed, nature returns to that same fixed state. A concomitant of that belief is that people are outside of nature and only have destructive, undesirable effects on it. This is an ancient belief that can be traced back at least 4,000 years in the writings of early European civilizations. But it is incorrect; nature is always changing at every level of space and time; organisms are adapted to, and require, those changes. Moreover, people have had effects that are taken to be "natural" because they happened long ago, and which are seen as good. Our solutions to environmental problems, at every level, from the local to the biosphere, require that we understand how natural systems work and use this knowledge. To plan for a better future, we need this scientific understanding, freed from the mythology that still dominates environmental sciences.

Eric J. Chaisson

What are the three most critical issues pertaining to humanity and the biosphere?

The "three *E*'s" are chief among the most critical factors facing humanity and Earth's biosphere during the 21st century and throughout the millennium beyond.

Evolution

Humans are part of an evolutionary universe. We, among all life forms, share a common ancestry with the galaxies, stars, and planets, each of these changing structures (including us) being open, non-equilibrium, thermodynamic systems. A good understanding of our cosmic roots, and a detailed knowledge of how all life relates to everything else, will help us create a wise, viable future course.

The unifying scenario of cosmic evolution now grants us an opportunity to embrace a modern, interdisciplinary worldview that people of all cultures can adopt – a Big-Bang-to-humankind story that traces generative and developmental change ranging from quarks to quasars, from microbes to minds.

Evolution brought us here; change is good. Change must continue if sentient beings are to survive in Earth's biosphere, where losers far outnumber winners.

Energy

Arguably, all ordering and organization in the universe depend on energy flow. Much like giant stars or microbial life, today's civilization runs on energy, in fact, increasing amounts of it per unit mass for increasingly complex systems.

There is no way to avoid the need for more energy; energy is good. Rising energy *densities* are required for sentient beings to continue populating Earth either 100 or 1,000 years from now. Humanity and the biosphere might benefit from an economically managed symbiosis, much as life has benefited before.

Ethics

The next great evolutionary leap forward could be labeled "ethical evolution" – the espousal and development of a global culture, one where planetary citizenship becomes as important for us as it is for microbial life forms.

The current trajectory of our society displays sensitivity toward the needed ethics, as exemplified by enhanced awareness of human rights, environmental progress, and global security – but is there enough time to embrace the needed ethics before an array of global problems makes sentient life improbable?

Working Conclusion

Humanity, as we now know it, will not likely exist on Earth in 1,000 years. Either humanity will not exist at all owing to its inability to master each of the "three *E*'s," or … our descendants – at least those sentient beings that remain on Earth – not only will have accepted a symbiotic relationship with Earth's biosphere, but also will have created a symbiosis with networked machines. The result may well be an intelligent, carbon-silicon cyborg that is indeed able to welcome evolution broadly considered, to use energy efficiently and wisely, and to enjoy a sense of ethical well-being.

Ricardo Guerrero

What are the three most critical issues pertaining to humanity and the biosphere?

1. Sustainable development is a concept that must be continually reinforced and extended in order to confront the environmental transformations caused by human activities – ranging from farming to environmental degradation – on ecosystems. It also refers to renewal of the natural products exploited by humans.

2. Biodiversity and its conservation. Life on Earth comes in many shapes and sizes, from microscopic beings to whales and humans. Together, these organisms and their interactions are what constitute biodiversity. As defined at the UN Earth Summit held in Rio de Janeiro in 1992, biodiversity is the variability found in all living organisms (terrestrial, marine, and other aquatic ecosystems) and in the ecological complexes to which they contribute.

Besides its importance in ensuring a vast source of different, potentially renewable products of direct interest to humans, such as pharmaceuticals, foodstuffs, and alternative fuels, there are other, far more fundamental aspects of biodiversity. For instance, it is the great diversity of plants that enables the existence of many different kinds of animals, both herbivores and omnivores. Moreover, although biodiversity related to the microbial world has long been ignored, it is essential to appreciate that the species of microorganisms inhabiting the Earth have developed numerous chemical, physical, and structural characteristics that, together with their diverse metabolic strategies, ensure the functioning of all ecosystems – and thus of the planet itself.

The benefits of biodiversity are manifested at three levels: ecological, economic, and scientific:

Ecological benefit: The specialized functions of each species play an integral role in regulating the balance, diversity, and health of ecosystems.

Economic benefit: Biodiversity is a resource for daily life. An estimation of the value of biodiversity is a necessary component of any discussion on the inherent wealth granted to us by biodiversity and on its distribution. The concept of *ecosystems services* quantifies the economic value to humankind of all the functions carried out by the natural environment. Thus, for society, biodiversity is also a field of activity and profit.

Scientific benefit: Biodiversity is important because each species provides a clue to the history of evolution on Earth. In addition, biodiversity allows us to understand how life functions and the role of each species in sustaining the multitude of ecosystems that make up our planet. Molecular biology has enabled us to access the unique genetic material contained in each living species. The value of this knowledge and capability is incalculable, as evidenced by continuing progress in medical and genetic research, which, no doubt, will eventually lead to discoveries that cure diseases and reduce mortality worldwide.

3. Education is the key to acquiring and disseminating knowledge and culture. It is critical to creating a society that is able to rediscover the values of respect towards others and towards Earth, where life evolves. Education is the means to achieve, as a reality and not as a utopian dream, freedom, equality, and fraternity.

David Macdonald

What are the three most critical issues pertaining to humanity and the biosphere?

I see three topics cascading, ultimately, from the single issue of human population size and resource consumption. These three are:

a) habitat fragmentation and deterioration

b) invasive species and emergent diseases

c) climate change

Lynn Margulis

What are the three most critical issues pertaining to humanity and the biosphere?

The biosphere, the place where life exists, is limited to a volume, a 20km hollow sphere at the Earth's surface, fewer than 12,000 meters (12km) toward the abyss (the sea bottom) and 8000 meters (8km) to just above the mountain tops. Humanity (*Homo sapiens*, a relatively recent African primate closely related to *Pan paniscus* and *Pan troglodytes*, chimpanzees) now numbers 6000 million individuals. More than 70 per cent of the arable land is used for cultivation of its food grasses (*Avena*, *Oryza*, *Triticum*, *Zea*, *Hordeum*, etc.) and other plants (*Cannabis*, *Gossypium*, *Linum*, *Nicotiana*, *Phaseolus*, *Solanum*, etc.). The numbers of *H. sapiens* continue to increase whereas those of both *Pan* species (now fewer than 10,000) continue to decrease. The late Holocene is a short epoch of unprecedented extinction and environmental change.

I identify only one critical issue, albeit a complex one with many related ramifications. **How can population growth, genetics and behavior of *H. sapiens* be modulated in ways that retain the legacy of Franz Schubert, dignify death and extinction and retard loss of non-human planetmates?**

June Marie Mow

What are the three most critical issues pertaining to humanity and the biosphere?

1. Changing the trend: areas of high diversity (biological and cultural) as overlapped with areas of abundant poverty.

Many indigenous and local people living in areas with high biodiversity are "poor." In many countries there is evidence that indigenous and local people entitled to territory and natural resources are marginalized by national and multinational companies. Whenever new nature-based products are found, entrepreneurs tend to ignore the rights and needs of traditional users, and consequently forget that their survival as individuals and people depends upon the very resources they are exploiting. Traditional users are then abandoned, poor and at the limit of "extinction" due to depletion and/or alteration of natural resources and systems, and economic exclusion. Thus, if we layered maps of selected areas in all continents with high bio-cultural diversity and poverty, it would demonstrate that areas of rich cultures and high biological diversity would be exactly the same as the areas where the population is at the poverty level according to the standards of poverty measurement.

2. A well-being index designed especially by and for indigenous and local people.

Monetary wealth and achievement of material needs are not the only things that matter for the well-being and sustainability of humankind. Social well-being, family and community support, ontological needs such as respect for each other, relationships, dignity, meaningful work, life itself, love, protection, and food security are goals for sustainable living. Therefore, development goals and indicators should not be defined and structured homogeneously in a top-bottom approach with full recognition and respect for cultures. It should be the result of processes that involve the people as stake- and right-holders of their own development. The processes should explore and "take advantage" of people's creativeness and collective conscience.

3. Carrying capacity – molding a new ecological pattern.

The current ecological pattern leads to exceeding, instead of raising, the limits of carrying capacities and to the alteration of humankind's capacity towards sustainable living. Humankind today is thus competing with future generations. Carrying capacities are not kept as wealth, but rather, are used up.

Exceeding carrying capacities impacts not only the physical aspects of humanity. Also, higher population and overcrowding create animosity and conflicts, such as preventing friendly and healthy relationships between different groups.

Therefore, it is essential to look at new perspectives in order to understand the complexity of issues and to bring forth alternative ecological patterns for the well-being of the future of mankind.

Shekhar Singh

What are the three most critical issues pertaining to humanity and the biosphere?

1. Unsustainable and increasing levels of consumption (and profiteering) by the financially rich countries, and by the rich and powerful people in the poorer countries.

This is exacerbated by two major factors – discriminatory global and national political structures and processes, and unbalanced developments in science and technology.

a. Prevailing political structures allow global and national centres of power to consume and destroy nature and natural resources while transferring the costs of such destruction to those who are weaker.

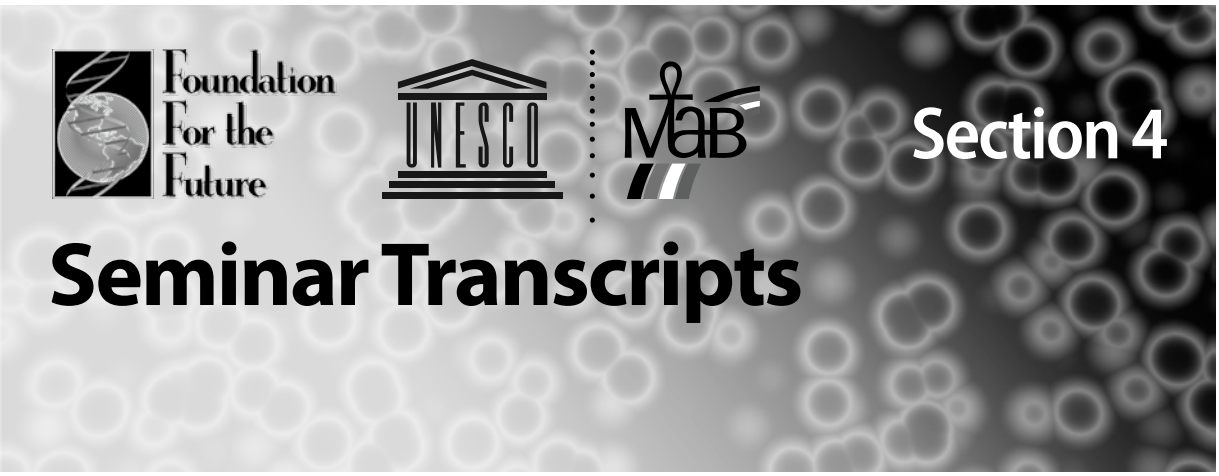
b. Science and technology develop in a socio-political ethos. Therefore, for many decades the ability to use natural resources and destroy nature has developed much faster than the ability to regenerate and protect them.

2. The lack of a real option to conserve, for billions of poor people across the world.

Just as environmental destruction leads to poverty, poverty leads to environmental destruction. Where regimes related to the ownership of land and other means of livelihood marginalize large proportions of populations, and where infrastructure projects and modes of production and services economically displace people, the affected people often have no other real option except to commit ecological suicide by over-exploiting nature and natural resources.

3. Profound ignorance about how to manage nature and natural resources in a manner that is compatible with human needs and pressures.

Prevailing scientific wisdom stresses the imperative to minimise human use and interference in wilderness areas for biodiversity conservation. However, scientific evidence in support, for example, of minimum viable populations, or for establishing the minimum acceptable numbers and size of conservation areas, is patchy and mostly unconvincing, making it difficult to argue the case for conservation with policy-makers and bureaucrats.



The seminar "Humanity and the Biosphere: The Next Thousand Years," held September 20–22, 2006, convened eleven prominent academics, scientists, conservationists, resource managers, and practitioners in international environment relations to explore critical components of the human-environment relationship with significant implications for the future of Planet Earth.

A primary goal of the seminar was to provide a forum for assessing the state of knowledge with respect to the biosphere and to arrive at consensus on the most critical factors for the long-term future of humanity and the biosphere.

In two days of meetings, plus the opening reception, the participants gave and heard presentations and commentary, and discussed the factors most critical to the future in this subject area. Following are transcripts of the reception speeches and all seminar sessions.

Opening Reception

As host of the seminar "Humanity and the Biosphere: The Next Thousand Years," UNESCO Division of Ecological and Earth Sciences also hosted the opening reception in the Bar Miollis. The cocktails and hors d'oeuvres reception was attended by UNESCO and Foundation For the Future personnel, seminar participants and observers, and guests.

Natarajan Ishwaran, Director of the Division of Ecological and Earth Sciences, welcomed the Foundation officers and seminar participants to the first event jointly sponsored by UNESCO and the Foundation, then introduced the speakers.

Dr. Walter Erdelen, Assistant Director-General for Natural Sciences, UNESCO, Paris, and Walter Kistler, Co-founder and President of Foundation For the Future, gave welcoming addresses. Transcripts of both addresses follow.

Foundation Executive Director Bob Citron introduced the film *Cosmic Origins: From Big Bang to Humankind*, acknowledging the key role in the film's creation played by Dr. Eric J. Chaisson, Tufts University, who was in attendance as a participant in the seminar.

"Humanity and the Biosphere – UNESCO Contributions: Past, Present, and Possible Future"

Welcome Address by Dr. Walter Erdelen

Dr. Walter Erdelen has been the Assistant Director-General for Natural Sciences, UNESCO, Paris, since 2001. His extensive background in biospheric subjects includes service as Associate Professor at the Institute of Biogeography at Saarland University, Saarbrücken, Germany; Professor of Ecology and Biogeography at the Department of Zoology, Institute for Animal Ecology and Tropical Biology; and Director of the Ecological Field Station, University of Würzburg, Germany. His remarks (which follow) opened the seminar "Humanity and the Biosphere: The Next Thousand Years."

WALTER ERDELEN: First and foremost, I should welcome you, Executive Director of the Foundation For the Future, distinguished invited experts, ladies and gentlemen, friends. It is a great pleasure and an honor for me to be here with you today on the occasion of the UNESCO/Foundation For the Future seminar on "Humanity and the Biosphere: The Next Thousand Years." From the outset, allow me to express my thanks to the Executive Director of FFF, Bob Citron, for the opportunity to co-organize such an important seminar. I would also like to express my sincere appreciation to the distinguished experts who have accepted to contribute their ideas to the reflection before us: how the relation between humanity and the biosphere is likely to evolve in the future, in which direction, what implications this will have, how we can drive such an evolution towards preferred trajectories, and what implications can be derived from a new consciousness of renewed interaction between humanity and the biosphere.

The seminar is an important one because it brings together two organizations that are knowledgeable and experienced in the topic we will be addressing. UNESCO is *the* specialized agency within the United Nations system for education, science, and culture. The organization promotes scientific programs at the international level on issues of global concern, coordinates the implementation, and assists in building the capacity for their execution. Applying the findings of scientific research and monitoring, as well as technological advances and innovation as a whole, are part and parcel of our programs.

UNESCO's Man and the Biosphere Programme was conceived 35 years ago with a specific purpose of elucidating the interactions between people and the biosphere through science, including site-based research and of conveying findings and lessons learned to all governments in the world for a more sustainable interaction between people and the biosphere from an environmental, social/economic, and cultural standpoint.

The mission of the Foundation For the Future is to increase and diffuse knowledge about the long-term future of humanity. The Foundation does so by providing a think tank for discussing issues related to many disciplines and fields of application of human knowledge, and by assessing how human actions impact on the long-term future of the planet.

What are, now, the challenges for humanity and the biosphere in the new millennium and beyond? Let me mention a few, based on current debates on the subject. The emergence of a global civil society, and in terms of multinational financial flows, the global dynamics of stock markets, the evolution of our information and communication technologies, and the recognition of global issues and problems such as the international concern about ethical issues, global climate change, and the North/South divide. Environmental challenges in the 21st century, some of which are likely to continue beyond it, include enormous recent impacts on the atmosphere; health risks from ground-level ozone and fine particulates;

health risks from over-exploitation of service water resources and aquifers; increasing threats to biodiversity; increasing exploitation and depletion of wild fish stocks; worsening land and soil degradation, particularly in developing countries; the degradation and fragmentation of many, if not most, existing habitats and ecosystems; the increase in frequency and intensity of natural disasters; and climate change and its impact at all levels. I think you could continue with this list – you could go on and on.

Further challenges include social transformations, which continue to occur with increased pace, frequency, and intensity. Institutional arrangements are finding it difficult to adapt to these transformations. Cultures are on the verge of extinction, and cultural diversity, including linguistic diversity, is being eroded and lost. Moreover, the effects of all these challenges for the new millennium and the future are often cumulative, thus making the global situation and its local manifestations even more difficult to deal with.

Let me now introduce to you, briefly, how UNESCO is in the process of addressing some of these pressing challenges. First, UNESCO does so by promoting the use of science for development. Science in the new millennium is, in fact, the science of complexity. Simple structures interact to create new phenomena and assemble themselves into devices. Large, complicated structures can be designed atom by atom for desired characteristics. In general, with new tools, new understanding, and the developing convergence of the disciplines of physics, chemistry, material science, and biology, we build, in fact, on our 20th century successes and begin to ask and solve questions that were, until the 21st century, in the realm of science fiction.

In dealing with complex systems, we deal with nonlinearity, emergence, self-organization, multiplicity of scales and of legitimate perspectives, and structural uncertainty – also defined as ignorance. Speaking of ignorance, this term has a different meaning in use. Scientific ignorance is the lack of knowledge in the particular domain that science could contribute towards improving. This is why we must strive towards scientific literacy. In a society that is becoming increasingly driven by science and technology, scientific literacy is not a luxury; it is a necessity. Let me, in this context, also quote a Nobel laureate, who said, "The most important product of knowledge is ignorance" – maybe that is a point for further discussion later in the evening. Scientific research and discovery, and associated technological applications are the driving forces behind the creation of knowledge societies. In turn, how science impacts on society is not only dependent on scientific findings, but also on the way in which society shapes science through public perception, national policies, and institutional mechanisms for organizing research programs and activities, and promoting their applications.

In the endeavor to promote scientific literacy, science education is also at the forefront of UNESCO's efforts and has been for many years now, without discrimination and encompassing all levels and modalities. I should say here that we are currently finalizing a book publication on the history of the natural sciences in UNESCO, and that gives an idea of what has happened through 60 years. As you know, we are currently celebrating our 60-year anniversary. Moreover, a broader scale than science education and science popularization is also needed to promote an improved understanding of science and adequately orient public perceptions and attitudes about science and its applications.

UNESCO believes in the importance of a new science for this millennium. Information and communication technologies (ICTs) have been made possible by science, but have also changed the latter in the process itself. ICTs have accelerated synergy among different science specialties. Subsequent to the formulation of integrated approaches to scientific research, the knowledge base has become increasingly interdisciplinary. What better than bioinformatics, genomics, and reverse vaccinology to subscribe this? Changes in paradigms, or the new interdisciplinarities, are demonstrated also by terms like *biocultural diversity*, *ecological economics*, and *bioethics*. These interfaced disciplines have been made possible by a knowledge explosion in genetics, molecular biology, and the biotechnologies. Interdisciplinarity is inherent in our search for solutions to environmental issues and problems, and it is one of the key aspects that we are currently discussing in the review of our major program here in the natural sciences.

Changes in paradigms have also been made possible by viewing the basic applied science – I should call it a *pseudodichotomy*, which is, indeed, a continuum – by exploring the interlinkages of modern science

and local, indigenous knowledge systems by trying to combat ignorance by valuing diversity – both biological and cultural diversity – and finally, and last, not least, by the dynamic networking of institutions at all levels: national, subregional, regional, and global.

It is UNESCO's position that scientific disciplines should increase their contact, not only with one another, but also with other modes and traditions of inquiry, especially in terms of the ethical, social, and environmental implications of scientific and technological developments. It is stimulating to note that several of these themes will, indeed, be given special attention at this seminar. In particular, I am pleased to note the interlinkages between scientific knowledge and the issue of long-term sustainability, in which UNESCO is increasingly involved through its relevant programs. In fact, mobilizing science for sustainability may become one of the overarching objectives of our next medium-term strategy, which covers the time period 2008–2013.

Our joint seminar is about a vision – a vision on how to ensure sustainability into the long-term future. The Man and the Biosphere Programme was, indeed, a visionary initiative at its inception already in 1971, when the General Conference of UNESCO decided that the MAB Programme should focus "on the general study of the structure and functioning of the biosphere and its ecological regions, on the systematic observation of the changes brought about by man in the biosphere and its resources, on the study of the overall effects of these changes upon the human species itself, and on the education and information to be provided on these subjects."

More than ever, we are confronted with this very fundamental preoccupation of how humanity should deal with the biosphere, especially now that we realize the extent to which we have dominated the biosphere and we have transformed ecosystems, in some cases promoting their diversity and the services they provide for human well-being, but in most cases, unfortunately, reducing the biosphere's capacity to sustain humanity itself. Our understanding of the changes brought about man in the biosphere and its resources and the overall effects of these changes upon the human species itself are perhaps broader and deeper today than in 1971. For example, climate change and global warming consequences are understood, and the implications for the future of human/environment relationships are better appreciated today than in the late 1960s when MAB was conceived.

Moreover, an important paradigm shift has taken place, by which humanity is now seen as an integral part of the biosphere, as anticipated already in the MAB vision. This makes humankind at the same time accountable and responsible for finding solutions. It empowers society with the right to take decisions that will shape management interventions, but also with a duty to confront the costs of those choices and the implications for future generations.

UNESCO's Man and the Biosphere Programme has, indeed, gone through different phases, reflecting changes in the thinking of the broader international scientific community. At the beginning, MAB focused on the impacts of increasing human activities on different ecosystems, ranging from tropical forests to small islands; conservation of natural areas and the genetic materials they contained; the effects of major engineering works, urban areas, and energy flows; demographic, perceptive, and other futures of human ecology on the environment.

In the current mood of reform prevailing within the UN system as a whole, this seminar is a timely event of reflection to guide the future vision and orientation of MAB. In a world facing accelerating biodiversity loss, unpredictable climate futures, and risks for the sustainability of human well-being, what are the themes and issues a program like MAB should focus on? We are hoping that your open-ended discussions on the future of humanity/biosphere relationships will provide us, here in UNESCO, with ideas, insights, and trends that could help us in adapting the program to current and future needs of global society.

Based on how both our institutions find the experience of working together in the organization of this first event, I am sure that it will be a positive one and we may discuss possibilities for further cooperation in the future – in fact, what we have already embarked on when we opened this meeting. "Humanity 3000" could be an apt theme for UNESCO's Natural Sciences Sector and FFF to collaborate on during the UN Year of Planet Earth in 2008, and this also we already touched upon. We hope that we can continue to encourage dialogues such as this one among scholars and practitioners more frequently in the future. We need our best minds to tackle the issue of humanity's future relationships with the biosphere, and we need govern-

ments and civil society to act upon this new thinking.

I wish you a most successful seminar, and thank you very much for your attention.

"Why the Foundation For the Future Has a Thousand-Year Outlook"

Welcome Address by Walter Kistler

Walter Kistler is co-founder and President of the Foundation For the Future, which is dedicated to the increase and diffusion of knowledge concerning the long-term future of humanity. He is a recognized pioneer in the invention and development of high-performance instrumentation for aerospace as well as a number of other industries, and he has played a key role in the creation of several high-technology companies. Mr. Kistler is the owner of more than 50 US and foreign patents and the author of a number of papers published in scientific and trade journals. His book Reflections on Life was published in 2003.

WALTER KISTLER: Ladies and gentlemen, I would like to welcome you to this meeting, this combined meeting of the Foundation For the Future and of UNESCO – the first time we work together with an important organization like this. I would like to say a few words about our foundation.

There are different organizations today that consider the future or are interested in the future. There is one thing unique about our organization, and that is its long-range view. We have a thousand-year outlook. You see in our logo the famous helix of genes. What is not generally known or appreciated is that each one of these genes has an average life expectancy of three million years, so the helix is something very permanent, very reliable. Since the helix is the basis of humankind and is certainly very important in forming or deciding the future of humanity, our foundation takes its cue from there and looks at a minimum of a thousand years' future. Maybe I had best explain why.

Assuming you are looking at the countryside as representative of the future. Let's say that there is a big plain with lots of little moleheaps covering it. That is our present, with all the little problems that plague humanity and take all the attention. Most people are so interested in these present problems – which, of course, bother you – and they fail to see that in the distance are the snow-covered Alps, the mountain summits. In the long range, in a thousand years, the moleheaps will all be forgotten, but the big mountains will still be there. So, we like for our foundation to concentrate not on the little moleheaps, but on these big mountains that will really play a role in the future and will still be there in several hundred, or several thousand years. These will not be forgotten; all the stupid, little things are forgotten.

That keeps us above politics, which I think is very important for our foundation. We are apolitical; we are neither Right nor Left; our concern is one concern. If you enter our building, you will see that this concern is permanently engraved in the floor because we want this to be our permanent motto and guidelines: "The truth, the whole truth, and nothing but the truth." We go for truth and not for local fads and political influences. That we shove to the side. Some people may like it; some may not like it; we don't care. We look at the long-range future.

Thank you.

"Why the Foundation For the Future Has a Thousand-Year Outlook"
Welcome Address by Walter Kistler

Introductory Session

HOST: Natarajan Ishwaran
FACILITATOR: Sesh Velamoor
PARTICIPANTS: Plenary Session

We are very pleased to have this seminar … We will be very interested in drawing insights and ideas that we can use for our future work in UNESCO.

NATARAJAN ISHWARAN (HOST): Good morning. Welcome again. After yesterday evening's more informal moment, we are back here with the beginning of the seminar.

My name is Ishwaran. I am the Director of the Division of Ecological and Earth Sciences in UNESCO. We are very pleased to have this seminar. This is, we hope, the first of a series. Using Humphrey Bogart language, "it's the beginning of a long and beautiful relationship." We hope that this kind of event will open up the possibility within UNESCO, also, to think of issues that may not be in the immediate future. All of us who are working in this organization are compelled to address issues that are of current importance and that affect our budgets and our planning frameworks, and so on. As Walter Kistler said yesterday, we are all looking at the little mounds and forgetting the big mountains out there that might continue to exist beyond us. So, we hope that this will be a good experience and that we will be able to continue this relationship by having similar events in the future.

For this seminar, we have no expectations in terms of what we want you to say, in terms of our programs. You're totally free to say whatever you want, and we will be, of course, listening. We will be very interested in drawing insights and ideas that we can use for our future work in UNESCO. It's up to us to benefit from your discussions. Some of my staff who work for the Division of Ecological and Earth Sciences and the Man and the Biosphere Programme will be in and out to listen to the discussion. And we have specific time slots when MAB staff can ask questions and make comments. Beyond that, the table and the floor are all yours.

With those words I will pass the meeting to Sesh, who is going to be the orchestrator of this whole exercise. Thanks.

The mission of the Foundation is to increase and diffuse knowledge concerning the long-term future of humanity.

SESH VELAMOOR (FACILITATOR): Thank you. My name is Sesh Velamoor. I direct programs at the Foundation For the Future, and part of my responsibility is to moderate workshops that we routinely do at the Foundation in Seattle, Washington. You'll see a lot of me for the next two days, and I hope that we'll part as friends in spite of it.

The mission of the Foundation is to increase and diffuse knowledge concerning the long-term future of humanity. It's important to keep in mind that statement of our mission, because everything we do here will be pointed towards accomplishing that objective. To begin with, the "increase" part is pretty much how the seminar is structured to meet that requirement. Basically, it starts with presentations on various aspects of the subject under discussion, followed by conversations between participants. Then tomorrow, we will have free conversations to identify and to flesh out critical issues pertaining to this large subject of "humanity and the biosphere." That's the general framework insofar as how we will go about doing this.

The "diffusion" part of the mission statement basically has to do with the fact that we document

everything that is going on so that we can present the material to people outside in the public arena. At the same time, we document to create an archival source of information for whoever wants to do research and/or for future generations, as we would like to think.

The first part of what we do is self-introductions by participants. Let's start with David.

Our objective is to find practical solutions to prevailing problems for conservation around the world, underpinning them with scientific fact and evidence.

MACDONALD: My name is David Macdonald. I'm the Director and founder of an organization called The Wildlife Conservation Research Unit at Oxford University, known to its friends – I hope it only has friends – as WildCRU. We specialize in ecological and behavioral and related work on the conservation of wildlife around the world. Our objective is to find practical solutions to prevailing problems for conservation around the world, underpinning them with scientific fact and evidence.

… for the last 20 years or so I've been concurrently working on environmental management issues, specifically issues relating to wildlife management …

SINGH: My name is Shekhar Singh. I'm from India. Currently I'm associated with the National Campaign for People's Right to Information, which is a mass movement in India that was mainly responsible for formulating, and persuading the government to pass, the "right to information" law. It now works at ensuring that the law gets properly implemented. But I don't think that's why I'm here.

Until recently I was teaching at various institutions, the last of which was the Indian Institute of Public Administration. Though by training I am a student of philosophy and taught philosophy for many years at a university, for the last 20 years or so I've been concurrently working on environmental management issues, specifically issues relating to wildlife management and the conflicts (in India these are very common) between the local people, especially village communities, and protected areas like national parks and sanctuaries. I was also for a while in the government of India, heading the Division on Environment and Forests in the Planning Commission, and therefore got a glimpse of what happens within the government, which I hope will help us in our discussions.

I represent … 250,000 species of protoctist organisms that are very important to us but about which we know very little.

MARGULIS: I'm Lynn Margulis. I come from the University of Massachusetts where I defected from the Biology Department because they're not concerned anymore with the planet. I represent, I hope, 250,000 species of protoctist organisms that are very important to us but about which we know very little.

I'm here as representing the biosphere, so rather than to speak, I want to pass around a Man and Biosphere project that is 11 volumes – the biosphere as it is now and not known to the people who run the Man and Biosphere Programme. There is the problem: distribution of the knowledge. The knowledge may exist, but it does no good when prejudices and preconceptions dominate the knowledge. So, I pass this around to show you especially. Eleven volumes on the state of the biosphere today – I could bring only one, because I could carry only one – but open it, please, and look at it. That's what we're trying to preserve.

I started the European Climate Exchange two years ago, together with my CEO, and we are facilitating carbon trading …

DE HAAN: Good morning. I'm Albert de Haan. I'm apparently the only stranger here amidst so many scientists. I'm coming out of the financial markets. I used to be a currency trader. I started the European Climate Exchange two years ago, together with my CEO, and we are facilitating carbon trading, which is mandatory in Europe and voluntary in Chicago. If I'm sounding now and then a little bit "unscientist," please do take note that I'm coming from a different world.

I'm very pleased to be here. I will learn a lot and

I hope that you can experience a little bit the financial markets approach to climate and climate change. Thank you.

I've spent 40 years trying to understand how to make forecasts about ecological phenomenon …

BOTKIN: I'm Dan Botkin. I'm a Professor Emeritus from the University of California Santa Barbara, but actually, like Lynn, I have escaped from biology departments and set up my own nonprofit so that I could do what I hoped was important about dealing with the environment.

I've spent 40 years trying to understand how to make forecasts about ecological phenomena, everything from endangered species to forests in response to climate change and human disturbances.

CITRON: I'm Bob Citron. I'm the Executive Director of the Foundation For the Future. I work for Walter Kistler.

I'm an environmental planner and manager, and I have worked many years with small islands.

MOW: My name is June Marie Mow, and I come from a very small island in the Caribbean. I'm an environmental planner and manager, and I have worked many years with small islands. So, I have this perspective, and I hope to share it with you.

I'm associated with three universities in the Boston area: Tufts, Harvard, and MIT.

CHAISSON: I'm Eric Chaisson. I'm associated with three universities in the Boston area: Tufts, Harvard, and MIT. At Tufts I direct the Wright Center for Science Education; at Harvard I basically teach a course on cosmic evolution at the Harvard College Observatory; and at MIT I co-run another center in the Aeronautics Department. It's important to be a moving target among the universities in the Boston area.

And if you're wondering why a rocket scientist is among you, I suspect it's because the organizers expect me to play the role of *d'agent provocateur*. And I may just do that today.

I am also a microbiologist and worked for many years trying to justify and to explain the view that microbes are not bad; they are necessary.

GUERRERO: My name is Ricardo Guerrero. I am from Barcelona, Spain, one of the few representatives of the Mediterranean Sea here. I am the Scientific Secretary of the Institute for Catalan Studies, which is the academy of the Catalan people, about 10 million people in the Mediterranean area.

I am also a microbiologist and worked for many years trying to justify and to explain the view that microbes are not bad; they are necessary. Microbes were here before, and microbes will be here after the human species. So, after 1,000 years, 2,000 years, 3,000 years that Walter talked to us about, microbes will exist, not humans.

I've spent most of my career working in UNESCO … in ecology and resource use in the humid tropics …

HADLEY: I'm Malcolm Hadley. I'm a soil biologist by background. I've spent most of my career working in UNESCO in Ish's division, what was then the Division of Ecological Sciences, and the MAB Programme. My major interest during that period was in ecology and resource use in the humid tropics and in the whole question of the communication of scientific information for different groups of people.

KISTLER: My name is Walter Kistler. I am a physicist by education. And I am the founder, together with Bob Citron, of the Foundation For the Future. I mostly provided the funds; he mostly provided the capability and know-how. And together we were able to make

this thing that we hope will be successful in the long-range future. Thank you.

ISHWARAN: There are some members of the UNESCO staff who are here. I'll start with Salvatore, and maybe then Jane and the others can introduce themselves.

ARICO: Thank you. My name is Salvatore Arico. I'm an ecologist by education, specializing in marine ecology. But I'm particularly interested in the interface between science and policy and how, especially, scientific assessments can inform the policy-making process. I work with Ish in the Division of Ecological and Earth Sciences.

ROBERTSON: Good morning. My name is Jane Robertson. I also work in the Division of Ecological Sciences, though I have a rather special status at the moment. I'm on leave in function of my early retirement, but I've been working with MAB and UNESCO for 28 years. During that time I worked particularly in the World Network of Biosphere Reserves, which are sites in the MAB Programme where we try to put into practice ideas about a sustainable future. Thank you.

PERSIC: Good morning. My name is Ana Persic. I am an ecologist by education and specialize in ecotoxicology, and I have just recently joined UNESCO and MAB and the Division of Ecological and Earth Sciences.

SCHAAF: Good morning. I'm Thomas Schaaf. I also work in UNESCO Division of Ecological and Earth Sciences. By training I am a geographer. I am in particular in charge of dryland ecosystems and mountain ecosystems all around the world. As regards drylands, we study soil and water management and sustainable development. As regards mountains, we look into climate change issues and how we can assess strategies to cope with climate change in the future. Thank you.

FACILITATOR: Just to clarify, the people in the outer circle who have introduced themselves are in a special category called "observers." In the course of the next two days there are intervals during which they are invited to interact with the participants, depending on their areas of expertise, with questions they might have or clarifications they might seek from the main panel of participants.

Without further ado, let's begin the program.

Presentations and Discussions
Guidelines

Before a full day of presentations and discussions, the seminar facilitator provided an overview of the structure of the seminar "Humanity and the Biosphere: The Next Thousand Years."

FACILITATOR: Sesh Velamoor

PARTICIPANTS: Plenary Session

In the early communications between UNESCO and the Foundation about this seminar, we arrived at four themes, and then we built the seminar around them.

SESH VELAMOOR (FACILITATOR): This seminar "Humanity and the Biosphere: The Next Thousand Years" has been designed to address the key areas under this topic in a variety of formats: presentations, Q&A, discussions among the participants, and discussions bringing together participants with personnel from UNESCO's Man and the Biosphere Programme.

This seminar structure is in keeping with the Foundation For the Future's mission to "increase and diffuse knowledge concerning the long-term future of humanity." What surfaces in your presentations and discussions we view as increasing knowledge. Our distribution of the transcripts subsequently is part of diffusing the knowledge that will surface here.

In the early communications between UNESCO and the Foundation about this seminar, we arrived at four themes, and then we built the seminar around them. One keynote theme is the Biosphere in the 21st Century, and we invited presentations on that theme from Daniel Botkin, Eric Chaisson, Lynn Margulis, and Sylvia Earle. Those presentations will start us off this morning. The second keynote theme we selected is Climate Change and Biosphere Futures: Threats and Opportunities, and we thought that Albert de Haan can speak to that. Two other participants that we had expected to speak on this theme had to cancel their attendance at the last minute.

We also selected topics for panels. Panel 1 will address Information, Expert Knowledge, and Decison-making: Ecological Sciences and Biosphere Futures. Our opening speaker on this theme is Shekhar Singh, followed by commentary from June Marie Mow, Malcolm Hadley, and Magnus Ngoile. Panel 2 will address Conservation and Extinctions, with a presentation from Ricardo Guerrero and commentary from David Macdonald.

Each of the speakers will be followed by questions from the floor and a discussion period.

Keynote Theme 1
Biosphere in the 21st Century

The 21st century will see the peaking of global human population at about 9 million and then, it is to be hoped, the population total will stabilize and perhaps even fall. In addition, human populations may also become more and more concentrated around urban areas.

At the end of the 20th century, humanity recognized a global biodiversity crisis. The international community has set itself an agenda to demonstrate ways and means of significantly minimizing biodiversity loss by 2010. Is that target feasible? Is it possible that humanity may take a turn toward better ways of sustaining biodiversity? Under what conditions could that happen and how can better incentives and options for biodiversity be made more appealing for the general public?

Speakers addressing this theme were Dr. Daniel B. Botkin, Dr. Eric J. Chaisson, Dr. Lynn Margulis, and Dr. Sylvia Earle. Transcripts of their presentations follow in this section, which concludes with a plenary discussion of the material.

Keynote Theme 1 – Biosphere in the 21st Century

Presentation by Dr. Daniel B. Botkin

… when it comes to … thinking about ecology and our living resources, we have functioned and still continue to function mostly from a nonrational point of view …

BOTKIN: I have spent 40 years trying to work out how to make forecasts about our living resources, about ecological systems. It is possible to do it, but we're often on the wrong track. When we want to make forecasts for a thousand years, we would like to do it rationally – as scientists especially. Here we are in Paris, more than 200 years after Descartes. We are children of the Cartesian revolution, great believers in rationality and we, as scientists, are supposed to be the purveyors – the ministers, so to speak – of rationality. But, unfortunately, when it comes to making forecasts about the environment or thinking about ecology and our living resources, we have functioned and still continue to function mostly from a nonrational point of view, and I want to clarify that in my talk. The best summary of my talk is a statement made by the American cowboy philosopher Will Rogers, who said, "It ain't what you don't know that gets you; it's what you do know that ain't true."

A funny thing happened to me in the early 1970s when the United States passed a new law, the Marine Mammal Protection Act. The odd thing was that the commission set up by the law didn't understand the law, so they asked me to come and explain to them what it meant to talk, as the law did, about "the health and stability of marine ecosystems" and "an optimum sustainable population of marine mammals."

Having been trained originally in physics, I looked at data about marine mammals – that seemed to be a good place to start – and I looked at the forecasting methods in use. I was very surprised to find that the scientists advising the US government were giving advice that I knew contradicted the facts, and I knew *they* knew contradicted the facts. Now, I didn't believe they were intentionally dishonest. I did not think they were charlatans. What I found out, after thinking it through, was that the advice they were giving was advice based on the great Western civilization idea of the balance of nature. They believed in this idea so deeply that it blinded them to what the information told them. I wrote about that in my book *Discordant Harmonies* [subtitle: *A New Ecology for the Twenty-First Century*, Oxford University Press] published in 1990.

What has happened since is that now there is lip service paid to the idea that these are non-steady-state systems and that we are going to think about the Earth as dynamic. But when you look at what people are actually doing, they are still making forecasts about all of our living resources – from the possibility of extinctions to Pleistocene extinctions to the management of wildlife and fisheries and forests – based on the steady-state idea of the great balance of nature. So, we have a fundamental problem, and I want to go over it with you in a little detail in the time I have to bring home the seriousness of the problem.

… the key to the idea of the balance of nature … is that nature left alone, undisturbed, achieves a permanency of structure … And if disturbed, it will return to that same form.

First of all, the key to the idea of the balance of nature, which you can trace back to the Greeks and Romans, who puzzled about the idea of nature, is that nature left alone, undisturbed, achieves a permanency of structure and form that will remain forever. And if disturbed, it will return to that same form. This is beautifully illustrated by a painting by Frederic

Edwin Church, one of the members of the Hudson River School of Painting in the United States, called "Morning in the Tropics." There are three important qualities in the painting that represent, from the Greeks on down – in fact, all the way from Babylon on down – the keys to the idea of the balance of nature: Nature alone is very beautiful. Nature alone is completely still. And there are no people in it.

The problem, of course, that the Greeks had and that we have is that if nature is supposed to be perfect, why isn't it actually perfect? And the answer always was *people* – one of two ways, which will be very familiar to you. Either we were put here as the final cog in the gods' wheels and machinery to perform that final perfection and we've failed, or nature's perfect without us and we screw it up.

We live in a time when there's a lot of naysaying; there's a lot of love of nature without people, and a lot of blaming people for the problems with environment.

We live in a time when there's a lot of naysaying; there's a lot of love of nature without people, and a lot of blaming people for the problems with environment. So, as a scientist who is trying to make forecasts, I come at this, in part, from a cultural point of view, believing that nature's wonderful and so are people, and that we have to get away from, first of all, false approaches and, second, we have to get away from this division of seeing people and nature as separate.

Now, I've done forecasts. I developed in 1970, with IBM, a computer model of forests that is not a steady-state model. It's not a complicated model. These are not intractable problems. They are not beyond the reach. That's what you hear, but it's not true; it just takes us breaking away from these old ideas, and we still are not doing that. Joseph Campbell, the anthropologist, said that every society needs a nature myth in the sense of an explanation of how nature came about and how it works. He said that our problem is our nature knowledge is 4,000 years old, and it's wrong. Our science tells us a great deal, and a few examples will bring home the point. The fundamental model that lies at the basis, still, of most of the forecasting, including the forecasts of human population done by the World Bank, going back to the early 20th century, is the Logistic Growth Curve, which says that a population will grow up to a carrying capacity that is fixed in time. And it says that there is no change in the environment. It is a mathematical statement of a steady-state world, except for human harvesting of living resources.

Now today I am helping the International Whaling Commission deal with the management of bowhead whales, which are controversial because of the United States treaty with the Eskimos that allows Eskimos to take whales. The question is: How many should they take, and how do you decide on it? This keeps coming up, especially because Norway and Japan want to harvest whales and take every opportunity they can to embarrass the United States by actually looking at information. So, starting in the early 1970s I began to work with a marvelous anthropologist, John Bockstoce. He obtained 20 percent of the logbooks from every voyage made by the Yankee whalers, all of whom came out of New Bedford, Massachusetts, and went hunting the bowhead in the north Pacific. Their hunting was so amazing: Sometimes they would stay over the winter, have large banquets, and play baseball on the ice. These were long voyages. This commercial whaling from New Bedford went on from 1849 to 1914.

We have digitized, from what the first mate wrote down every day, 66,000 days of observations. To our knowledge, that is the largest, greatest dataset about any mammal. So, we know a great deal about bowhead whales and the hunting of them. For example, we can look at a five-year period, and see where whales were caught; we can see the geographic distribution of them. If you could go back and forth between the records as we have mapped them, you can see that there's a great change in the geographic location of the catch, probably in part because the whales were smart enough to run away from the whalers, and also because their populations were dropping greatly. Also, these animals travel thousands of miles. That's being monitored now. We know this.

The International Whaling Commission scientists asked us to help them by providing them with this very detailed, geographic, historical data. I asked the people doing the modeling what kind of theory they were going to put our historical information into. They said that they are using the Logistic Growth Model, which says that the environment never changes; there is nothing about a population that affects it except its

size. When I politely said to them, "There are problems with that approach," they said, "We vetted the models, and decided that this was the right approach, and we are not changing."

Now, I don't know what it means to vet a model, but I can tell you that this is not appropriate.

This is ruining our management of our natural resources. And it's not intractable. It is culturally dominated by misinformation.

You could say, "Well, from Ockham's Razor's point of view, maybe it's efficient to use the Logistic Growth Curve." But I can tell you that the world's fisheries have crashed in part because of the management. This is not small change. This is ruining our management of our natural resources. And it's not intractable. It is culturally dominated by misinformation.

I spent ten years at the request of the states of Oregon and Washington looking at the salmon problem, because there's a lot of concern about salmon. The State of Washington passed a special law, funding me with a million dollars to look at the relative effects of forest practices on salmon. The first thing we found out is that nobody counted anything. Worse than that, the fisheries scientists who studied salmon argued *against* counting salmon! It took us five years to persuade the State of Washington that if they wanted to know whether what they were doing was affecting salmon, counting salmon might be helpful. It was a mystery why the State of Washington and its salmon scientists did not believe in collecting data on the very thing which concerned them. The answer, in part, is because they believed in the balance of nature and that therefore all they had to do was stop what they were doing, and nature would take care of itself. As a result, the data available were embarrassingly small.

Here's a hypocrisy problem. The people in charge of the management kept swearing to me that they no longer use the Logistic Growth Model and its derivatives. Two years ago I was asked to help the Tlingit Indians of British Columbia who were having another environmental problem that I don't have time to go into. I got to know their chief very well, a very intelligent, thoughtful, perceptive man. He said that he had just been down to a meeting on managing salmon and they drove him crazy with this terrible talk about the Logistic Growth Model.

In the real world, salmon abundances change over time. I also don't have time to tell you my story about the elephants in Africa, but it's the same for them too; change is natural. The elephants in Africa represent the conflict about whether it's people or not. I will tell that story another time.

If we had rational models, based on true dynamics, and actually looked at data and got away from our mythology, and took a little bit of a positive approach about people, maybe we could do something.

We, the people involved in making forecasts and in managing our natural resources, have this helplessness: We are told that everything people do is bad and that we are helpless to correct things. But we're not totally helpless. Costa Rican parrots have turned up in San Francisco, let loose as pets, and they're very happy there. Although this transportation of parrots was inadvertent, it demonstrates that we can move them around and help them respond to rapid environmental change. These are not impossible tasks. If we had rational models, based on true dynamics, and actually looked at data and got away from our mythology, and took a little bit of a positive approach about people, maybe we could do something.

We must educate and advertise the idea of change. I was asked to come up with a replacement for the American iconic figure of Smokey the Bear, which represents the standard steady-state idea: "Only you can prevent forest fires." The winner was Morph the Moose, who says, "Change is natural." And Morph's friend, the turtle, says, "You'd better get used to it."

We have to communicate; we have to educate. So, I'm hoping to start my education with the leaders, who are the people you must always reach. We need the help of physicists who don't just apply their 19th century steady-state equations, which is what usually happens with failed physicists. You're obviously not failed physicists; I hope you will bring truly imaginative modeling approaches and theoretical approaches. These are very tractable problems.

Thank you very much.

Keynote Theme 1 – Biosphere in the 21st Century

Presentation by Dr. Eric J. Chaisson

A Physicist Speculates on a Biosphere Reserve

Introduction

I wanted … to see for myself how much this glacier had changed, and thus to gauge the magnitude of our climate's warming. (The answers are a lot and a lot.)

CHAISSON: Just a few weeks ago, I was preparing to climb to a glacier – one of the largest ones left along the US-Canadian border. Grinnell glacier resides in Glacier National Park, which is a vast natural reserve and wilderness area set aside perpetually in northern Montana – to some, the crown jewel of the US National Park System. Glacier Park is also part of the world's first International Peace Park enlarging into southern Alberta to include Canada's Waterton Lakes Park, and together they comprise a United Nation's World Heritage Site – an utterly wild and wondrous place "where the mountains meet the prairies" amidst the Rocky Mountain chain that extends well up into the Canadian Rockies. This raw and robust biogeographic system is the most spectacular place on planet Earth that I personally have ever seen with my own eyes.

Even from many kilometers away and even through the occasional smoke rising from area forest fires, the Grinnell glacier is visible beneath the steep and sharp Mount Gould, which tops off at an elevation of ~3000m (or almost 10,000 ft). Nearly a decade earlier, I had first visited this glacier as part of a Wright Center group led by one of Glacier Park's leading ecologists, Dan Fagre. I wanted to return to see for myself how much this glacier had changed, and thus to gauge the magnitude of our climate's warming. (The answers are a lot and a lot.) Fortunately, this time we also had an expert guide with us – my daughter Megan, who is a park ranger and a trained geologist. She lives and works in this wild and wondrous place – and gets paid for it!

Still many kilometers from our objective, we encountered a sign posted along Logan Pass – a beautiful bronze plaque bolted to a human-sized boulder. It read at the top, *UNESCO, Programme on MAB – Man and the Biosphere.* Turning to my daughter, I asked, "Where have I seen that MAB logo before?" At which point she replied, "Dad, you have been invited to Paris to discuss that very same topic, and you better get serious about it." The plaque read, "Glacier National Park is recognized as part of the international network of biosphere reserves … a network of protected samples of the world's major ecosystem types devoted to conservation of nature and scientific research in the service of man. It provides a standard against which the effect of man's impact on his environment can be measured."

I am pleased to see in the audience today in Paris the Director of the MAB Programme, the ecologist Natarajan Ishwaran. Congratulations to him and his colleagues at UNESCO for having sustained this MAB Programme for a full generation, since the early 1970s (though I prefer to refer to it as "Men and Women and the Biosphere," and even more correctly "Men and Women *in* the Biosphere," for we are surely integral to the biosphere and not apart from it). Not many scientific or educational programs persist for such a long time, and it is, perhaps more than anything else, *sustained* efforts of this kind that will make a real difference if we are to better – and sustain – our global environment.

… the biosphere is that thin membrane of organisms wrapped around Earth's surface where the totality of life exists …

Recall that the biosphere is that thin membrane of organisms wrapped around Earth's surface where the totality of life exists – so thin that its thickness cannot be discerned edgewise from the International Space Station now orbiting our planet. It is this biosphere, more than any other feature of Earth, that makes our planet unique (thus far) in the known universe. And places like Glacier National Park, among 482 other bioreserves and refuges in 102 countries around the world, are isolated islands of preserved landscape embedded in a sea of human activity – remnants of what once were expansive ecosystems all across Planet Earth.

Rapid Adaptation

A trip to Grinnell comes complete with many challenges – prime grizzly bear habitat, steep cliffs, icy terrain, and daunting stories about those who have perished over the years from heart attacks, exposure, and varied injuries, despite heroic attempts by helicopter rescue crews. Eventually reaching the edge of the Grinnell glacier itself at roughly 2 km (~7000 feet) elevation, we encountered the ultimate sign astride the melting glacier: "*Warning:* Hazardous snow conditions. Glacier travel not recommended." Of course, when intrepid explorers like any of us here at this meeting – especially an adventurer like aquanaut Sylvia Earle, the chief science advisor of the National Park Service – see a sign like that, it's like a young child spotting a puddle of water that just has to be stepped into – so, onward we went up onto the glacier itself.

Modern data seem indisputable that global temperatures have now reached the same warmth as when these glaciers first began melting 6,000–12,000 years ago …

The glacier was indeed melting this day in late summer 2006. Heavily melting, in fact, with numerous waterfalls gushing from its extremities, frigid lakes of stunning turquoise water pooling by the glacier's perimeter (complete with car-sized icebergs), and rocky debris embedding the glacier itself clearly evident. The temperature at the glacier was ~18C (or ~65F) – and in the mid-30sC (or mid-90sF) back at the lodge in Many Glacier Valley from which we began our trek, meteorologically one of the warmest days in the park's history. Modern data seem indisputable that global temperatures have now reached the same warmth as when these glaciers first began melting 6,000–12,000 years ago, but it also seems true, as often reported in peer-reviewed journals based on studies of Greenland ice cores, that big swings in temperature occurred then (and well before then as well), varying by 10 Celsius or more in less than a single millennium, sometimes astonishingly in hardly more than a century. Ours is not the first time when rapid heating has affected Planet Earth.

The Grinnell glacier itself is utterly spectacular, even if rather small now (~1 km^2) and shrinking quickly, in fact definitely smaller than it had been when I reached it hardly a decade ago. Geologists estimate that it will have completely melted by 2030, and by 2040 there will be no more glaciers in Glacier National Park – which is why the rangers now call it Glacier Park not for its glaciers (which will all soon be gone), but for the toweringly sharp rocky mountains framing broad alpine valleys carved by the advance and retreat of huge kilometer-thick glaciers over the past several million years.

Most tellingly, compressed and heavily folded rock protruding through the glacial melt made clear how geologic tectonics have rearranged and distorted eons of sedimentary layers – all the while lifting them up several kilometers in elevation. Much of the rock in this area is sedimentary, having been laid down layer upon layer in an ancient sea (the long gone "Belt Sea"). Most of it is dated at ~1.3 billion years old, but it was upthrust by collisions of small island arcs the size of today's Japan with the North American continent much more recently, perhaps only ~70 million years ago, after which the glaciers went to work sculpting the park's mountains. Absorbing the big picture, I pondered the evolutionary events that must have geologically built the Rockies, and especially the physical energy needed to raise sedimentary layers to great heights. And I thought about the ethical implications of humans potentially aiding this glacier's recession.

… empirical data also imply that Grinnell and its neighboring Rocky Mountain glaciers were likely on their way toward oblivion during the past several centuries, possibly even millennia, without our help.

Then again, as I picture Megan on her skis spanning the Continental Divide, in fact atop the so-called Crown of the Continent – where glacial waters flow uniquely into three oceans, the Pacific, the Atlantic, and the Arctic (via Hudson's Bay) – I wondered if it would really matter, in 25 years, whether she is still able to ski this glacier or merely walk along the rocks beneath it. Surely, this glacier among all worldly glaciers wax and wane with the Ice Ages, ultimately the result of Earth's changing orbit, tilt, and wobble while moving about the Sun (the 20,000–100,000-year "Milankovitch cycle"). Various environmental tracers imply that Earth had no glaciers at all during the most recent interglacial warming trend ~130,000 years ago, and that we now reside within another interglacial period like so many others that naturally and regularly oscillated over the past many millions of years. Though there are compelling data that we humans are anthropogenically accelerating the melting of this and other glaciers, empirical data also imply that Grinnell and its neighboring Rocky Mountain glaciers were likely on their way toward oblivion during the past several centuries, possibly even millennia, without our help.

Just because most of our great cities are now perched on the banks of waterways – a perfectly reasonable place for our agricultural ancestors to have begun building them ~8000 BCE in order to transport goods and services among growing city states – it doesn't necessarily follow that present-day humans some hundred centuries later should not expect some of them to be inundated by future changes in sea level. More specifically, just because New Orleans was sited below sea level by the French hundreds of years ago, it doesn't mean that American taxpayers should now rebuild it in the same place – but that's both a political and a politically incorrect statement to make on the other side of the pond, so I'll say no more about it at this meeting, other than to ask rhetorically: Are we going to do that for other cities as the waters inevitably rise?

Global warming is committed and inevitable, and we need to plan accordingly for a hotter, drier world … adaptation may well be more important than mitigation.

I wondered: All the while humans are inadvertently speeding change, are some actually seeking to stop it? Although we might like to think that we could halt climate change, I don't think it's realistic economically. Global warming is committed and inevitable, and we need to plan accordingly for a hotter, drier world. Trying to stop change altogether, to my mind, would be as foolish as further speeding it along. Change is here to stay; change is natural – a point stressed earlier at this meeting by ecologist Daniel Botkin. Perhaps we humans should accept some change – even the change we ourselves are likely accelerating – and get on with the business of learning to adapt to change more rapidly. In short, over the next thousand years – the timescale addressed by this meeting – adaptation may well be more important than mitigation.

Biodiversity

For me, and despite this glacier's sad melting, the most interesting parts of Grinnell are precisely where it *is* now melting. That's where underlying features are being revealed – geology and biology seeing the light of day, literally – for the first time in thousands of years, possibly since before the onset of the last major Ice Age some 100,000 years ago. Standing atop the billion-year-old rock, we spotted many circular patterns in the rock at glacier's edge – many more than I had noticed a decade ago. All around us meter-diameter roughly circular swirls embedded the rock – a kind of tile that resembled sliced cabbage heads laid down eons ago. These are fossilized stromatolites, some of life's earliest organisms, originally submerged in an ancient sea yet now hardened limestone and upthrust to nearly the top of the world.

Stromatolites played a big role in the formation of Earth's early biosphere, or more specifically in the change of Earth's early atmosphere. The ones we discovered at Grinnell were once residents of an old seabed dating back ~1.5 billion years – well prior to our ancestral supercontinent of Pangaea ~200 million years ago, even before the Cambrian "explosion" that

brought forth a burst in number and diversity of living species ~550 million years ago. As biologist Lynn Margulis, who is here at this meeting with us, knows well, these are clusters of unicells – not true multicells intercommunicating with each other, rather colonies of photosynthesizing prokaryotic microbes (cyanobacteria, or blue-green algae) that grouped together in stacked columns up to a half-meter tall. Living stromatolite mounds survive today in only two shallow marine environments that I know of – Shark Bay in northwest Australia, well north of Perth, and near Exhuma Sound in the Bahamas, not far from Nassau. But long ago stromatolites were widely outgassing oxygen into our atmosphere – at least as far back as 1.7 billion years ago (by way of direct fossils), probably as long ago as 2.7 billion years (by way of chemical traces), and perhaps even as much as 3.4 billion years back (based on controversial reports of crushed remnants among very old rock layers, also in Australia). They were foremost among primitive life forms that transformed our planet from one that was hellishly hot and devoid of free oxygen into one that is today relatively cooler and abundant in the oxygen gas that humans and many other animals so heavily utilize in our each and every breath.

Stromatolites were also among the earliest life forms on Earth that began the very long trek along the route to today's greater complexity. They were some of the creatures that gave rise, via symbiosis, to more advanced eukaryotic organisms having well-developed biological nuclei. And they are among the last common ancestors of all the plants and animals that came forth afterward, especially in the Cambrian and subsequent periods, when a rich diversity of species flourished on our rock-water planet, third out from the Sun. Glacier Park, in particular, is a genuine beneficiary of this complexity, given that its species density is highest anywhere along the huge Y2Y – the Yellowstone-to-Yukon conservation corridor.

Who is to say, for sure, that biodiversity is actually a positive development, a stabilizing influence environmentally?

As I pondered the field of fossilized stromatolites surrounding me atop Grinnell, I again wondered: Is biodiversity unquestionably a good thing? The biological record makes clear that when the stromatolites flourished, namely well before the Cambrian, there was not much biodiversity on Earth – in fact, hardly any at all. Yet, these life forms eked out a living, and sustained it for *billions* of years! Perhaps they did so because there was not much competition – competition that today helps limit the duration of many species to typically a few million years or so. Now, with life populating virtually every nook and cranny of our planet, the stromatolites are nearly all gone, conceivably crowded right off the face of the Earth by a rapid expansion in the number and diversity of life forms emergent over the past half-billion years. Who is to say, for sure, that biodiversity is actually a positive development, a stabilizing influence environmentally? Recent studies of simulated marine habitats published in the British journal *Nature* imply that biodiversity maximization and ecosystem function are often at odds. Perhaps in its magnanimous way, humankind is now trying to maximize the heavily populated biosphere with untold species whereas we ought to be instead managing it for sustainability among fewer species.

But if humans are now causing a mass extinction, then presumably we ought to be documenting hundreds, perhaps thousands, of species disappearing each year … hard biological data fail to document more than a few species actually vanishing annually …

What's more, are we sure that humans are now causing the 6th mass extinction of life on our planet, as argued by many biologists today? Let's do the numbers, says this slightly skeptical physicist, just to compare with those truly widespread extinctions that nearly wiped out life ~250 million years ago or the one that likely caused the extinction of the dinosaurs ~65 million years ago. My biology colleagues tell me that there are now ~1.7 million known species living and documented on Earth, but they quickly add that millions more have yet to be found. How many more is uncertain; some say 5 to 10 million species on present-day Earth, others claim 15 million, even as many as 30 million. I thought astronomers had a "dark matter" problem, with the far majority of mass in the universe so far uncharted; now, biologists also feel that most of the inhabitants of Earth's biosphere are thus far

unfound. Even so, let's take 10 million as a nice round number for the total species now extant on Earth. Since paleontologists estimate the natural extinction rate to be ~10^{-6}, namely a disappearance rate of about one in a million each year, this implies that ~10 species ought to be quite naturally going extinct annually. But if humans are now causing a *mass* extinction, then presumably we ought to be documenting hundreds, perhaps thousands, of species disappearing each year. By contrast, and despite 12 percent of birds, 23 percent of mammals, and 32 percent of reptiles (for a total of ~15,600 species) claimed to be endangered, the hard biological data fail to document more than a few species actually vanishing annually (<800 species gone extinct in the wild since 1500 CE). Moreover, the well-established course of biological speciation, or "disruptive selection" of genomes following environmental upheaval, will surely continue to bring forth new species, just as it has so many times in the past – a positive development that will further diversify our robust biosphere, which natural history shows has an amazing insensitivity to failure.

Big Picture

When I explore Nature, I tend to accentuate the positive – to see the grand sweep and stark beauty of the bigger picture all around me. And I look for grand themes, for connecting intellectual links, and for underlying unifying factors that might help me build my own rational worldview, rather than dogmatically believing someone else's. So, as I looked up and away from the old rocks and their fascinating stromatolites in order to internalize the park more broadly, I took in the full and vast vista of this wonderful piece of Earthly real estate. Accordingly, I saw the effects of physics, chemistry, geology, and biology at work all at once – and maybe those of sociology too.

A panoramic scan and mental synthesis of the view from deep inside Glacier National Park demonstrates for me, foremost and above all else, change – namely, *evolution* on all scales, physical, biological, and cultural. I also glimpse *energy* everywhere – energy that molds rocks, energy that reacts chemicals, energy that runs biology, and even energy that preserves the park. To be sure, energy flows and things change throughout the entire expanse of this fantastic biosphere reserve. And I like to think that the stunning view I absorbed from high up that day demands a kind of *ethics* that are just as important as evolution and energy – namely, an ethical obligation to protect this scene and others like it across the globe.

Thus, I arrive at the three *E*s of my grand worldview: Evolution, Energy and Ethics – about which I would like to become a little more controversial, if only because I fear that all of us at this meeting are on the same page, singing in the same choir, and for that reason alone I will continue playing the role of *agent provocateur.*

Evolution

Humans are part of an evolving universe stretching across billions of light-years of space and billions of years of time. All along the 14-billion-year-old arrow of time – from the study of physics and astronomy to geology, chemistry, and biology – we detect evidence for past events that, when organized in sequence like pieces of a great puzzle spanning the history of the universe, form a powerful intellectual road map of who we are and whence we came. In brief, we, among all life forms, share a common ancestry with the galaxies, stars, and planets, each of these changing structures (including us) being open, non-equilibrium, thermodynamic systems. A good understanding of our cosmic roots, and a detailed knowledge of how all life relates to everything else, will help us create a wise, viable future course.

The unifying scenario of cosmic evolution is a modern, interdisciplinary worldview that people of all cultures can adopt – a Big-Bang-to-humankind story that traces developmental and generational change ranging from quarks to quasars, from microbes to minds. To be sure, there seems to be a constant thread of change from the elementary particles in the early universe that changed to form the galaxies, which in turn changed their environments to create stars that, in turn yet again, produced the heavy elements needed to build planets such as Earth, which changed to yield simple life and then advanced life, eventually evolving into the cultured and technological civilization that we now share. Heraclitus, the philosopher of ancient Greece some 25 centuries ago, may have had it correct when he made perhaps the greatest observation ever: "all flows, all fluxes, nothing permanent except change" – though he would likely be amazed at the rich detail amassed to bolster today's new scientific philosophy.

But who are we to think that change ought now to stop? We humans are not the pinnacle of cosmic evolution, nor in an expanding universe will the arrow of time likely ever stop. I sometimes get the impression in discussions of biodiversity, climate change, and global warming, that some people think change should now halt to benefit our currently comfortable civilization on Earth.

Change is good; evolution brought us here. Change must continue if sentient beings are to survive within Earth's biosphere, where typically the losers far outnumber the winners (to be sure, some 99.9% of all species that once lived are now extinct.) Change and adapt, rapidly – or perish.

Energy

… there is no such thing as a "balance of Nature"; if Nature were so equilibrated, we would all be dead.

Arguably, the essence of all order and organization in the universe is energy flow. Much like giant stars or microbial life, today's civilization runs on energy, in fact increasing amounts of it per unit mass for increasingly complex systems. All systems – such as galaxies, stars, planets, and people – are distinctly out of equilibrium, dependent on energy, and in dynamic steady states. In short, there is no such thing as a "balance of Nature"; if Nature were so equilibrated, we would all be dead. Furthermore, all such complex systems are in quantitative accord with the celebrated second law of thermodynamics – they are islands of locally increasing order in a vast sea of universal disorder. The prime mover in all this seems to be nothing more than the expanding universe, but that's another talk.

A plot of energy flowing through various complex systems throughout the entire 14-billion-year history of the universe is most telling. Especially so, the value of energy rate density, that is, the flow of energy in and out of complex systems per unit mass. Such modeling shows a clear rise in energy rate density – from physical systems, to biological systems, to cultural systems. For example, any amoeba in your backyard is more complex than the Milky Way above, likewise more highly evolved animals are advantaged for their greater energy flow per unit mass than any plant. Surprisingly, a highly complex human being has more energy flowing through its body per unit mass than does the whole, yet simple, Sun – in fact, a million times more than through the Sun! Hard to believe until you compute the math. But once again, "doing the numbers" can be most revealing.

Furthermore, culturally oriented systems – such as our many technological inventions – will also likely consume more energy (per unit mass) on into the future, indefinitely. There seems no way to avoid the need for greater amounts of energy; energy is good. Rising energy *densities* will be required for intelligent beings to continue populating Earth either 100 or 1,000 years from now. Much as for our culturally built machines, whose energy rate densities are also rising, society evolves by using more energy (again per unit mass). Not inconceivably, humanity and the biosphere might benefit from an economically managed symbiosis between humankind and machinery, much as life has benefited before from symbiotic cooperation. Energy is likely to be forevermore central to any new economy, especially since dynamic global economies are also out of equilibrium, given their inflowing resources and outgoing wastes, although most of today's steady-state market economists don't seem to realize it.

Humankind will have to embrace energy from beyond Earth, namely from our parent star, the Sun, if we are to survive the next thousand years.

I conclude that energy is indeed good, and that total energy usage will increase throughout our society. Despite apparently running out of it on Earth, energy is essential to the operation of any open, thermodynamic system – and our technological civilization is no exception. Humankind will have to embrace energy from *beyond* Earth, namely from our parent star, the Sun, if we are to survive the next thousand years. Governments could begin to master non-polluting and infinitely renewable solar energy soon – and gain a great deal of global energy security as a welcome byproduct – if taxpaying citizens were willing to address, at wartime speed and intensity, this ambitious practical challenge with a research and development effort akin to the Manhattan Project (to

build the atomic bomb) or the Apollo program (to send men to the Moon) – if only we would make it a moral imperative to do so.

Ethics

I often tell the cosmic-evolution students in my Harvard course that we now need to replace the word "future" with the word "ethics" along the arrow of time. The next great evolutionary leap forward might then be labeled "ethical evolution." Such support and encouragement of a global culture, one where planetary citizenship is key to the survival of ourselves and our society, evokes a kind of evolutionary humanism for the good of all people.

Ethics, it would seem, now takes center stage in the cosmic-evolutionary story, at least for humankind on Earth. Fortunately, the current trajectory of our society does display sensitivity toward the needed ethics, as exemplified by enhanced awareness of human rights, environmental issues, and global security. But is there enough time to enact the needed ethics – including, for example, accepting climate warming and adapting to it, investing heavily in renewable energy R&D, and perhaps eliminating cherished concepts of nation-states such as national sovereignty – before an array of global problems makes technological life improbable on Earth?

Furthermore, what ethics should we embrace? Whose ethics? Religions were probably invented to impart a sense of ethics among early agricultural communities, but seem less relevant (and perhaps even fundamentally dangerous) nowadays. Philosophies, too, granted import to ethics among humanistic societies of old, but seem invisible in today's high-tech world. Nor will science itself likely generate the needed ethics, what with our heavy reliance on technology and our dogmatic determination to probe deeper and farther, beyond the world without end. Stated more bluntly at this Parisian meeting convened at the United Nations' UNESCO campus: *Who shall speak for Planet Earth?*

A good place to begin might be for each and every person to espouse the Earth Charter Initiative begun a decade ago – an international declaration of basic principles for building a just, sustainable, and peaceful global society in the 21st century. Incorporating international law, contemporary science, and the wisdom of the world's great religions, the Earth Charter, so ably championed by Steven Rockefeller of the United States, proposes an ethical vision that hopefully inspires in all peoples a new sense of global interdependence and shared responsibility for the well-being of the human family and the larger living world.

Those civilizations, anywhere in the galaxy, that adopt global ethics, or planetary citizenship, will survive – and those that do not, will not.

In the end, our future survival may be guided by a principle of cosmic selection, akin to Darwinian natural selection, that operates on larger scales, beyond biology and on into the cultural, indeed astronomical realms, to wit: Those civilizations, anywhere in the galaxy, that adopt global ethics, or planetary citizenship, will survive – and those that do not, will not. In fact, cosmic selection might be the answer to the so-called Fermi Paradox: When the famous Italian physicist Enrico Fermi contemplated the likelihood of extraterrestrial intelligence, he asked, "Well, if so, then where is everybody?" Despite claims to the contrary, astronomers have found not a shred of observational evidence that intelligent life exists beyond Earth. Perhaps no one survives much beyond a level of technological expertise capable of self-destruction.

As often the case in evolution, the issue is timing. Can our civilization get its act together quickly enough to ensure its own survival? In the language of the evolutionist, will humankind be among those sentient beings selected by Nature to endure? Or will the meek truly inherit the Earth after all, given that microbial life does seem able to adapt better and faster to rapidly changing environments?

Conclusion

I conclude with a hopeful image that I have burned into my mind: My daughter, "Ranger Meg," talking intimately with young children. It occurred shortly after we had come down from the glacier, when Megan was slated to give an evening campfire talk at one of the park's outdoor amphitheaters, explaining why Waterton-Glacier International Park is a UNESCO World Heritage Site. Although there were mostly adults present, and although she did a nice job describing the sweeping vista and raw beauty of the

park, indeed the need to continue to conserve it as an international symbol of preservation and peace, Megan was most eager to chat with several young children after her talk. I keep telling Walter Kistler and Bob Citron of the Foundation For the Future that there is nothing more synonymous with the future than children, and I saw it displayed there that night most clearly.

As I and an official of the US government sat in the audience, eavesdropping from a distance on Megan's conversation with these kids, we heard them using phrases like "bear habitats," "endangered species," "protecting wildlife," "clean water." They weren't just shooting the breeze; they were talking shop – about the future of Planet Earth and its inhabitants. I thus propose a 4th *E*, for *Education,* and not merely because I'm an educator, rather because education is a common element that undergirds each of the other 3 *E*s. Education can help us understand *evolution* and its vital role of adaptation, achieve new *energy* even at a cost of some social upheaval, and recognize the inherent role of *ethics* along the way to becoming planetary citizens.

The bottom line, I think, is that our children have written off us older adults. Our generation has messed up the Earth, top-down. Megan and her young and enthusiastic group of park rangers are already talking to the next generation, already educating. Her generation gets it, and they probably will manage, bottom-up, to fix our soiled environment, our polluted atmosphere, our dirtied water. Indeed, it is our children's children – the youngsters of the next generation, many of whom will be alive in 2100 – who will hopefully inherit a better planet. The result may be a robust symbiosis of humankind and the biosphere – a sustained society that welcomes evolution broadly considered and the universal roots it provides, goes with the energy flow efficiently and wisely, and adopts for the good of our species an environmental ethics much as is now so well represented by the remarkable biosphere reserve known as Glacier National Park.

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Keynote Theme 1 – Biosphere in the 21st Century

Presentation by Dr. Lynn Margulis

… all life chemically is the same … knowing what organisms are here and what our relationship is to them is crucial, but it is impeded by our preconceptions.

MARGULIS: I'm very glad to be here. Thank you very much.

I read the personal statements of everybody. Shekhar Singh says we must recognize that the problem lies in the rates of consumption by us and our ideas and preconceptions. This is very important, and I was very moved by that. David Macdonald points out that there's really only one problem: It's my problem; it's his problem; and it's our problem. I think it's behind Dan Botkin's mention of energy, and that is: There are too many of us. There are ways that social animals traditionally have cut the population, which we can talk about later, but ultimately *all* the environmental problems stem to the problem of population growth and habitat fragmentation. I was very glad to read about it.

This talk will be about our preconceptions – it's something that Dan talked about with the problem of using the wrong equations – our preconceptions that block us from doing what is scientifically sound. That's basically the point. I want to give one little example of live organisms.

"Biodiversity"– life's diversity and life's unity – was a term made up to stand for "biological diversity." What we know today and why we can do a DNA probe of the mitochondria of people is that all life chemically is the same. We have one example of life on Earth, and Darwin showed common ancestry. It's one example with, of course, many different parts. I will claim that knowing this diversity is crucial, knowing what organisms are here and what our relationship is to them is crucial, but it is impeded by our preconceptions.

First we're going to look at folk classification, which is your mother's classification, the Cartesian classification, the classification we receive from the Bible. It doesn't matter what you do as a professional, this is the classification. In the folk classification, when people talk about biodiversity they are talking about plants or animals. Basically that's what they're talking about: plant or animal. Lovelock says it's because we have to know how to respond to something. Can you eat it? Can you mate with it? Is it going to poison you? Our essential human dichotomy comes from that issue of having to make an immediate decision about a live organism. Will it eat you or will you eat it?

This gives us a classification with plants on one side and animals on the other side. Under plants are cryptogams, which means that their sexual parts do not show up. That's what cryptogam means. That's the old tradition of plants, and that included fungi, water molds, and so on. And then we have the plants whose sexual parts show up; those are flowers and cones. Then we have the animals. "Invertebrate" means that they are not important. That's all.

PARTICIPANTS: [laughter]

… we have to unlearn before we can learn.

MARGULIS: And "vertebrates" means they're important. So, plants *or* animals – those are the choices. In this classification, there are no other choices. The higher plants are the flowers and the beautiful scenery, such as Eric showed from the Rockies. And then

there are the higher animals – that means your pets and your cows, and so on. And what are bacteria? They're germs. And what are fungi and water molds? That's contamination of the water. And what are slime molds? That's crud. And what are algae? That's green crud. And bryophytes and ferns – those are mosses.

Let's look at the animals. What are the arthropods? They're insects and crabs; sometimes the crabs that are on your pubic hairs. Then there are mollusks; they're escargot here, but they're snails in the United States and we don't eat them. Or they're clams. And then we have echinoderms, which are starfish, sea urchins, and so on.

Now, I've been told: That's wrong; that's not the full classification. There are *three* forms of life: plants, animals, and man. Why? Because man isn't truly an animal. So, we classify man as the highest animals, of course. The world was made for us – not just "man," but certain men. Let me show you. We have primitive man. They're the aborigines, the Southeast Asians, the Africans, the Arabs, and the Native Americans. This is the rough view of people I deal with every day of what life is. Then we have the intermediate-level people: Chinese, Jews, Japanese, Russians, South Americans, and East Indians. But then we have the advanced people, and, of course, those are the civilized Christians, North American and European white men.

But then I've been told that *that* classification even isn't right. You have to realize that 60 percent of the United States does not believe that evolution exists, that there was evolution. They don't believe that. They think science is something you waste your money on, but sometimes it gives you better TV. So, even this classification is wrong. Man is not an animal at all; he's a lower angel.

That's the full classification, then, and that's what we fight with biodiversity, because we have to unlearn before we can learn.

"Bacteria are germs and we must destroy them" … As long as we continue to think this, we cannot study or understand anything.

Bacteria were classified for 50 years in the standard textbooks. When they were first discovered, they were thought to be extremely small animals; that's because they swam. Later they were found to be members of the plant kingdom and were usually classed with fungi. Bacteria are simple organisms consisting of one cell; each cell is composed of a cell wall. We have heard: "Bacteria are germs and we must destroy them and kill them. They are agents of disease." All of our terminology is military. As long as we continue to think this, we cannot study or understand anything.

I'm going to give only one example of dangerous ignorance today, because there is very little time. I think that's what Dan was alluding to and I know that's what Eric was alluding to, dangerous ignorance: what you *think* you know, because you don't know. Scientists must admit ignorance, because that's how science proceeds.

[Film clip showing the growth of bacteria] This is 15 minutes, half hour, 45 minutes, one hour, one hour and 15 minutes, one hour and a half, one hour and 45 minutes … and the weight of the Earth in less than a weekend. That is what Nietzsche means when he talks about the will to power. This is inevitable. The growth of populations is inevitable. Unless we understand that growth and change are inevitable, we can't deal with the real problem. This is like what Bob [Citron] showed with people – only instead of 160,000 years, this is less than a week because they're bacteria. But all populations at all times are growing like that. Plant or animal? Neither.

I completely agree that our narrative must be based on science, on *real* science. We may not like the science, but it must be based on science. Nobody knows really anything about the origins of life. We have a record of bacteria. Eric showed a nice picture of stromatolites; those are bacterial skyscrapers. We have the origin of this group of organisms who have no representation in any political body in the world. And then we have the presentation of animals very late, about 600 million years ago, and plant and fungi come together at about 450 million years ago. The first nucleated cells appeared about 2,000 million years ago. So we have a world, as both the previous speakers mentioned, that's dominated *not* by mammals or animals or plants.

The origins of life – about which much talk exists, much gossip exists, and very little is known – occurred by 3400 million years ago. We have in the bacteria the ability of photosynthesis, the ability to make oxygen, the ability to move, the ability to sense, the ability to

sense life, the ability to sense mechanical stimulation, the ability to sense sound waves – everything occurs already in bacteria, that is, everything except speaking any language. The ability to ferment and interact with carbon compounds … we have hundreds of other abilities. These are the ones that merged to form us and merged to form the predecessors of the only organisms we ever talk about when we talk about biodiversity – unfortunately.

… there's only one thing that distinguishes people from the other mammals: an incredible ability not to just tell stories but to deceive oneself and deceive others … we talk; therefore, we lie.

Most organisms on the Earth today are *neither* plant nor animal, but we dichotomize only two choices – three choices: plant, animal, *and people*, because people are obviously not animals. Not your relatives, not my relatives. (There might be some that are animals but we don't talk that way.) We talk about biodiversity as being *outside* people. When we talk about biodiversity, we talk about the biosphere without even talking about people in it. But of course we're in it. We're very late. I think there's only one thing that distinguishes people from the other mammals: an incredible ability not to just tell stories but to deceive oneself and deceive others. That is, we talk; therefore, we lie.

So, what is the suggestion? That we complete the Linnean tasks. Linnaeus classified 10,000 organisms; he did a fantastic job and we're nowhere near finishing that.

All organisms ultimately are bacteria. They're either bacteria direct or they're communities of bacteria. And bacteria are not bad. So, what is the suggestion? That we complete the Linnean tasks. Linnaeus classified 10,000 organisms; he did a fantastic job and we're nowhere near finishing that. The suggestion is to complete the Linnean tasks: to recover, maintain, and retain the best books, the best wall charts, the best films, the best videos, the best museum collections. I want to tell you about one example only, one example, and we're going to show that right now.

Post-Sputnik: What do Americans do when they have a problem? They throw money at the problem. So, that's what they did. Post-Sputnik they got the best scientists in the world to film live material. They made 44 films, and they're spectacular. They did it in 1971 and now almost everyone involved in the project is dead.

First of all, only 1.5 to 1.8 million (fewer than 2 million) organisms have ever even been documented in the record. Up to probably 30 million exist today; 99.9 percent are extinct. For every *one* today there are 999 to 1,000 extinct. The vast majority are going extinct. Do you think you're going to die personally? Yes. Do you think you're going extinct? Absolutely. The question is your timescale. Maybe not 3,000 years.

There are only 182,000 or so in the fossil record named, but, of course, there are probably hundreds of millions. The famous extinctions are the Vendian, the Permian-Triassic, the Jurassic-Triassic, and so on. The one we're in now is the Holocene, and it's a terrible extinction. We're living in the Holocene. It takes about 10 million years to recover from an extinction, and most mammals live maybe three million years. We've had maybe half our time. We're going extinct; the question is when and how and the quality of that extinction. It will take, according to E.O. Wilson, four Earths – destroying four Earths – to sustain the rate of consumerism today in the United States. China is looking at that. Where are we going to get the four Earths from?

I said before that the task is to complete the Linnean task: recover and maintain the incredible knowledge that's available. But to whom? Not to the people making decisions. Not to the people who have the power. Who has this information? Who has the right models? Let me show you this one example. It's called cryptocotyle. It's a worm, a platyhelminth. This animal is related to schistosomiasis. Schistosomiasis, to people in Africa, is Bilharzia. It's a disease of liver fluke. Next to malaria, it's the most serious disease. I want to show you the live footage that was made a long time ago, then show you a comparison with the film reconstruction.

(Playing movie.)

These 44 films have been sitting in a garage. [Narrative on film: "Many of these flatworms have an average life history with several morphologically distinct larval forms, living in different intermediate hosts. …

The marine snail, the common periwinkle, eats the developing eggs and becomes the second host of the parasite."]

We get them from the snails. They go into your fingers and toes, especially where the dams are in Africa. It goes through four stages; there are no shortcuts. You have to *know* these things. This [shown in the film] is a sucker, to suck into the tissue to take all your food from your intestine. It's hermaphrodite, both male and female in the same animal.

[Narrative on film: "Two testes lie in the rear and adjacent to them, the seminal receptacle, an organ used for sperm storage. Near this there is an elongated ovary where the eggs are produced…."]

This was a $20 million project, and the films are in a garage in Massachusetts because no one would pay to distribute them. No one knew what they were. No one is going to make any money off them.

Why schistosomiasis? Because they are permanently in the copulatory position. These are male/female; they're hermaphrodite. They are permanently copulating. Just as schizophrenia is split mind, this is split body, and that's how they're recognized. They're in the liver.

There are no shortcuts. You have to know about the cercaria and the metacercaria and the life cycle in the fish and the life cycle in the snail. People get it from the snail. There's no easy, single bullet of molecular biology to kill them. You have to *know* something about natural history.

I can't show all of the film to you, but I want to show you that these have polyembryony. What happens is that there are 30 eggs, 40 eggs, each of them grows to an embryo. This is a bag of embryos to make hundreds and hundreds on a *daily* basis. People are debilitated; I wrote down the symptoms. This is born in the person's liver. No one understands anything; they don't know the names; they don't know why it is. When it goes to the fish, it enters the fins of the fish. In Boston Harbor, 100 percent of fish are infected. Why don't the people get it? Because we're not a tropical country.

Durdin was the greatest filmmaker of his time. He was from England, and his work was bought by the Canadian Broadcasting Company. He made most of these films under government support. I was there when they made them – I was about 16 years old then. They made 44 films. They asked me if I could pay to keep the films cool. I couldn't pay my own students! Every few years I tried to get the films, just to look at them to see if they were okay, because they get very red and the quality gets very bad. There are films on sex in ferns, on Labyrinthula…. I want to show you the difference between the original and the reconstruction. I showed them to my students until they wore out. We restored this one only. The 44 films have information impossible to put together, all done on 16-millimeter film. No one can do anything because the people who know about the things are dead. That's the real reason. No one at the NSF wants to talk to me about this because either they don't know – most of the people – or they know and they're culpable but they couldn't distribute it; they couldn't pay to keep them cold. They're in a garage, in a moving storage place.

The knowledge exists of very obscure things among very obscure people, who never talk to the people who make the policy decisions.

What I'm saying is what Dan was saying: The knowledge is there, but the education isn't there. The knowledge exists of very obscure things among very obscure people, who never talk to the people who make the policy decisions.

I'm finished, but I am giving you a sheet of paper on which I put two cases: schistosomiasis and filariasis, which leads to elephantiasis and other very serious tropical diseases. I don't know if you know this, but the symbiosis biologists have found out that it's not the nematode worm that's killing the people, it's the bacteria carried by the nematode worm. Since they found that out, now they are treating it with antibiotics, just like ulcers. The fundamental biology has to be known, and it's not known because no one teaches it.

FACILITATOR: Thank you, Lynn

Keynote Theme 1 – Biosphere in the 21st Century

Presentation by Dr. Sylvia Earle

… the next decade may be the most important little piece of time in all of human history because of the consequences of our actions, the once-and-nevermore decisions …

EARLE: My first image is a picture of my Aunt Ida. She's 101 years old. I include this image just for perspective, because there, in a human lifetime, a history of unprecedented change has been lived. It's true with my parents, certainly my grandparents, but most particularly those who have been around during the latter half of the 20th century and now tiptoeing into the 21st. As never before, we have seen change of such magnitude in such a short time, certainly caused by one species. So, that's part of the perspective. Let's look back and think of where we've come from, and especially what's happened in recent times.

The other perspective is shown in this image of two of my four grandsons, because they're going to inherit the consequences of what we do, or what we don't do. I think the next decade may be the most important little piece of time in all of human history because of the consequences of our actions, the once-and-nevermore decisions that we will make, either consciously or by default. I'm motivated to try to get it right. I'm sure you are, too, for various reasons, but these are two of my very special reasons for trying to get it right.

We've all grown up during a time when this image [the Planet Earth from space] became apparent for the first time. Certainly my parents did not know it as kids; I didn't know it as a child. We are blessed with that perspective of Earth as viewed by people up there in the sky, looking far into the universe and seeing that nowhere else is there anything quite like this planet. We dream of going elsewhere, and I daresay some day we will – personally, not just vicariously – travel to Mars, to the edge of our solar system, and maybe beyond, but the likelihood of establishing another outpost in the universe where even half of the present 6 billion people could prosper is highly unlikely.

Water is not just water, not on this planet. Even in a single drop of water there may be a thousand variations on the theme of … little microbes …

Consider what we take for granted: A planet blessed with water. That's fundamental. There is plenty of water elsewhere in the universe, but nowhere that we know about is there water that has been around for as long as you just heard water has been around, filled with life. Water is not just water, not on this planet. Even in a single drop of water there may be a thousand variations on the theme of the lovely little microbes Lynn showed to us. That's been vindicated recently with a new means of determining the variations on the theme of the small creatures on the planet genetically. Craig Venter, who spent such a lot of time recently looking at the human genome, has been going around the world taking little scoops of water from the ocean and discovering in spoonfuls of water a thousand or fifteen hundred different kinds of microbes. That's not individuals; that's individual *kinds*. We're talking many millions of individuals. Not so on Mars. There may be life there; we haven't determined for sure. Not so anywhere else that we know about.

I had a reporter ask me once why she should care about the ocean. That's where 97 percent of Earth's water is. It seemed a little odd, since she was an Australian reporter. Australia being an island country, you'd think she'd kind of get it, but it's not unusual for people even who live close to the sea to take the

ocean, or water generally, for granted. She said, "If it dried up tomorrow, what difference would it make?" I countered with, "Okay, imagine drying it up tomorrow. This is the difference it would make. We would have a planet much like our sister planet: a lot of the same ingredients with the exception of lots of water and lots of life."

Without water, there is no life. It's just that simple.

We take life for granted and all that life provides for us. At least in my perspective of the astronauts' view, it's not just water; it's living water, water filled with life that makes the difference. Without water, there is no life. It's just that simple. If you do away with the ocean, you do away with 97 percent of the water; you do away with that part of the planet that regulates climate and weather, shapes the chemistry, stabilizes the life support, at least from our standpoint. The microbes could probably get by with something other – they did for a very long time before the likes of humankind arrived – but we, being humans, have begun to look at the world as if the ocean and all that's in it, as with the land, is our own. We're carving it up and laying claim to it, at least for much of the ocean. Actually, 64 percent of the ocean does not have much in the way of jurisdiction at all. Yes, there is the Law of the Sea, but not all nations, including my own, have signed on to that great document.

[Referring to slide] Here you'll see a country that may be familiar to most of you: Madagascar and the area Madagascar claims as its own. When you think about it, that's the real Madagascar. It's not just the land; it's the land plus the area that it claims and that is acknowledged to be under Madagascar's jurisdiction. All around the world, most countries lay claim to ocean out about 200 miles. The United States is more than twice the size that you see on maps if you include the Exclusive Economic Zone. It's true of Canada, true of Australia, certainly true of Indonesia. We have a different perspective about how we treat the ocean, but we still haven't taken the plunge and gotten to know the ocean in ways that will really make it possible for us to appreciate what it delivers to us.

[Referring to slide] There's Madagascar in perspective from the fishes' standpoint. This is very primitive as compared to the view that we will soon have for understanding what actually lives around those peaks and valleys, to see that where the water is, there is plenty of life, not just on the land.

[Referring to slide] The green area on this overall map of the world represents places that are now claimed by various nations. The blue part remains as open ocean, the high seas, where almost anything still goes, where fishing is beginning to move inexorably deeper and further offshore without regulation, so that almost anything goes out there at this point. Certainly that's true in much of the ocean even within the regulated part of the planet.

What difference does it make if you do drastic things to the ocean? Isn't the ocean big enough, resilient enough, to withstand whatever humans do to it? … Policies have been made on that basis.

The reason I'm laying the groundwork here is to consider why this matters. What difference does it make if you do drastic things to the ocean? Isn't the ocean big enough, resilient enough, to withstand whatever humans do to it? Certainly that's been the perspective for most of my life. Policies have been made on that basis. Going back to the 1960s, around the world it was thought that our job is to try to feed people by taking more from the ocean, that food from the sea will fill the gap that is formed as the numbers of people have increased but the arable land has decreased over time. So, let's go to the sea and extract the wildlife there. We have learned in a very short period of time that, in fact, there are limits to what we can take out of the ocean. And we've begun to learn, to our dismay, that there are limits to what we can put into the ocean as well.

We know, from our ability to move around the terrestrial part of the planet, something about the mountains. We have only begun to realize how many mountains there are in the ocean. Just in recent times we've begun to realize that there are mountain chains that run like great backbones down the Atlantic, Pacific, and Indian Ocean that we didn't know existed when I was a child, part of the great discoveries of the 20th century, the terrain that dominates the planet that

our predecessors were not aware of. But even people today are largely unaware of the 50 to maybe 100,000 mountains that haven't yet appeared on maps. A few we have begun to map and to identify.

What we're talking about here are islands under water that have great diversity and abundance of life … as we go further and deeper into the sea, we are endangering the biodiversity of life there, as well.

Here's the interesting thing: Every one that has been studied in any detail at all – only 200 or 300 are in that category – have proven to be high in endemism, that is, that there are creatures that live there and nowhere else that we know about. The further apart they are, the greater the diversity, just as is true with islands that poke up through the ocean and are what we put in the category of "land." What we're talking about here are islands under water that have great diversity and abundance of life – not the kinds of creatures that we normally think of as creatures in danger, but, in fact, as we go further and deeper into the sea, we are endangering the biodiversity of life there, as well.

Mountains have certainly given us clues about changes that are taking place as snow retreats, as glaciers have been disappearing. We have graphic evidence of changes in the climate.

I'm sorry I missed the earlier presentations today, but I know that both then and in the times that will follow there will be people far more expert than I talking about the climate and the changes that are taking place, but I think it's clear to all of us that ice ages have come and ice ages have gone over time. Even in the last 800,000 years there have been significant swings with temperature cooler and temperature warmer than it is today. These correlated with ups and downs of carbon dioxide, naturally occurring swings in carbon dioxide in the atmosphere. But what is new is our impact on these natural trends.

Talking with some polar scientists recently, I have discovered what some of you probably already know: The last time that the planet was without ice caps was about 38 million years ago. It may be only in the next 200 years, maybe by the end of the 21st century, that there won't be ice at the poles again. We don't know for sure, but what we do know for sure is that we're in the middle of a warming trend, and that that which has characterized all preceding recorded human history is going to be very different in the immediate future, and possibly the distant future, assuming that humans have a future. I would like to think we can make that happen.

We have come to know in the 20th century, and especially the latter half of the 20th century, at an accelerated pace about how the land, the air, the sea, and life on Earth all tie together inextricably. That is news in a way. As an ecologist, I grew up looking at how things relate to one another, but I'm so impressed how almost every day, every week, every month, there's new information about how everything ties together, that the atmosphere and the ocean are so closely linked. Phenomena such as the El Niño phenomenon: We really didn't understand that this was something more than a South American phenomenon until starting about the 1970s, and then in the '80s and '90s, as information came together and we began to see the links. Now I think it's safe to say that most people who make it their business to understand the weather, to the extent that we can, realize what a profound impact the ocean has on the weather, certainly on climate, and how effects from the lands can be global. [Referring to slide] Here are sands of sub-Saharan Africa being wafted across the Atlantic, causing changes in the nature of the Caribbean Sea and the corals that are there. The little spores from certain fungi are being carried across the Atlantic and causing swift and dramatic changes to the nature of the coral reefs in the Caribbean. In fact, coral reefs around the world are subject to global changes partly because of the increase in temperature.

In 50 years we've lost or seen a serious decline in half of the coral reefs around the world, coincident with the time when we have seen a decline of something on the order of 90 percent of the big fish in the sea.

But perhaps just as important and maybe more important are the changes through what we're taking out of the ocean and what we're putting into the ocean. In 50 years we've lost or seen a serious decline in half of the coral reefs around the world, coincident with the time when we have seen a decline of something on the order of 90 percent of the big fish in the sea. Not just the big predators, although that's certainly

key – the tunas, the swordfish, the sharks, the cod, the groupers, the snappers, all those things that you love to eat, that I used to love to eat; I've sworn off fish for a while, I hope not forever – but places such as this beautiful coral reef are becoming increasingly rare. Pristine reefs, areas where you can expect to see sharks in abundance. It's a good sign of a healthy ocean when there are lots of big predators around, because it takes a lot of small guys going up through the food chain in order to have big predators roaming around. Naturally, you expect to see a lot of sharks, a lot of big fish. These are not annual occurrences. This shark may live 30 years or more. A grouper may similarly live to be 30 or 40 years. Some of the deep-sea fish may be older than your great-grandparents, like the now-notorious Chilean sea bass, otherwise known as Patagonian tooth fish, or orange roughy. They are known to scientists as "slimeheads," but when you order them from a menu, in English at least, it says "orange roughy." Creatures that take 30 years to mature may be 100 years old by the time they reach your plate. Some think they may be 200 years old if they are allowed to live their full life span, or even older. This is true of many of the deep-sea creatures that are slow-growing and live a long time. But these are the very areas that we are, for the first time in all of the history of our species, now intruding ourselves.

We didn't know about the existence of hydrothermal vents in the deep sea when I was a child, let alone the importance of chemosynthesis as an alternative to photosynthesis as a means of fixing energy from the natural systems, the natural chemicals that are there. There is chemosynthesis in the forest floor and in salt marshes, but it took going to the deep sea to begin to appreciate the magnitude of this as an alternative pathway for supplying food to the rest of the creatures that live in communities around such areas. There's so much that we've learned in the 20th century that holds us in good stead going forward. If we still were as ignorant today as we were in 1900 about the value of natural systems, especially thinking about the importance of the ocean, in my case, we wouldn't know about the existence of the diversity of life out there.

… the natural systems make life possible for us. To the extent that we disturb them, we jeopardize our own future.

Even today it is a great concern that policy-makers, let alone children, haven't yet gotten the news about how important the ocean is, how diverse life is, how the ocean shapes the character of the planet, how if we don't take care of the ocean we are putting ourselves in jeopardy. It's true of natural systems, of course, around and across the globe. Salt water, fresh water, terrestrial, marine, whatever it is, the natural systems make life possible for us. To the extent that we disturb them, we jeopardize our own future.

And we certainly have disturbed the natural systems on the land. Possibly one of the reasons that we have gotten away with as much as we have in terms of the destruction of forests and other areas where diversity of life is apparent on the terrestrial part of the planet is that until very recently the ocean has been largely left alone. It's only in our time that we, as predators, have begun to take on the ocean on a megascale. Not feeding local communities, not feeding families, but feeding an insatiable luxury market that seems to have no end. And what is lost in the process? The diversity of life that is dependent on the interconnectedness of these systems.

When you consider that less than 5 percent of the ocean has been seen, let alone explored, it gives you some grasp of the magnitude … of our ignorance …

We've only begun to be aware of the expanse of life in the sea, the knowledge of sponge reefs as well as coral reefs, and the intricacies of life associated with them. The theories about the diversity of life being greater on land than in the sea in terms of species may turn out to be, as we get to know the ocean better, just a matter of perspective. When you consider that less than 5 percent of the ocean has been seen, let alone explored, it gives you some grasp of the magnitude not only of our ignorance but of how much there is left to understand, to explore, and how vulnerable

the ocean is, given the in-roads that we are making in this very short period of time. We don't even know the magnitude of the losses because of the changing chemistry that we have imposed on the ocean, as well as the physical alterations that we have made.

We're just beginning to be aware of the importance of jellies in the ocean. When I served as the Chief Scientist at NOAA, there was a move in the early 1990s to have a cessation of driftnetting in the high seas because of the destructive nature. Not only were the targeted species, the big tunas and the like, being taken, but in the process whales, many sharks, and other nontargeted species of many sorts were a so-called "by-catch." I raised the question, as I naturally would, being a fan of jellies, "What about the jellies? They're getting torn to shreds as well." The then-administrator of NOAA looked at me sadly, shook his head, and said, "It's going to be a long time before anybody gives a damn about jellies." It was that very year that the Monterey Aquarium put forth an amazing display of jellies. Thousands and now millions of people see jellies with new eyes, especially as we are beginning to understand their role in the ocean. These are the lions and the tigers. They are far up the food chain, actually further up the food chain than lions and tigers. After all, think about lions and tigers and wolves and foxes as predators. They eat grazers; they eat rabbits or deer or other things that munch on grass that fixes sunlight. These guys eat sometimes little fish or small crustaceans that, in turn, have eaten other creatures in the plankton and so on down. They may be four or five levels up in the food chain, not just two or three. These are important components of what makes the planet work. Jellies are also considered to be exactly what leatherback sea turtles like to graze on.

So, we have come to see the life out in the open ocean with new eyes, new respect for how these species shape the character of the planet, how they transport food around, how the plankton feed some of the big guys. In an expedition this summer out in the clear waters off Bermuda, in a bucketful of water, not even counting the microbes, just looking at the plankton that you can see with your own eyes without a microscope, you could see 15 phyla, all in their larval stages – in just that little bucketful of water. It is a very different way of looking at diversity of life than what you find in even the most diverse places on the land.

We have to think about diversity on a megascale in the ocean. Nearly all of the major divisions of life are out there in the sea in some form or another – including this little collection of Coelacanths, these ancient fish that were rediscovered for the first time outside of fossil forms in 1938; now dozens have been found in a number of places around the Indian Ocean and even in Indonesia. They're still considered to be quite rare, but the fact that they're there at all, that their roots go back 300 million years, and they're still out there relatively unchanged! But, then, so have the jellies, and they've been around 500 million years. So have starfish; so have a lot of so-called "living fossils" that we think of simply as "those sea creatures out there." Fish that aren't related to sharks and rays are somewhat more recent arrivals, but they precede mammals by a lot. We should look at these creatures with respect, not just as something swimming with lemon slices and butter, but rather as something to be valued swimming in the ocean. Not that fish don't taste good, and I think that we can extract some fish out of the ocean at some level without consequences, but not at the level that we're trying to impose on the natural systems now.

We aim for sustainability; we're not making it with respect to fisheries. I can't think of a single successful, sustainable commercially (that is, large-scale) fishery …

We aim for sustainability; we're not making it with respect to fisheries. I can't think of a single successful, sustainable commercially (that is, large-scale) fishery that is taking place today in the ocean. Not tunas, not swordfish, not cod, not herring, not grouper, not snapper – go on down the list – not orange roughy. We started to take them less than 40 years ago, and now Australia is considering putting them on the endangered species list. That's a swift reduction.

Parrotfish, grazers: even they are now being munched on as a luxury market, not as fish that are likely to go out of style because of habits of local people eating what they take from their backyard, their ocean nearby. As grazers, they should have a pretty good chance of being more abundant, more likely to yield at least some level of extraction over a long period of time. But not when they are taken from one part of the ocean and marketed in the other side of the world,

which is the case today. We lose touch with how many of them can be extracted without impact.

Some of us have had the joy of getting to know fish face-to-face on their own terms. The more we know about fish, the more we realize that they do have faces. They do have individual characteristics. There are no two fish exactly alike. I don't mean that parrotfish are different from puffers or sharks; I mean that every little one of the spotted puffers has a unique arrangements of spots; every parrotfish, similarly. Those are things that we recognize with cats and dogs and horses and zebras. We are just beginning to appreciate the immense diversity even within species, and why that matters. It's not good enough just to have a few of these creatures, but we need a good diverse gene pool representing the broad sweep of what each species represents.

One of the good-news stories of the 20th century is that with a moratorium on the commercial taking of whales … there has been at least a modest recovery …

Turtles, again, have been around for a very long time in the history of life, certainly 100 million years. They preceded dinosaurs. They're still out there swimming around in the oceans of the world, but they're in a precarious state at this point. We should have learned, with whales, that there are limits to how many we could extract, how many of what kind. In fact, we did learn that by doing that basic thing of stopping the killing of whales, by and large. It's the first thing you want to do if you want a species to recover and perhaps prosper. One of the good-news stories of the 20th century is that with a moratorium on the commercial taking of whales, the big ones at least, there has been at least a modest recovery of some species.

There are actions that we can take that give signs of hope, but not if we continue down the track that we are on presently with most wildlife in most of the ocean. Not all of it is because we are out there actively after such things as the fish and the whales and the seals and the sea lions. The incidental taking of them accounts for a huge take. More than 300,000 marine mammals are killed every year in the process of taking fish; several hundred thousand sea birds likely also.

The targeted species are one thing. Those that are taken for food or, in some cases, because of their fins, represent a real problem. The orange roughy are creatures that very few people have ever seen even half alive, let alone in their own realm because they live at 2,000 feet. It's hard to get to where they actually occur except with a net. In the process, ancient corals are sacrificed. [Referring to slide] This particular coral is thought to be perhaps 2,000 years old.

We are clueless to what's happening in the deep sea because we're not there to look at the consequences of trawls, which are like bulldozers … the system itself, the equivalent of a forest, is being thrown away.

We're thinking a thousand years into the future in this seminar. How long would it take to replace something that is lost in the process of gathering orange roughy for a dinner that might last for 20 minutes? The ordinary by-catch is maybe 10 to 1, sometimes 20 to 1: For every pound that is kept, that much is thrown away. We know what bulldozing of forests looks like; we know what clear-cutting of a forest looks like. We are clueless to what's happening in the deep sea because we're not there to look at the consequences of trawls, which are like bulldozers, only in this case the bulldozers are being applied to catch a few pounds of protein; the system itself, the equivalent of a forest, is being thrown away.

We are not concerned about this largely because we don't know about it. We don't see what's being lost. But it isn't just individual species on a megascale that are being consumed in the process of obtaining the few fish that we extract. Whole ecosystems are being lost. It's like saying that we just trashed the Amazonian rain forest when you lose large areas of the deep sea with their abundance of diverse life on a scale that exceeds by some measures the diversity of life on the land.

You can see what happens when a forest is cleared. We know the consequences, to some extent, because we can see the rivers flowing red and flowing off into the sea. We can see what happens when we chop up the land and turn it into monocultures. We can see what happens with farms and fields, and when we plant ourselves over much of the terrain.

What we don't see is the consequence of what we do under water. Does it matter? Well, I would like to hear your thoughts about whether it matters or not,

whether that idea of the 1960s and prior to that time that the ocean is so big, so vast, so resilient, it doesn't matter what we do to the ocean because it will recover somehow. But as one who has spent a lot of time around coral reefs and out in the deep sea as well, observing trawling activities, where trawls have been and places where trawling has not taken place, I earnestly hope that in 10 years, 50 years, 100 years, and certainly a thousand years we'll be able to have places, enough of the ocean, to have resilience. We still have half of the corals reefs left. I earnestly hope that there will be places like this for our great-great-great-great-great-great grandchildren. This is what they expect of me, and I think they expect of all of us, that we have come to the point where, as never before, we know how vital the natural systems are to our survival, let alone our well-being, our economies, our security, and of course our health.

But it's our survival that's really on the balance sheet right now. Take care of the wild systems, the natural systems that support us, and we'll be writing ourselves an insurance policy.

But it's our survival that's really on the balance sheet right now. Take care of the wild systems, the natural systems that support us, and we'll be writing ourselves an insurance policy. Diminish them, destroy them, watch them degrade, be cavalier about what we do in the deep sea, in the forests, and we'll pay the price. I hope that there will be kids around asking their parents and their grandparents a thousand years from now, "Please, leave the place at least as good as you found it."

Thank you.

Keynote Theme 1 – Biosphere in the 21st Century

Plenary Discussion

… if I were to encapsulate what was stated, we need to seriously reexamine our mindsets and our models before we approach such a large issue as humanity and the biosphere.

SESH VELAMOOR (FACILITATOR): We've had a set of wonderful presentations. I suppose if I were to encapsulate what was stated, we need to seriously reexamine our mindsets and our models before we approach such a large issue as humanity and the biosphere. This next session will be a conversation among the presenters and everyone else present in the room. It is aimed at interactions between participants with respect to any of the presentations that were made. If you would like to ask a question of a presenter or make a comment about a presentation, you're quite welcome to do that at this point. Ricardo?

Everybody talks about education, but what can we do? … What are the plans to change the thinking of people?

GUERRERO: I would like to ask Dr. Chaisson: What are the possibilities of fulfilling the two last *E*s, ethics and education? Everybody talks about education, but what can we do? What is the United States doing? What can UNESCO do? What are the plans to change the thinking of people? We talk a lot about it and about ethics. What is the possibility of making this a cosmic ethic, a universal ethic, which is difficult – especially today.

Most scientists do not accept their ethical obligation and responsibility to disseminate as well as to research, to share as well as to discover.

CHAISSON: Actually, I've been asked the same kind of question before the US Congress. A very powerful senator, Senator Barbara Mikulski, asked me once how we can do this. And I said to her, "The solution is a 1 percent solution. If every scientist in the United States – speaking only for the United States – spent 1 percent of his or her time, just a few days per year, devoted to meaningful dissemination of their knowledge across the spectrum of education, especially from universities reaching out to the primary schools, the middle schools, the secondary schools, the high schools, just 1 percent of their time, then we could, in fact, make a powerful educational statement." That's become known on Capitol Hill as the "1 percent solution."

But it is true that if you get every university and ask every university in the States – again, speaking only for the United States – to adopt secondary schools in the vicinity of that university, and just spend a little bit of time reaching out beyond the universities, we could make a very big difference collectively, where the whole becomes much greater than the sum of the parts. But we don't do that. Most scientists do not accept their ethical obligation and responsibility to disseminate as well as to research, to share as well as to discover. It's an absolute ethic that we need to embrace more as scientists, not only for the ethics of civilization, but the ethics of our profession, to make certain that we pass on the knowledge *and* the uncertainty and the ignorance that we have to the next generation.

… there has to be some kind of charismatic leader or some kind of charismatic movement that captures the imagination of the times and leads to a major change.

BOTKIN: I think that's very nice sentiment, but I think it's kind of a linear-thinking solution, as if it were just a matter of raising the level because everybody was out there to be educated. My experience is that we have these extremely dominant worldviews, and you won't change them by bringing in a professor to a secondary school, that there has to be some kind of charismatic leader or some kind of charismatic movement that captures the imagination of the times and leads to a major change. So, I'm discouraged to think that your way won't work, but I think it won't work.

CHAISSON: I'm not proposing at all that mental damage be done by allowing university professors to enter high schools; rather, as we do at the Wright Center at Tufts, we ask university professors to work alongside master teachers at the middle school and high school and elementary levels, so that the teachers themselves, who are in the trenches working with our children, will have the knowledge shared by their own peers, who are the master teachers.

But we're the people who are the cutting edge of the sciences at the university level, much more than the pre-college level. I think we have to share our information and our excitement and our enthusiasm. I'm a follower of Ralph Waldo Emerson, by philosophy. He said, "Nothing great was ever achieved without enthusiasm." I think we have to pass on the enthusiasm and excitement that we feel for science to the master teachers, and they, in turn, into the classrooms.

In actual fact, those who have the "ethics" of being able to transfer their environmental costs on to other people will survive … ethics actually is working against conservation …

SINGH: One theme that seemed to be common to both Daniel Botkin and Eric Chaisson was that change is inevitable and might actually be good. I, for one, was delighted to hear that, because that's a departure from the classical biological standpoint that we labor under. But the caveats didn't come out clearly because, obviously, one cannot go to the other extreme and say that all change is good. In philosophy, you cannot derive "what ought to be the case" from "what is the case." Therefore, there has to be some sort of an understanding of what type of change we shouldn't fight and what sort of change we should fight – and in what time frame. For example, the first presentation by Bob Citron talked about change, but surely that's not the sort of change that we're looking forward to. So, that's one question.

If I might pose one more dilemma, specifically to Eric Chaisson: You talked about ethics, and it was interesting. What I consider an integrated conservation approach is not integration only between economics and environment, but also between politics and ethics and various other things. But the dilemma remains. It's optimistic to presuppose that those who have the right sorts of ethics will survive and those who have the wrong sorts of ethics will perish. That's what I understood you to be saying. In actual fact, those who have the "ethics" of being able to transfer their environmental costs on to other people will survive, but those who do not transfer costs to other people will not survive. Those are the ethics of survival. So, ethics actually is working against conservation, because you are being told that unless you become self-centered and aggressive, and have control over somebody else's natural resources, never mind if you ruin your own, you're going to die out.

There ought to be some sort of ethic that we can all buy into based on science … that will transcend culture, that will transcend religion …

CHAISSON: That's why, in my slides, I said change is good; energy is good, but the slide also said, "Are ethics good?" It was a question, because I asked: "Whose ethics? What ethics?" There's an issue there.

But I look at the Earth, "the big, blue marble," as Carl Sagan used to say all the time, and I wonder, as the astronauts do: Where do those political boundaries come from? They're not on the Earth, when you look down from an astronaut's point of view. I'm talking about planetary citizenship. I'm talking about global morality. There ought to be some sort of ethic that we

can all buy into based on science, factual science, that will transcend culture, that will transcend religion, that will transcend the politics, and a common ethics for the good of all people – not for individuals but for the good of all people collectively.

But I'm puzzled as to how we can achieve it, which is why I said, "Well, are, really, ethics going to be good? Whose ethics? What ethics?"

FACILITATOR: Eric, I would have a question for you. In that the first *E* is evolution, do you suppose the ethics is a consequence that is bound to occur – not necessarily in a preemptive sense, but as a need, as a necessity, in a reactive sense – if, for instance, we were to take into account what Dr. Margulis said, that we will need four Earths to destroy in order to approximate the consumerism that is prevalent in Western society?

CHAISSON: I don't think the microbes need a sense of ethics. I don't think the lower forms of life (using that valued term "lower") needed a global sense of it. We are the first species that can affect the world globally, it seems to me, and technologically. I think maybe the ethics emerge over the course of the arrow of time inevitably for those civilizations that are willing to accept it. And those are the ones that will survive to enjoy the benefits. Those among technological civilizations that don't begin to foster a sense of ethics will be those who do not make it.

But, finally, who are the ones making the decisions, and how can science play a role in the decision-making process?

MOW: I have a question, maybe for both of you. How do you see science having some effect on policy-makers and decision-makers? We're talking about educating and going to high schools and to primary schools. But, finally, who are the ones making the decisions, and how can science play a role in the decision-making process?

CHAISSON: The US Congress makes it clear that they, the politicians, will make the decisions unless the scientists prioritize budgetary objectives. And that's why we in the scientific community, especially and notably in the astronomical community, for some reason, we have been able to get together as a community of astronomers over the past several decades to prioritize our efforts in order to tell the Congress what kind of policies we would like – lest we allow the politicians to set that policy.

So, it's up to us to take the initiative, and to explain, to disseminate, to educate the politicians so that they understand what we think is important to be done by way of science policy.

FACILITATOR: What about a bottom-up push, insofar as affecting policy by going to the people rather than to the politicians?

If you look at the dynamics of natural systems and understand what kinds of dynamics allow the systems to persist, it's a quite straightforward method.

BOTKIN: There are two questions that have been asked that I haven't been able to respond to, and I would like to respond to both of them. The first one was the problem Dr. Singh brought up about if you admit to any change, all changes might be good, that comes up every time I give this talk. I refer to it as the Pandora's Box problem; there's a great fear of that, and I've written about it. The answer is straightforward. If you understand natural changes, then nature becomes your guide. If you look at the dynamics of natural systems and understand what kinds of dynamics allow the systems to persist, it's a quite straightforward method.

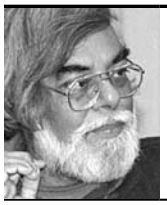
Another point to make about this is that it requires an understanding of what stability really can be. For example, in terms of control, an airplane is a good example. The fact that you can make an airplane dive doesn't mean that you have to or want to make it crash. In fact, if it was totally stable it *would* crash. It needs to be controllable, which means it has to have lack of complete stability; this allows you to change its direction. So, this is readily answerable, but you rarely get a chance to answer it because everybody's so frightened by this Pandora's Box syndrome.

In regard to how you make the step, in addition to very influential groups of physicists being able to go to Congress, there's the rest of us who have no esteem with Congress. In a book called *Strange Encounters: Adventures of a Renegade Nationalist*, I told a story

about Lee Talbot, who worked in the Council of Environmental Quality under Nixon, and how he actually got policy laws changed. It's a very interesting story because it tells how you work through the political process when you don't have the prestige of a physicist, and make something happen. I think there are many routes to that, but his story is a very good story.

CHAISSON: Indeed, all things are changing. We're moving out of the 20th century, which was the century of physicists, and into the century of biologists, I'm afraid. So, you'll soon have your power.

BOTKIN: It's not the century of ecologists. We're way down at the bottom.



Why should a tiger's eating a deer be all right, but my destroying a rain forest not be all right? Where does one draw the line?

SINGH: I want to respond to the question about ethics. There's a very interesting debate, which I'm sure you're familiar with, in evolutionary biology where there seems to be a glorification of what we would consider unethical values, because evolutionary biology talks about survival of the fittest of each species and, within species, of each individual. While you're talking about methods which are absolutely opposite, *prima facie*, to the principles of evolutionary biology or survival of the fittest, because you're talking about having an ethics where people would look out for each other, and say, "Well, okay, never mind. If it's a choice between you and me, let me sacrifice myself and let you live," etc. It's an interesting debate, and I would be very happy to hear the wisdom across this table of how one can take this further.

Also, there is the point you made about change. Again, this is a debate that we often have, but the trouble is that if you say, "Well, it depends on what is nature," that begs the question. There are many problems with this, and I won't go into all of them, but let me just mention one. Are human beings a part of nature or not? If you consider them a part of nature, then why is all the change that human beings bring about not good? Why should a tiger's eating a deer be all right, but my destroying a rain forest not be all right? Where does one draw the line?

These are debates that have gone on and on, and it would be nice if one could get fresh wisdom on them.

BOTKIN: Of course, once you admit that there are changes, then you have to have a set of ethical principles. With these you decide what changes you want, and then you seek to achieve them. So, you're correct, but you can do both.

… economists … are the priests in our secular society … the ones that are literally the gatekeepers to the people who make the decisions …

HADLEY: To respond firstly to the point Dr. Singh made, whether man is part of nature or outside nature, the building where you are now and the program that Ish directs is called "Man and the Biosphere," as though man is not part of the biosphere. Quite clearly, from the beginning this program had the philosophy of man – *man* being the synonym of *humans* – human beings in the biosphere, yet it was called "Man and the Biosphere." Perhaps it's not the place to go into why that was so, but just to respond to that.

While we're talking about the *E*s, can I put another couple of *E*s on the table? Indeed, economy would be one. About 15 years ago the people that were running the MAB Programme, the MAB Council and its bureau, set up what were called four new research orientations. Ish was very closely involved in developing one of these, which was called "Human Investment and Resource Use." This was in the late 1980s. And the group of experts who were brought together to discuss that said the focus of this should be on the interface of three *E*s: environmental integrity, economic efficiency, and equity. (Equity we haven't mentioned yet, but perhaps we'll come back to that.)

If I could then take the second of those, economic efficiency, and throw a question to Dan Botkin, who made the point about scientists being concerned with linear dynamics, with equilibrium states, etc.: Do you think that one of the reasons we remain in that mindset is because of the overpowering importance that the economists have as the gatekeepers to the establishment – borrowing from Australian zoologist Roger Bradbury – that they are the priests in our secular society, and that they are the ones that are literally the

gatekeepers to the people who make the decisions in government? For many of the people in the economics community, the general equilibrium model is the one that still is at the basis of their approaches. So, my question is: Are the scientists in a sense held back on their thinking on linear dynamics, on equilibrium or nonequilibrium models, by these gatekeepers of the establishment?

BOTKIN: I wish it were true. The importance of the economist is certainly to be recognized – that's a very good point – but, for example the International Whaling Commission science advisors, they truly believe in these equilibrium models, and they know almost nothing about economics. So, it's a part of our world mindset, but I wouldn't limit it to that. I think the economic problem as the gatekeeper is a significant factor, but it isn't the only factor. There's just this huge cultural inertia.

FACILITATOR: Would Albert de Haan, the currency trader, have something to say about that?

… in the economic/financial world, it's very simple how you will change it because you will lose money – and money is something that in that world counts …

DE HAAN: It's one of the first times I've ever been called a priest.

What intrigues me, using models and using wrong models, in the economic/financial world, it's very simple how you will change it because you will lose money – and money is something that in that world counts, as it does in many other worlds as well. For me what is intriguing is that I don't see a big gap between the economic/financial world and the scientists' world. But there again, I think it's a matter of awareness. I was completely stunned that there are governments using wrong models and still can do it and persist in it, where the other world has gotten its own mechanisms to get you out of the game – it's as simple as that – and adopts the models that are applicable for the times you are in because of the changes you go through.

… often when push comes to shove, science is regarded with hostility rather than with affection in the political arena.

MACDONALD: In passing, a brief answer to Shekhar Singh's question about whether man should be considered part of the biosphere, it seems, from everything that I know and believe, the answer has to be *yes*. If we're to find solutions to the sorts of problems we are going to debate in these two days, the starting point must be that mankind is part of a natural system rather than aside from it.

But the point I wanted to make was a device to get us back to the conversation of a moment ago about the importance of education and the responsibility of scientists to be involved in it. Three speakers alluded to that responsibility. I, in my own small way, have also spent quite a lot of my life doing things like writing books and making television films, believing that it was important to educate the public. I noticed, at least in the context of children in Britain today (of which I have three myself, so I have some hands-on experience) that I rejoice in the amount they know and understand about science, about environmental problems, and about the solutions that we're debating here today.

My question is whether the speakers see a way of moving from wide dissemination of knowledge and appreciation of issues to political action that takes into account that knowledge.

This is getting to a question for you. There's some source of pessimism. Although I find my children and their friends very knowledgeable about these issues, I find that that knowledge – and some of it translates through to politicians – doesn't yet have much impact on policy and decisions that are being made. Similarly, I observe that although the public is bombarded daily by information from science and is now wiser than it once was or at least more knowledgeable than it once was, often when push comes to shove, science is regarded with hostility rather than with affection in the political arena. So, my question

is whether the speakers see a way of moving from wide dissemination of knowledge and appreciation of issues to political action that takes into account that knowledge. It seems to me that there's a bit of a chasm at the moment between the two.

BOTKIN: I think that's a key question and very important – and I don't think we have good solutions. One answer is what one of my friends said, "That's why Moses had to lead the Jews through the desert for 50 years; he had to wait for the old generation to die off."

But what I see in the United States, having written a prize-winning textbook, is that even the publishers and the teachers don't know how to distinguish good science from bad science. There's something fundamentally wrong. I'm delighted to hear that your students appreciate science, but in America it seems to be less and less so. I'm just saying that there's a gap in America that's a serious problem in how you evaluate science.

Inevitably, anyone who studies evolution in the English-speaking world has a 19th century view that random mutation makes new species … individuals are selected for …

MARGULIS: I had a comment to Shekhar Singh about reflecting wrong models. Inevitably, anyone who studies evolution in the English-speaking world has a 19th century view that random mutation makes new species, that the social relations are ignored, the individuals are selected for – this kind of (to me, anyway) extremely British view (forgive me, I love the Brits) but Spencerian concepts of "competition and nature raw" are just endemic. There's been a big revolution in evolutionary thinking, but unfortunately it's not among the evolutionary biologists at all, because the evolutionary biologists have held the purse strings to this competition view of destruction, that all evolution is really fighting of animals – none of which is the case at all. The people who are making the real progress are people who study this parasitism I showed you as symbiosis, for example.

So, we have these models that are much more subtle than the mathematical/financial ones. They're the ones that show the relative merit of the white Christians over the black women – it's that kind of model. Those models are so deeply entrenched, and they have to be changed. I don't know how they are going to be changed.

The trouble lies in that scientists have not been able to create an external situation where science can flourish. It can flourish in classrooms …

SINGH: I am delighted that there is this alternate way of looking at evolution and, as you rightly said, it's not well known. I would be very happy to understand it, because otherwise, as a student of moral philosophy, there is this constant dilemma.

What I wanted to respond to was the point David Macdonald made. I've been a teacher of moral philosophy for a long time, and I think I have the same sort of frustration that sometimes scientists have vis-à-vis biological science or ecology or conservation: that you can train your students in all the different values of ethics, but when they go out into the real world and they face the real challenges of life, this scientific construct starts crumbling. I would argue that there are different types of sciences. For example, if you're a pure mathematician, what you learn or study might not have much relevance to the actions in your life. But if you're a moral philosophy student or if you're a student of ecology or conservation, then your discipline has a very direct bearing on how you live life.

The trouble lies in that scientists have not been able to create an external situation where science can flourish. It can flourish in classrooms; it can flourish in seminars. But when people go out into the real world, the world is an entirely different setup where either you follow your scientific constructs and so you're a misfit – and some of us *are* misfits – or you start fitting in with society, in which case your science has to take a back seat. This is, to my mind, one immediate dilemma in front of us.

The easy wins have been had. We're now on to a series of problems where there are no easy wins.

MACDONALD: Taking up Shekhar's point, and also responding to Dan's very helpful comments as well, getting back to this business of communication and how to get the message through, I have a suggestion for why it may be problematic, and I would like people to respond to that.

It seems to me that in the last two decades we've seen wonderful progress in conservation biology in the wider sense: people becoming interested in issues of biodiversity, and so forth. But to start with, we went through a period where there were easy wins. My proposal to you is that the easy wins are over. The easy wins were cases where, through education and science and better understanding, we could come to see that certain things were "bad things," perhaps being done by people who could be characterized as "bad guys." For example, pollution, toxic emissions into the environment, and so forth. It's fairly straightforward to understand that if somebody's pouring a nasty chemical into a river, it's bad news, and regulations should do something about it. At least in the Western European context, a lot of things have been done about that. The easy wins have been had.

We're now on to a series of problems where there are no easy wins. We're looking at people's lifestyles, everyday people's lifestyles being changed, and we're looking at us as citizens, I think, vacillating unhappily, schizophrenically (using Lynn's use of the word earlier), between our appetites as consumers and our demands as citizens and our philosophies as ethical beings. So, I think the easy wins are over. One reason that people now can know a lot and yet a lot doesn't change is because all the choices are hard choices. There are no more win-win's; there are lots of losers; and we'll all be losers in at least some ways in the short term if humanity is to get to a better place in the longer term.

BOTKIN: These are all very interesting comments, but Singh made an interesting point. I gather that you're thinking maybe sciences should become hobbies again, so that the activity of science is something we all *do* rather than it just be something we learn in the classroom.

I like that idea, but again I'm sorry to give a negative experience. There was a centennial of the Lewis and Clark Expedition, the famous explorers who went across the North American continent from 1804 to 1806. I wrote some books about it, so I was asked to help in a National Geographic educational program on how to help secondary schools appreciate the Lewis and Clark Expedition. I said, "Lewis and Clark were wonderful at observing and measuring. Why not do the measurements, the surveying that they did?" I had the opportunity to work with some high school teachers to do this. The high school teachers disliked the measurements so much that they actually cheated on the exercises so they wouldn't have to work. So, something has gone out of our society. I love the idea of science becoming a hobby. I even tried to teach that you would teach this and make it fun. Maybe I wasn't the right person. It's a serious dilemma, but I like the suggestion.

To take decisions, you really need to work with people whom these decisions are affecting … it's not only a decision on the policy level …

MOW: I think we need to combine better social sciences with natural sciences. To take decisions, you really need to work with people whom these decisions are affecting. That's why I think it's not only a decision on the policy level, but also a decision in the real world, because normally scientists think that their approach is the only approach. But when you speak with people, the decisions would be affected by what people are really doing in the everyday world.

So, I think we need to work more as natural scientists with social scientists, with politicians, and finally take the decisions that will be put in place.

SINGH: A quick response to the point about hobbies. You have a story that might not be a success story, but there are a lot of success stories and I thought I would just share one briefly with you. In India many years back, in the early 1970s, we started a program working with school and college students, bringing to them the elements of conservation. We found that the

problem was that you could lecture to them, but then if they could not put the theoretical knowledge they had to practical use, they would soon lose interest. So, we started little plots, with the help of the government, where students could go and conserve those plots, plant trees, go and count the birds, etc. We are 35 or 36 years down the line, and some of these students are now senior civil servants. They still go back to those plots and take that knowledge with them. Many of them have told me that all of the theoretical learning would have not helped if they didn't have one small place where they could go plant a tree and watch it grow. So, there are examples of doing this that we tend to forget sometimes.

David Macdonald had a very interesting distinction between easy choices and hard choices. But even when you were telling them, did you notice that the examples you were giving were not between easy and hard choices, but between other people doing things and doing things for yourself. That's the dilemma. It's always easy when somebody else has to stop polluting and not easy when *we* have to stop.

MACDONALD: Exactly.

It's a question of getting out the knowledge that as a society we have. We have it in libraries, we have it in computers, we have it in DVDs … It's a distribution problem.

MARGULIS: With respect to hobbies and hands-on education, there is in the Archive of the World the African Primary Science Project that was in Dar es Salaam; it was also in Uganda and also in Ghana when we went. These are hands-on activities that just illustrate your point, that when the people – not just the students but when the teachers are deeply involved – and they like what they're doing and they make the measurements, and they are practical and can see what it's leading to, it changes their lives because learning is by doing. The problem is that there's no way to distribute. In the United States the publishers own the curriculum. There's no Ministry of Education. There's no one who gets paid except to make money for the publishers in four colors, so they publish lies because they can sell them faster. They publish lies because California and Texas don't believe in evolution, so they take the evolution part out of the book. In Europe, at least there are people who develop educational techniques who are not paid for the product; they're paid to try to get the science across to the students.

The big problem is not that it doesn't exist. These activities exist; there are wonderful programs, including ones that you've developed, but they're not distributed because there's no way to distribute them, at least in our country. And in other places I don't know whether they exist or not. It's a question of getting out the knowledge that as a society we have. We have it in libraries, we have it in computers, we have it in DVDs, we have it in the practical experience of the people who are planting trees, but it's not distributed. It's a distribution problem. I think it's naive to think that very few people can do that because they're good people. They can help, but they can't do it.

FACILITATOR: Dr. Sylvia Earle is with us now. We're grateful that you have arrived earlier than what we had anticipated. I would like you to introduce yourself to the other participants, and then we'll go on to the next session.

Where I'm really committed is trying to find a place for ourselves within the natural systems that support us, but with a special eye to that neglected part of the planet, called the ocean …

EARLE: Thank you. Before I introduce myself, I want to jump into this conversation with one small observation that seems relevant. I've spent quite a lot of time working with National Geographic, for whom pictures are almost everything. They do admire good words, but they embody that often quoted comment, "a picture is worth a thousand words." But they also, in more recent times, have become committed to supporting exploration with a theory – with an understanding, I believe, more than a theory – that an experience has got to be worth at least 10,000 pictures. It's the garden Dr. Singh is talking about. It's the hands-on, actually doing of something that really stays with a person.

Deep Ocean Exploration and Research – which I am now Chairman of – is a little venture that I started when I stepped down as the Chief Scientist of NOAA in the United States and wanted to start something so

that I could consult and do things while continuing my interests as a marine biologist and one committed to developing new technologies for ocean exploration. But since 1998 I've been Explorer-in-Residence at National Geographic, a position that, if I had known it existed when I was a child, I would have aspired to. I was the only one at the time, but now there are more than a dozen individuals who are given space and some support by the National Geographic to do what the name implies, to go have fun exploring.

As well, I serve as the Chair of the Deep Ocean Exploration Research entity in California that is really run by my daughter and son-in-law, and about ten engineers who work with them.

I have until recently been the Executive Director of Conservation International's global marine program. I still work with them, but not in that role. And also with a little entity down in Corpus Christi, Texas, called the Harte Research Institute, named after the benefactor, to focus on the Gulf of Mexico to find sustained use of that great body of water.

Otherwise, I have a long history of being in the ocean, working as a biologist. Where I'm really committed is trying to find a place for ourselves within the natural systems that support us, but with a special eye to that neglected part of the planet, called the ocean, where I think much more needs to be considered as we try to figure out how we go forward from this point onward. The ocean is generally regarded as that big blob of blue out there but we need to consider it much more seriously in every respect, whether it's biodiversity or economics or whatever.

MARGULIS: Sylvia, it's a pleasure to see you again. My suggestion is that we change the name of the planet to *Planet Water*, not just *Ocean* but *Water*, because some of us come from lakes and rivers. I think we should change the name in a very deliberate way.

FACILITATOR: Dr. Earle, it might interest you to know that we have involved experts on the ocean in some manner or the other from the very start, in almost every one of our seminars and conferences. You perhaps have heard of Dr. John Delaney from the University of Washington?

EARLE: Of course.

FACILITATOR: He's a regular participant in our seminars. To that extent, we do not exclude the ocean at all.

Another thought has crossed my mind, in relation to this discussion. During the winters I go to India. One of the projects that I'm involved in there is a school in the villages, about 300 kilometers outside Chennai, where children from seven different villages come riding bicycles into the school environment. They do a science project every year. After the tsunami hit the southern coast of India, they did a science project on the tsunami and how tsunamis come about and what the effects are and what can or cannot be done. They put together an extraordinary exhibit, science-based, hands-on with cardboard, foam, crayons, slate, and chalk. I wish I could have taken some pictures to show everybody. It was just incredible.

… this is the first year in the history of humanity where more than half of the world's population lives in cities rather than in rural or countryside environments.

MACDONALD: One additional comment, thinking of what people said earlier about the "disconnect" between people's experience and nature and wildlife. I think I'm right in saying that this is the first year in the history of humanity where more than half of the world's population lives in cities rather than in rural or countryside environments. I think it's probably rather relevant.

FACILITATOR: With that, I think we can conclude this session and go on to the next.

Keynote Theme 2

Climate Change and Biosphere Futures: Threats and Opportunities

Climate change will cause environmental, ecological, social, and political changes during the next century, the impacts of which are difficult to predict. In the meantime, climate change has opened the door for carbon-denominated financial instruments to enter global markets. Is this an opportunity or a threat? Many environmentalists and some economists question the ethics behind assigning quotas and permits for carbon trading to industries that created the problem in the first place! But could carbon financing and trading help biosphere causes like biodiversity conservation? What are the prospects and how do we move forward in these fronts?

Albert de Haan delivered a presentation on carbon trading and using market mechanisms to combat climate change.

Keynote Theme 2 – Climate Change and Biosphere Futures: Threats and Opportunities

Presentation by Albert de Haan

Can Trading Help Save the Planet? Using Market Mechanisms to Combat Climate Change

SESH VELAMOOR (FACILITATOR): The theme for this set of conversations is climate change and biosphere futures: threats, and opportunities. We'll get started with Albert, speaking on carbon trading.

DE HAAN: I'll do a little bit of an introduction. Although you might have the idea that we, coming out of the financial markets, think only about money, money is only a means to achieve some things. To cover a little bit of my background, I studied law for six days, and after that I started to work at a bank as a currency trader.

FACILITATOR: Six days?

DE HAAN: Six days, yes.

FACILITATOR: Is that all it took?

… if there is a financial incentive for meeting targets – in the case of CO_2 emissions, the target is lower emissions … That is step Number 1.

DE HAAN: No. That's why I had to choose another job. Actually, I went to a bank at a certain stage, and we were talking about how banks operate. I had been trading for many years. In 2001 were the Marrakesh Accords. I was there at that time, not trading but more on business development, and I had a request to my Dutch boss. I said, "If there is Kyoto and Marrakesh, and there is an emission right that is tradable by the nature and cause of Kyoto, I would like to set up an emissions trading desk at Fortis Bank." Then I went to his boss and told the same story. I said, "I think with our business there might be some chance to have a new business developed called *emissions trading* or *carbon venturing*."

From 2002 on, I was responsible for what we call in the bank *carbon venturing*. That meant that all the Kyoto mechanisms – I don't know if you're aware of clean development mechanisms (CDMs) and joint implementation – all these mechanisms were the sole source for financing at our bank, because there was a part of the financing that created a different project cash flow, which is called emission reductions, that were tradable and sellable.

What I would like to argue is not that trading is the solution for climate change. What I would like to argue is that if there is a financial incentive for meeting targets – in the case of CO_2 emissions, the target is lower emissions – wherever in the world you reach it, it's acceptable and accepted. That is step Number 1. If you decide that you want to have lesser emissions because of the greenhouse gasses and the climate change effects on it, that's Number 1 to choose.

… if you make an incentive for meeting a target, and if you combine it with a heavy penalty for not meeting the targets – that is proven to be the most efficient way.

Economists tend to say that that's an economic decision, to do for climate change, because of the effect. If you take studies by the reinsurance companies – AIG, Swiss Re – if they extrapolate what's happening in the climate change now and they compare it to the cost of their insurance portfolio under reinsurance, I can tell you: They get scared. So, partly Kyoto is formed not only on, you might say, right decision, but also formed on the fear of cost and all the costs and effects on economics and on life, together with the fact that we need to do something on the conservation side. If you want to have some goals to achieve, it has been proven that if you make it tradable – in other words, if you make an incentive for meeting a target, and if you combine it with a heavy penalty for not meeting the

targets – that is proven to be the most efficient way.

During my presentation you will see some slides about European Climate Exchange, which is meeting a pre-Kyoto trading mandatory scheme in Europe. I would like to give you a little bit of the observations we do. My role in this small organization – we consist of five people in Europe – is to create awareness in the industry that companies can trade if they want to.

I think we have a shared problem: I have to convince the politicians that what they decided to do as a tradable solution has been a good choice. If you have to influence the politicians, you have to influence the public as well. So, we do a lot of presentations in creating awareness. For example, once a quarter I'm in Brussels to have a cup of coffee with the people from DG Environmental, just to tell them what I see, because part of my role in this organization is to go and look for the smokestacks. We have been visiting 91 percent of all the big emitters in Europe. By visiting them, we also notice what they are trying to do to meet the caps set, you might say, by the politicians.

The interesting thing that is happening now is that there are environmental people in industries who used to be the "enemy" for the producers and for the financial people in the organization, because the only role they had was to implement the environmental laws in such a way that they couldn't get fined, but they weren't "incentified" to do anything proactively. Under this scheme, by putting money in what companies emit less, where they can sell the allowances that they have in surplus after emitting less, that is a financial incentive, which is giving a different role for the engineers in a company to work very hard on improving the efficiency of their facility.

On the other hand, under the Kyoto project mechanisms, you can also export knowledge and technology to other countries where the proceeds of lower emissions you can use for compliance in the European scheme.

I will very briefly tell you about the emissions trading scheme and what kind of role we play ourselves there. There is a scheme that has already been working for nearly 25 years. This is the US sulphur scheme, which showed that it works to have a financial incentive to lower emissions. Then looking ahead, with changing paradigms – actually, I have to agree with Sylvia – what we see of what has been changing is so enormous that I will try to think only for the coming three to five years, because that is where the action is coming and that is something where we can see. To give you one small example: If you go nowadays to Silicon Valley, 30 to 45 percent of the new initiatives are all technology- or energy-based. You see what the improvements are there on solar techniques. Some people say that climate change is "the hand of God." I don't believe that, but we might be very grateful to God for these high oil prices, because the high oil prices have been triggering not only sustainable actions, but has triggered new initiatives to generate and to think more carefully about what we are emitting.

Two weeks ago I was in Poland. The Polish power generators, by simply thinking about the logistics into their coal-fired, very big-emitting power plants, they improved the efficiency by two percent, which means that they emitted two million tons of carbon less. Now, you might say that it's not much, but at this very moment it's 25 million euros annual value that they'll get by being a little bit more efficient. And the cost of reaching that efficiency throughout Poland was one million euros. I think that's one of the examples where you can say that a trading scheme is beneficial for speeding up the processes of getting more and better technologies in place.

The emissions trading scheme is a mandatory scheme wherein the choice of Europe was not to wait until America or Russia ratified Kyoto …

Again, I would like to look ahead only for the coming five years. The emissions trading scheme is a mandatory scheme wherein the choice of Europe was not to wait until America or Russia ratified Kyoto, but the choice of Europe was if we want to do anything about the effects of greenhouse gas emission or CO_2 emissions on the climate change, we will start our own scheme. You might say that before Kyoto starts, which is the first of January 2008, we have a tryout phase in Europe from 2005 to 2007. It is really a tryout phase; a lot of people have no idea what to do and how to cooperate. I'll give you a small example. For the first time in 500 years now the cement industry is thinking about technology improvements of creating and generating cement. Before that they didn't care; they were not interested. But now, the big Mittal Steel in Poland increased effi-

ciency and actually made money – 130 million euros they made by simply being more efficient.

Now, these kinds of triggers are given to 5,000 companies. Why to 5,000 companies? Because these companies have experience by their environmental permits in how to measure the things they are emitting. I'm not a technician, but I understand that if you know what you put in a factory in installation, then you also know what it emits, if you know the circumstances of what it is being used for. That's something that we see happening. After shouting against it, they're all adopting it because it works. The Europeans, I think, took the right decision that the biggest polluters – the utilities, the power generators – are carrying the burden of the lowering caps, so they have to take care of lower emissions and less emissions. They are already working on it and, I must say, very hard.

The development of the carbon market itself – officially it was started the first of January 2005. The volume of trades done was 10 million tons in 2004 (you might say that this was "peanuts"). Last year, the first year of having the carbon-trades European trading scheme up and running, 250 million tons was traded of the 2.2 billion allowances available. People get allowance for one year; after one year they surrender them combined with the real monetized and verified emissions. This year [2006] so far, 600 million metric tons has been traded.

To give you an idea, we're talking about 13 billion euros' value that has been traded so far. So, you're talking about a market that, by political initiative, has been set in place. And every year the value of allowances given by the governments to the companies has a total value of 35 billion euros. It is given away – but the companies have to work for it.

On whatever is trading in Europe on the European trading scheme so far, we have a market share of 40–42 percent, which means that we are the leading exchange. We have a sister company, which is Chicago Climate Exchange, which is working on the voluntary market. We are offering our product for the mandatory market.

Talking about big changes and the change of paradigms: If you want to generate power in Europe – emissions have been priced because of the fact that there is an allowance price throughout Europe – whoever is generating power has to take into account the price of carbon. And if they take it into account, they have to choose, if they have the installation choice to make, whether or not to burn coal (coal emits .9 tons of CO_2 per megawatt hour generated) or gas, which emits .4 tons of CO_2. We see the large utilities constantly playing this game.

What is coming in addition to the CO_2 and the coal is that there has been an enormous increase in the use of wood as biomass firing into the coal, mainly the coal-fired power plants. I'll give you an example. Drax, which is the biggest coal plant in Europe, burns 30 million tons of coal every year. By using wood pellets and having techniques (they've got their own forestry know-how in-house), they have been able to burn 1 million tons of wood as co-firing, pulverize it, and put it into the boilers, which saved them 7 million pounds simply by the fact that they didn't burn coal and emit CO_2. That means that there is now a big demand coming out of the coal-fired power generators for having a quality of wood that can meet the requests and the parameters for having an optimal wood as an energy consumption. So, they are asking for energy crops. You wouldn't be surprised that a lot of politicians don't agree that there is a chance to have energy crops because wood is wood.

That's a big change that we are seeing and facing now in the market. And it's not only Drax who is co-firing. We expect that there was about 10 million tons of wood simply demanded, and mainly it is residues of, for instance, the furniture industry. It's waste, which is recycled and reused as an energy provider by co-firing it in coal power plants.

The big success, and actually this is why Kyoto started, was the big Clean Air Act in the United States … healthcare costs were $25 billion to $30 billion lower …

The big success, and actually this is why Kyoto started, was the big Clean Air Act in the United States, where sulphur (acid rain) had such a big effect on the US people that there was a decision that it should be capped by 50 percent within ten years. There was a big penalty. There was an enormous pressure to, in a very rapid pace, meet the caps set on the sulphur emissions. They reduced it in ten years' time by 50 percent. And I can tell you that the investments made, the costs to achieve this were about $2.5 billion to $3

billion. That was paid by the industry, probably passed on to the final consumer. But the big benefits we had and the Americans had out of that program was that the healthcare costs were $25 billion to $30 billion lower because of the fact (and this has been proven) that asthma and all kinds of respiratory diseases have nearly vanished. There was a very close correlation between the sulfur and the health situation, the lung situation of the inhabitants, primarily those living very close to the coal-fired power plants.

We are not surprised that last week the Chinese government said if they want to start anything to reduce emissions, they will start an SO_2 trading scheme, because if you see the enormous increase in the cost of healthcare in the Chinese suburbs, it's amazing.

This Acid Rain Program was successful. Reduction came on time and the biggest reason for the success was the fear factor – fear of the extensive penalties. If a company didn't meet a target, then it had to pay a lot of money. The Europeans made it even a little bit worse. If you don't meet your target and you have an overemission in the carbon market in Europe, you don't only pay a penalty. What you overemit is deducted from your next phase, but perhaps what's even more important is that there is a naming and shaming next to it. So, if a company in Europe is not meeting its target but has to pay a penalty, even if it's only one ton of overemitting, then the company will be mentioned by the Europe Commission in their press statements. Then the reputational damage is very, very big.

What is very important, and actually that's what the Americans taught us Europeans, is the health benefit. The Americans have a big trading experience, and on the CO_2 emissions, we had hardly any trading experience. Of the people falling under the mandatory scheme, it was only the utilities that used to trade and the others had no experience at all. But, again, here it was the health benefits that are not shown in the financial statements of the companies, but in the country really had a very big impact.

What I personally believe is that the EU ETS … and the Acid Rain Program are really examples that a cap-and-trade system can make a scheme work.

What I personally believe is that the EU ETS [European Union Emission Trading Scheme] and the Acid Rain Program are really examples that a cap-and-trade system *can* make a scheme work. But what is more important is that with the clean development mechanism, one of the Kyoto projects, and the joint implementation, which is mainly for European countries applicable, there is a possibility to achieve lower emissions outside of Europe in which you can benefit from the credits you have. And the countries where you can do it – the biggest now in CDM are India and China – they have learned that they can tax the receipts. I think the Indian government takes 60 percent of the receipt of the emission reductions and specifically for HFC-23 it's the Chinese government that taxes at 65 percent. Nevertheless, the projects work financially for the European companies who achieve it.

If you want to monetize a tree and make it more valuable standing up, being a sequestrator of carbon, than chopped down … give the local people the chance to benefit and make money out of the fact that they are maintaining a sink.

There's only one big thing that is missing, and that is what to do with forestry. Under Kyoto, forestry is accepted: reforestation, afforestation. Actually, the first time Ish and I met – I think it was in Brussels – there was an event where the Ambassador of Ghana (I believe it was) was complaining that finally she had something of value, namely, she had a sink; she had forest. And what did we decide in Europe? You're not allowed to have credits out of forests to use for compliance reasons in Europe. As from 2002, I am working as a volunteer on the Leuser Project, which lost the European Commission subsidy in 2004, and that was typically an example of a sink. One of the big discussions we face now is: If you want to monetize a tree and make it more valuable standing up, being a sequestrator of carbon, than chopped down to create anything else, that's something that might be very use-

ful because then you give the local people the chance to benefit and make money out of the fact that they are maintaining a sink. I personally believe that there will be a bigger role for sinks and it's needed as well.

To see what is happening with the oceans, just before Mr. Howard became Prime Minister in Australia we were in talks with WWF [formerly known as the World Wildlife Fund] because they have 4 percent of the Great Barrier Reef, the coral reef. Coral is a very big capturer of CO_2; Sylvia knows that better than I. The thing is: If you are able to make that a sink, then automatically not only is the protection there, but there also is money for the conservation. The idea that we still have with the Leuser Project is that if we are using that in the proper way and it is accepted as a sink, we will try to sell some of the receipts to the Japanese because the Japanese have said that they want to meet the Kyoto targets by purchasing 3.4 percent out of sinks.

The interesting thing is that you don't have to beg for donations if the Leuser Project is accepted as a sink, but you make a kind of business out of it. And the business is not meaning that you want to make a high yield dividend as a yield, but the thing is that you have cash. You don't have to beg for money. You don't have to rely on the politicians who say *yes* or *no* if they think you have a rather fishy project or not. You can generate cash, which you can use to buy additional land and have a normal economic business model for these kinds of sinks.

That's actually what I would like to do: Instead of doing a study, take one or two pilots and try it out. Perhaps there is a very decent Romanian project that might be suitable for the Romanian government to use as a greening model to sell their hot air to another government in Europe that might need it. That's something that is very attractive, because in the Kyoto atmosphere you have the possibility that countries don't meet the targets – and most Western European countries don't meet the targets – they can buy from countries who have surpluses, like Romania, but also Russia and the Ukraine. There is only one condition: The proceeds must be invested in green projects. So, there might be a combination of the new tradable environmental law in effect making a bridge between some disciplines that actually hardly talk to each other now. In my belief, that's the biggest advantage of what's happening now.

… it's not purely money; it's changing the mindset to think about the opportunities.

If I may conclude with one example from three years ago when I was a walking Don Quixote. In those days nobody believed in emission trading; nobody believed in Kyoto. I had a preliminary discussion here in Paris with a large tire factory. The interesting thing was that because of my banking experience, I knew the man who was the CFO. I also knew the man in charge of production because we had a day with him so we could see how they made their tires. And then in visiting their plants I met the man from the environmental division as well. I tried to get the three together. The astonishing thing was that they didn't know each other. They were supposed to work together and to have a lot of dialogue about what they should do about environmental issues inside the factory. Ever since then they have had a working group, and they are now 10 percent more efficient than their competitors in Germany. So, it's not purely money; it's changing the mindset to think about the opportunities. For the first time in the history of the company, the people who are doing the environmental measurements got a bonus because they're now appreciated for what they are doing and what they are capable of doing proactively, instead of watching to make sure the company doesn't pay too much money for something that is simply there by the law and the license.

I would like to stress that if you have the dialogue, the possibilities to communicate, then everyone realizes that we have another paradigm to think about. The box is changing so much and so fast it's hard to model. The interesting thing is that it's surrounded with a group of young people who are very enthusiastic about this subject, and they don't care about money. They care about what their feeling is and they want to have a better and a cleaner world. I stopped smoking not because my doctor said it, but because my daughter said, "Daddy, stop smoking." Children are keener and cleverer on what is happening in the world, and I think that's very important. And we have to take care that they can enjoy that as well.

Thank you very much.

FACILITATOR: Thank you, Albert. Dr. Ngoile?

… the whole formula is capitalism in a form that not many people actually understand. That's where information comes in.

NGOILE: About trading carbon and the like, this is something about which you might want to help us, because when I was head of the environment in Tanzania, in fact I was very enthusiastic regarding CDMs but very disappointed by the fact that the political will was completely not there. And it was because of a very simple reason: When you contemplate about carbon trading, especially in developing countries, and you're trying to think about equity, it becomes a nightmare because the whole formula is capitalism in a form that not many people actually understand. That's where information comes in.

What I would like to compare it with are the fishing access agreements, which I think we are all very familiar with. The information is with the one who wants to get your fish away. You don't have the information, so in fact you don't have a common denominator. The one that wants to take the fish and has the information comes up with the formula, and says, "Well, the base catch is going to be 5,000 tons," when in actual fact, at the end of the day, the same ships that fish take out 50,000, even 80,000, tons. The one that has to observe what is in addition to the 5,000 tons is the very one who takes your fish away. Consequently there's no equity and it's not a very good negotiation.

So, maybe within the CDMs, if a mechanism can be found that will bring in a certain level of equity, that might be something that developing countries may be able to buy. But I think, as you have pointed out, if it is carbon trading within the performance of industries in the developed world, then that might be the way forward, but forests and carbon trading and wherever you are, I think we're having a little bit of a difficulty there. That's my personal views. It's not the view of Tanzania; it's not the view of developing countries; but that's what I have seen.

Panel 1

Information, Expert Knowledge, and Decision-making: Ecological Sciences and Biosphere Futures

Do scientific information and expert knowledge make a difference in enabling the enactment of biosphere-friendly policies and legislation and their effective implementation? Particularly during the global environmental decades that began in the 1970s with the establishment of the United Nations Environmental Programme (UNEP) in 1972 and of the Man and the Biosphere (MAB) Programme in 1971, has science done all that it could do to better conserve and use biosphere resources? If yes, what are the good examples? If not, what could be done in the future?

Panel 1 featured Dr. Shekhar Singh in the opening speech, followed by commentary by June Marie Mow, Dr. Malcolm Hadley, and Dr. Magnus Ngoile.

Panel 1 – Information, Expert Knowledge, and Decision-making: Ecological Sciences and Biosphere Futures

Presentation by Dr. Shekhar Singh

Followed by Comment by June Marie Mow and Dr. Malcolm Hadley

… the science and technology that allow us to use or destroy natural resources have grown much faster than the science and technology to help us to conserve …

SINGH: Much of what I have to say follows quite neatly from the presentations that we heard this morning. First of all, I am not, in the strict sense, a scientist; I am not even a social scientist, having studied philosophy. The way I have looked at the question we are debating today is to step back and reflect on what, in our perspective, are the major impediments to environmental sustainability. The first of the problems, to my mind, is unsustainable and increasing levels of consumption and profiteering by the financially rich countries. But this is followed next by the rich and powerful people in the poorer countries. So, it's not just the rich countries that do this, but in our own countries people like me are also doing the same thing. This is made possible because of discriminatory political structures and processes, globally and nationally.

Now, I did hear yesterday the Foundation For the Future saying that they don't deal with politics. But I hope they meant that they don't deal with *party* politics, because you cannot deal with the environment if you don't deal with politics. Fundamentally, environmental issues are, like many other human issues, political issues. I feel that it's because of political structures (this is the debate we had on ethics) that allow a group of people in a country, or a group of countries on Earth, to consume a large amount of resources, but not face the consequences, passing the costs on to somebody else, that we face this sort of situation.

The focus of this meeting – and rightly so – is to some extent on science and technology. It's a well-known thesis that science and technology do not grow in a vacuum, but in a specific socioeconomic setting. What has happened in the last few hundred years is that the science and technology that allow us to use or destroy natural resources have grown much faster than the science and technology to help us to conserve or regenerate them. However, there is no inherent reason why one had to grow faster than the other. I'm always reminded of an Asterix comic where the Druid developed an acorn that was such that if you just bumped it onto the ground, a full-grown tree sprang up. Now, why couldn't we have technology like that? But we don't, because that was not the social, political, and economic parameters within which technology developed.

If there isn't a real option to conserve, then the dilemma that the people are faced with is: Do I survive or do I conserve?

One of the major focuses of my presentation is that I think such processes and structures created a situation where people don't have the real option to conserve and survive. One of the points from the discussion this morning was about taking science to the people, getting ideas across. We picked up on one aspect, on how to make it a hobby, but there is another aspect, that you also have to create a world where there is a real option to conserve. If there isn't a real option to conserve, then the dilemma that the people are faced with is: Do I survive or do I conserve? Either way, their survival is doubtful. They are forced to commit "ecological suicide." A good example of this is the trend of what is happening to protected areas (PAs) in many of our countries, certainly in India and in some of the other countries I'm familiar with.

Protected areas in many countries are like bio-

diversity supermarkets, with all sorts of food and goodies visible in the glass windows. However, these supermarkets are surrounded by hungry people and hungry livestock, all eyeing the goodies, so a big padlock is put on the door, and a fence and armed guards are put around to keep the people out. That is our conservation strategy. In actual fact, unsustainable tourism, extractive industry, mining, dams, roads, etc., have access from the backdoor, as do some people. So, you find that there are tourists coming in; there are industries; there are mines; there are all sorts of things, and some people are also coming in and taking resources, while the front is maintained. And the facade sometimes is artificial. The fruits and vegetables that you see in the window might actually have disappeared, but are painted on.

I'm not joking. Some years back I was working in the Andaman and Nicobar islands. We went to look at a lot of the islands, most of which were uninhabited and seemed to have excellent forests. And then one of the local people came to me and said, "You know, this is a myth. The poachers have been logging these islands." I said, "No, I just passed them by yesterday." He said, "Take a helicopter and look." So, I got a helicopter and flew over them, and they were like bald patches on the head – a 20-meters belt of forest had been left around the coast, and the rest had all been cleared out. So, you certainly have this phenomenon operating, certainly in India and I would presume in other countries.

Finally, our "protectionist" strategy results in the padlocks being broken and the fences torn down, and the protected areas are overrun and everyone loses. This is what really happens. Just as we have failed states, we have now failed protected areas, which are only protected areas in name. We did a survey in India that shows that the density of livestock is greater within protected areas than it is outside. I, myself, have been to places and looked for a particular protected area and asked somebody, "Where does the sanctuary start?" And I was told, "Oh, where you see all the cattle grazing, that's the sanctuary." So, this is what is actually happening.

The irony is that the poor need nature and wilderness areas even more desperately than the rich do, because their energy comes from wilderness areas …

The irony is that the poor need nature and wilderness areas even more desperately than the rich do, because their energy comes from wilderness areas and not by turning on a switch or a knob. At least this is true for more than 50 percent of the people in India – I don't mind speaking about India even though some would say that I am talking about just one country. Some time back I was in Beijing, and one politically incorrect speaker kept referring to India and China as "The Third World." When my turn came to speak, I put my arm around my Chinese neighbour and said, "We are not The Third World; we are a third of the world." That's actually correct, if you look at populations. So, what is happening in India is probably having an impact on the globe. In any case, it's not uniquely happening in India; it's happening everywhere. About half the people in India still have to go to nature for their energy needs. Their water comes from rivers, wells, and ponds, and not from the tap. Their building and other raw materials come from the forests, not from shops and yards. They don't build houses from material they buy but from material they collect. But sustainable access to these critical resources is being increasingly denied to them, forcing them to commit ecological suicide. This is the dilemma that we're facing.

The situation is exacerbated by huge and growing populations. When you come from India – I was told that you can't be British and not talk about the weather – you can't be Indian and not talk about populations. Certainly this is one of the big problems.

Scarcity of land, water, fuel, fodder, and other natural resources. Government preoccupation with rapid but essentially inequitable economic growth. Your fourth or fifth *E*, the equity one that was raised, comes in here. I particularly want to stress this, because in India what is happening, and I suspect this is happening in other countries also, is that we have persuaded ourselves and allowed others to persuade us that in the next 15 or 20 years we are going to become a world economic power. Every second issue of *Time*

Magazine or *Newsweek* talks about this. Therefore, our patience with social and environmental issues has become even less, because they're seen as impediments to this great goal that, for some reason or the other, we aspire to. This has become a real problem.

Rampant corruption and ineffective institutions. Inappropriate science and technology – I'll get into that in a little more detail. Ineffective democracy with poor awareness of environmental risks. There are many points, but these last two are the two I would like to focus on in this gathering.

What are the constraints in science and technology? Profound scientific ignorance about how to manage nature and natural resources in a manner that is compatible with human needs and pressures – this is the point that was being discussed this morning – because there is a stress on minimizing human use. Even today in countries like India, for a national park, IUCN classification means no people, hands off, no human interaction. In a country with 300 people per square kilometer and growing every day, if that is our model of conservation, it's going to become less and less feasible.

There is no good evidence on what are the minimum viable populations of species. How many tigers do I need to have?

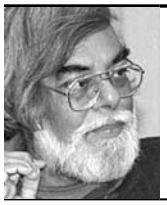
There is no good evidence on what are the minimum viable populations of species. How many tigers do I need to have? Some experts tell me that even the amount we have is nonviable – it's not a large enough population. But I'm talking about hard evidence; I'm not talking about what might convince one particular school of scientists. I'm talking about evidence that I can take to the Planning Commission, to the Prime Minister, to the policy-makers, and say, "Look, here is good evidence why we cannot go beyond those numbers." It doesn't exist.

What is the minimum acceptable numbers of PAs? How many protected areas do we want? No idea. What is the size of a conservation area? If you don't know what is the optimal population, you certainly don't know the size of conservation area. So, when I'm asked, "Why can't we take away half of this protected area to build a dam that people need to irrigate their field?" what answer do I give? Do I have any hard science to say, "No. If you reduce it by more than this amount, then the whole system will collapse"? Is that correct? If not, why am I holding on to these areas? And if it *is* correct, why can't we get proper evidence for it? This causes unnecessary hardship and makes it difficult to argue the case for conservation with policy-makers and bureaucrats.

It's not enough just to be participatory, but to have informed participation.

There is a critical need to make governance participatory. Now, I've said that there is a need for genuine democracy, but I've put in brackets "or a benign and far-sighted autocracy." I don't mind that, as a conservationist, though I don't think you can ever have a benign autocracy because it all gets corrupted after a while. Why do we need to make governance participatory? We need to make sure that people who want to conserve have the real option to conserve. There is a critical need to have informed participation. It's not enough just to be participatory, but to have *informed* participation. I have seen models of democracy where people are given no information but are asked to give their views and opinions. And then it is said, "What's the point of consulting them? They don't have anything to say. They're so ignorant." Well, obviously it must be *informed* participation.

There's a critical need to raise awareness. Even today, by and large, if you go to any of these countries and ask people what is the reason why biodiversity should be conserved, I don't think anybody would be able to tell you. They might say, "Oh, tourism, because people want to come and see elephants and tigers." Or they might say, "Religion, because our religion tells us not to kill." But nobody is aware of any scientific basis. And I'm not speaking about illiterate or "ignorant" people. You could go to a university and ask people. Sometimes even if you ask zoologists and botanists, they're not sure, because ecology is something that people don't necessarily study.



… transparency is fundamental to all governance, but it is particularly critical to the environmental sector …

In short, there is a need to move from representative to participatory democracy. We need to be able to get people to make decisions on their own, and not tell them that once in five years you cast your vote, and in the process of casting your vote you give away your right to have any say in governance until five years later, which is the system we have at the moment. Therefore, there is a critical need for universal transparency. And this is the second point. Transparency is especially critical to environmental conservation. Personally I believe that transparency is fundamental to all governance, but it is particularly critical to the environmental sector and links up with a lot of points that have been made this morning of why we have to go out and share knowledge and information.

The scale of environmental degradation is impossible to comprehend without aggregated information, usually available only with governments and scientific institutions. This morning we saw wonderful slides of remote sensing imagery. Well, what happens? In many of our countries slides like that are banned. They are illegal. You cannot use, for example, maps of a certain scale because they're supposed to be "security classified." You don't have access to aggregated data because, God forbid, somebody might use it to drop a bomb on you. So, there are all sorts of constraints to looking at aggregated data.

Many pollutants cannot be identified without scientific instrumentation usually not available to common citizens. I'm sure you are all aware of this, and this is true not only in countries like India but the world over, that the number of pollutants, especially air pollutants, that are regularly monitored is a very small fraction of what is actually in the atmosphere. Some of the pollutants that are not monitored are far more harmful to your health than those that *are* monitored, and yet they are not being monitored. And even if they were, if this information is not available to the citizens, how are they going to act on this?

Adverse environmental impacts are often a result of activities that are geographically and sometimes temporally far removed from the impact. This information about source and nature is not easily discernible by the public.

Adverse environmental impacts are often a result of activities that are geographically and sometimes temporally far removed from the impact. This information about source and nature is not easily discernible by the public. So, you need institutional understanding and support and transparency to know why something is happening here because of something that happened a thousand kilometers away or something that happened ten years back. Ironically, people often do not realize that they are being poisoned or that their biodiversity is being destroyed, and therefore do not feel the need to seek information until it is too late. Therefore, the government has a responsibility for *suo moto* disclosure. It is not enough to say, "Well, if people ask us, we'll tell them." For example, we are sitting in this room; we don't ask Ish, "Are you sure there are no hazardous pollutants in this room?" because we don't know. But if somebody told us that there might be hazardous pollutants in this room, then we would start asking him. This information has to be given.

What are the future directions? Reorient the research agenda to make it more relevant to the socioeconomic reality. This can be done only if democracy is strengthened. Again, I am making a political point. I do not think that research directions can be determined in a vacuum. Unless there is a demand from the people on their governments that this is what we want to know – "We want to know what is poisoning us; who is poisoning us; why?" – you're never going to get funding or support or even space for the sort of research we need to do, so you cannot divorce these two. Last, to strengthen democracy, the right to information is an essential tool.

Thank you very much.

FACILITATOR: We follow up now with comments first from June Marie Mow, then from Malcolm Hadley. June?

Commentary from June Marie Mow

… we see it happen very often that these ethnic groups are living in areas with very high biodiversity, but still they're the most excluded.

MOW: First of all, I think that many times the laws are there. In some countries you have the appearance of a move from a representative democracy to participatory democracy, but this is also just a facade, because these laws are not put into place. People are not informed because many of these processes are not put into place; they are not practiced. We really need to be aware that it's not only the scientific level or scientific knowledge, but also people do not know about their rights, including their rights to take part in a democracy. This is many times intentionally taken away from people.

In countries where you have an indigenous group, where you have ethnic groups, we see it happen very often that these ethnic groups are living in areas with very high biodiversity, but still they're the most excluded. They suffer from social exclusion, from economic exclusion. We see that although they are living in areas that are very rich, they are very poor people. I think it's because some of the national policies, some of these sectoral decisions, go against the environmental policies and the environmental decisions.

Environmental ministries are not on the same level as, for example, mining ministries or other sectors like transport ministries. So, the money or the financing that is allocated to these other sectors is much higher. As you said, Dr. Singh, the pace at which these activities are done is much quicker than what we see with environmental activities or actions to restore the environment. Really, there is not any equity between what is done to destroy the environment, the biosphere, and what is done to restore the environment, so we are always on unequal ground.

At the same time, the multinationals or the large national companies that have the production means go to these high-diversity areas. Dr. Singh was saying that the biodiversity was more needed by poorer people. I'm not sure I agree. Much of the richness is caused because the extraction of the "goods" of nature or national parks is really very high by these companies. I think it's a matter of how low or high the consumption is, and at what rate you can extract these goods from nature. What is shown in many places is that normally communities have to migrate, because their nature and their survival are very much related. But if somebody else comes in and takes out everything they need to survive, then normally they have to migrate, because they cannot compete with these large companies that are extracting on a larger level.

… there is no relationship between the targets that are set for economic growth and economic development and the targets that are set for the conservation of nature or of biodiversity.

This is where we have conflicts. In Colombia, where I come from, one of the main reasons for people leaving the rural areas and migrating to the cities is because the larger companies are taking over these rural areas because of the high biodiversity and because they need these sites for the economic growth of the company and of the country. I think that there is no relationship between the targets that are set for economic growth and economic development and the targets that are set for the conservation of nature or of biodiversity.

So, I do agree that we need a more participatory government, and this includes the fact that the people need to be informed so that they can participate. I think that this inequity includes information on how to participate. Normally poor people are not part of governments because in many countries the people who work at the government level are not actually poor people; they are people who have the opportunity to go to a university and have the opportunity to take part in this scenario. In our country, poor people don't have the opportunity to go to the university and so they are excluded also from the decision-making process.

I might conclude by saying that I think to have a genuine democracy, we are far away from this in many countries. And in other countries, like the European countries and in North America, I'm not sure how much people really want to be a part of participatory governance.

Thank you very much.

Commentary from Malcolm Hadley

… those areas where one hopes and tries to conserve as much biodiversity as possible must be looked at as open systems, with local people being the driving forces of conservation.

HADLEY: Shekhar Singh gave us a graphic example of a model for conservation, the biodiversity supermarket being padlocked with a metaphoric wall around it. Is that really, though, what conservation of biodiversity is about these days? Perhaps in some countries it remains that metaphoric wall around a conservation area. But perhaps when one looks over the last 20, 30, 40 years, there have been changes in the perception of people – people generally, not just the conservationists – of what really needs to be done if one is to arrive at conservation, a wise use of biodiversity at the same time as using that biodiversity for the needs of local populations and for the socioeconomic development of the country.

As many of you know, UNESCO has been concerned for the last three and a half decades with trying to address that issue of how to reconcile conservation with development through its Man and the Biosphere Programme and through the concept of biosphere reserves, which, as Ish mentioned, now [in September 2006] number 482 biosphere reserves in 102 countries. The basis of that concept is the idea that one cannot put a metaphoric wall around particular parts of our biophere, that those areas where one hopes and tries to conserve as much biodiversity as possible must be looked at as open systems, with local people being the driving forces of conservation. And if one doesn't have the local people as driving forces for conservation, then it will fail sooner rather than later.

If, indeed, one tries to reconcile conservation with the use of biodiversity, then this implies that we set aside different parts of our biosphere for different functions …

If, indeed, one tries to reconcile conservation with the use of biodiversity, then this implies that we set aside different parts of our biosphere for different functions – that at the same time that one has particular areas where there is a protected area, at the same time that is not in a metaphoric enclosure, but it is an open system. It links up, then, with what within the biosphere reserve concept is called the "buffer zone," and in due course merging into a transition area with different parts of the overall biosphere reserve being zoned for different purposes.

Within the 482 biosphere reserves, I don't think there are examples quite as blatant as the one described by Shekhar Singh for the Andaman and Nicobar islands, but there are certainly many biosphere reserves that, shall we say, do not meet the objectives that were placed in them. There are some that exist just on paper. There are others where some of the functions might be more or less successfully attained, but where others are really lacking.

Over the last 10 or 15 years an attempt has been made within this particular initiative to bring more credibility to the biosphere reserve concept and the World Network of Biosphere Reserves, including the setting up of what's called a strategy named after the city where it was developed, the "Seville Strategy," and also a sort of rules of the game, a Statutory Framework whereby biosphere reserves can be conceived, planned, and managed.

We've also tried over the last 10 years or so to put substance to the idea of participatory stakeholder involvement. A lot of attention is being given to the whole question of conflict recognition and conflict solution. One of the most recent activities is the publication of a technical note that was first published in French, which contains four substantive words that anyone who knows English but doesn't know French would understand. The title in French was "Biodiversité et acteurs: des itinéraires de concertation." The translator of this technical note translated it word for word: "Biodiversity and Actors: Itineraries for Concertation." This English translation has been going around for quite a while for revision. When it landed on Ish's desk, he said, "What's this word, *concertation*?" The person who was responsible for the note said, "Well, it's people working in concert with each other towards a shared goal." She was thinking of the term as it's used in French, but Ish said, "Well, it doesn't exist in the English dictionary." So, I started looking in dictionaries, and *concertation* doesn't exist in any English dictionary, but I put it into Google, and

8.21 million entries came up. Now, a fair number of those refer to *concertation* in French, but there is an incredible number in English, many of them from the European Union and the European Commission.

Among the conclusions that might be drawn from this little tale is that there are languages other than English in which scientific advance is being explored and debated. And that non-English mother-tongue specialists as well as regional institutions may take the lead in incorporating ideas and terms from diverse cultural contexts into the English lexicon.

Anyway, let me go on to a couple of other points, Dr. Earle mentioned the value of photographs in respect to words. I wonder whether the photographs of *National Geographic*, or of similar magazines, still have an impact, since we see so many interesting photographs, time after time, to express an idea. On the other hand, if one can come up with graphics that illustrate a particular concept, the graphics can have an incredible effect. Shekhar Singh gave us the example of the padlocked ecosystem. Twenty-five years ago UNESCO produced an exhibit called Ecology in Action. Jane Robertson, who is sitting at the back here, was responsible for one of the sections having to do with conservation. She came out with the idea of having a glass jar with – was it an elephant?

ROBERTSON: Yes, an elephant inside.

HADLEY: Contrasting that was the glass jar being broken and rent asunder. That graphic is now 25 years old, and it's still widely used as encapsulating a particular approach to conservation. So, by all means, use images. But I wonder whether it's not innovative graphics that we should be seeking and not so much the nice photograph.

FACILITATOR: Thank you.

Panel 1 – Information, Expert Knowledge, and Decision-making: Ecological Sciences and Biosphere Futures

Commentary by Dr. Magnus Ngoile

FACILITATOR: Magnus, if you would, please introduce yourself because you arrived late and were not part of the introductory session. I don't think everybody here knows who you are.

We are moving further and further away from nature than ever before. And this is being facilitated by what we call "technology."

NGOILE: Yes. I'm Magnus Ngoile from Tanzania. Currently I'm coordinating the Marine and Coastal Environment Management Project, and my comments will be a bit about that project as well, just to be able to link it to the subject matter under discussion.

I have four points that I would like to highlight. I'll start with myself. If you talked about Africa, you must have come across statements like "a child of two cities," "don't uproot the pumpkin," and the like. In fact, myself as a living example, I've gone from a child of two cities, now I'm just a child of the city with my children. In the old days, I used to go back from school into the village, and I never thought about boiling water. It was quite okay for me to just take water from the stream and drink it; it was fine. When I go back now, I go with bottled water, and everybody in the village wonders, "What has happened to this child?"

It is not impossible that at the end of the day, we may not want the nature we are preserving anyhow … if we end up like dinosaurs, I think that will be best, because we are completely irresponsible.

What does that mean? That presents exactly how we, as human beings, have changed. We are moving further and further away from nature than ever before. And this is being facilitated by what we call "technology." What is happening is that, as human beings, we are creating our own environment, which is ours. And then we see nature as *there*. It's like a football game. Why do you have squabbles in football games? The ones that are bringing in the squabbles are not the footballers. The ones who are bringing in the squabbles are the spectators. We, as human beings, have gone so far to being spectators of nature and of wantonly destroying it. Had we been part and parcel of nature, we would be very careful about what we do. It is not impossible that at the end of the day, we may not want the nature we are preserving anyhow. We will have created our own monster, and if we end up like dinosaurs, I think that will be best, because we are completely irresponsible. That is Point Number 1.

Now I come to Point Number 2. If you look into Tanzania, if you look into the GDP index, Tanzania is at the bottom line. We are a very poor country, whatever the scale may be. But even with that poverty – now tell me about driving forces – we still have more than 30 percent of our country conserved. If you take all the national parks and game reserves, that's more than 30 percent.

There was a very heated debate in Parliament asking: Why should the Masai be denied of a huge chunk of land, the Serengeti? Why should they? They are just wandering around in Tanzania, and their homestead has been converted into Serengeti. You wonder: Who is the beneficiary of Serengeti, if it is not the same historical, colonial whatever? And that's being enhanced. Because if you look into why we are managing the protected areas in Tanzania, of course I would say, "Yes, it is because of the economy" – and it's tourism. So, the people who are living very close to these conservation areas, they are a time bomb because the conservation is not theirs; the conservation is there for somebody else. They can see that others are coming.

We have to think very carefully when we talk about conservation. Conservation for whom? Who is driving the force for conservation?

I think we need to think very carefully and answer the question, especially when it comes to developing countries, because at the end I will say: What's the vision? We have to think very carefully when we talk about conservation. Conservation for whom? Who is driving the force for conservation? In fact, we have a similar case, Mafia Island Marina Park, which was started with the communities around for conservation. But then sometimes you just make a slight mistake and the whole thing turns around.

There's a small village in the Mafia Island that is constructing houses out of coral stone. Then suddenly, because you have a marine park, then you say: "No more extraction of coral stone." And then these poor communities ask, "How are we going to build our houses? We don't have trees in this island. Where are we going to get the building material?" This brings the whole question of balance.

Sylvia talks about the coelacanth. My country is one of those areas where the coelacanth was actually found in large numbers. In fact, we are all very scared. We never thought that the coelacanth would be found in Tanzania. But lo and behold, we started with the first one, and then it went into the third, fourth, and fifth, and then the tenth, and then suddenly it was almost like now the coelacanth is being fished. We had to think very carefully upon how we could actually act and make sure that the coelacanths were not being caught anymore. We had to find the reasons why the coelacanth suddenly was being caught. I think we must also monitor the patterns of fishing. In fact, the coelacanth that were being caught in Tonga were being caught simply because there were prawn trawlers that were licensed to fish in the area. So, they were disturbing the habitats, and the coelacanth had to move away from their deeper caves into shallower caves, where the fishermen then could get them very easily. Whatever management actions are being made, we must also think that there are some valuable animals that need preservation.

All of you know about Mt. Kilimanjaro. On Mt. Kilimanjaro, in fact, the ice cap is moving away very fast. We are not quite sure whether in the next ten years we will actually have ice on Mt. Kilimanjaro if the rate as it is happening now continues. Of course, we can blame that on climate change, and then we can ask: What's bringing climate change? There are lots and lots of things.

… a large part of the developing countries, even if they have declared their EEZs, they are unable to manage them effectively.

Specifically I would like to talk about the EEZs. I would like to point out something that probably if we did an analysis might be able to help. These EEZs have been set up – and I think some countries have declared them and some countries haven't. But I would say that a large part of the developing countries, even if they have declared their EEZs, they are unable to manage them effectively. I think it's important that if we look into the EEZs, I would encourage developing countries to negotiate like what Tanzania did. And here I want to mention specifically the project that I'm coordinating, which is the Marine and Coastal Environment. We call it the Marine and Coastal Environment Management Project simply because the primary objective of the project is to be able to manage well our EEZ. We have taken an IDA credit of 51 million US dollars and a GF grant of $10 million, so it's a total portfolio of 61 million US dollars.

What Tanzania is trying to do is to demonstrate the need of integrating the management of the EEZ, as well as our territorial and internal waters. Most countries for now, when we talk about managing coastal resources, in fact, it's not even territorial waters; it's probably just internal waters. We don't have the capabilities to be able to manage our EEZs. The sums of money that are required are like what Tanzania has been able to receive. Anyway, time will tell. If we are successful, we might be a model for most developing countries.

But what humanity has done is also to divide the ocean. Why would you want to divide the ocean into coastal waters, territorial waters, and EEZs? What's the rationale for that? It means you are giving us an opportunity, as developing countries, to be able

to deal with what we can, and actually just let go of what we can't. If it was one package, then you would aid at just managing your waters. I think that will be something that is absolutely wonderful if you could manage it.

Now, let me conclude with a saying that really has no connotation on religion. Being a Christian, I read the Bible. If you read *Genesis*, especially when the human being was being created by God, before falling, the instruction was so clear and so good. *Extremely* excellent. I don't know where we faulted. If we could go back to those basic principles, I think it will work.

There was a ship that was sailing around with some ecologists and a multiplicity of disciplines. I have been told that, in fact, there exists a document that was signed between the Pope and the other Christian part on that ship. And that document – if it were to be preached in churches as an authoritative document – would make a huge, huge change. Unfortunately, it never went beyond the ship. But the signatures are there; the document can be displayed; it could be distributed to many, many of the churches; and it would probably light some form of a fire. I asked if I could get access to that document so that I could also try it in Tanzania, just to see if the bishops wouldn't listen to that message. I think even the Muslims have environmentally oriented, authoritative documents as well. It's time we start thinking about quoting those documents, and not only our own intellectual documents. I think the means to reach there are available. So, let us go back to the origins of integration of human beings and Mother Nature. Let us see the ideals that were used in those times. It's time we went back. Creating our own cocoon will only lead us into the dinosaurs' story.

Thank you.

FACILITATOR: Are there any questions for Magnus?

We have, at this very moment, in total $6.4 billion available for CDM projects, and there are over $1.5 billion value of projects approved by the CDM Executive Board.

DE HAAN: May I answer the question concerning the CDM [clean development mechanism]? I must say that two or three years ago it was kindergarten-like behavior, mainly because there were no proper rules for CDM. The Executive Board was very inactive or had a lack of manpower to generate it. I think that figures might be the best proof of what is happening. We have, at this very moment, in total $6.4 billion available for CDM projects, and there are over $1.5 billion value of projects approved by the CDM Executive Board. So, I must say that this is a very, very fast-growing market, and in private funds, Climate Change Capital just raised $1 billion just to invest in CDM project. So, it's growing very fast.

NGOILE: Thank you.

… the great bulk of the hydrocarbons on the planet are the methane deposits in the deep sea … The ocean is the great reservoir and the great stabilizer …

EARLE: I believe you may be referring to the event that took place in the Black Sea, where on a big Greek cruise ship there were about a thousand people – I was there as well. It was the Patriarch of the Greek Orthodox Church who really was behind some of this. It was quite amazing to see the proclamation that ultimately emerged that acknowledged the ethic, the responsibility, basically, of people to take care of nature. It was quite remarkable. And I agree with you that it's sad that it hasn't become headline news everywhere and become a more widely accepted and embraced proclamation. That speaks back to the point of the importance of the religious move, the ethic, of appreciation for taking care of nature.

On this matter of the carbon and carbon trading, and so on, I hope that somehow we'll get the ocean more on the balance sheet because of the importance of the impact of excess carbon that relates to a number of things. We were discussing some of those during the break: the consequences of the carbon dioxide that is in excess of what the natural systems in the ocean can absorb, and the formation of carbonic acid that is leading to a trend toward acidification that *is* a worry for the fate and the future, not just of coral reefs. Anything with calcium carbonate is basically at risk and most particularly the small planktonic photosynthesizers – for example, the foraminifera – that do

the heavy-lifting in terms of oxygen production and carbon grabbing and ultimately carbon sequestration. But also at risk are the existing mighty deposits of carbon throughout the oceans of the world. Look at the Bahamas, where we have great subsea deposits, and the White Cliffs of Dover are largely made up of the calcium carbonate shells of ancient sea creatures. But there are still sea creatures of those ancient deposits in the deep sea. Releases because of the actions of an acidification could create a feedback mechanism: more carbon dioxide released, a greater greenhouse effect, but even more worrisome with a warming trend is the release of the methane in the deep sea, the gas hydrates.

I'm very curious to talk about the fact that the great bulk of the hydrocarbons on the planet are the methane deposits in the deep sea. They *far* exceed anything that we've so far measured on the land in terms of oil and gas. The ocean is the great reservoir and the great stabilizer and the great anchor against radical change, whether it's temperature or chemistry, but very particularly against what's happening to the carbon cycle. And just a slight increase in temperature of the ocean could release a significantly greater amount of methane than is now being released. I've seen at nearly 2,000 feet, looking out from a little submarine in the Gulf of Mexico, where methane is bubbling up out of the bottom, and right around there are these beautiful formations of the tube worms that really thrive in that atmosphere. They require a certain amount of this raw methane in order to drive their particular food chains. But that is nothing compared to what *will* happen if the temperature of the ocean increases. The methane that is currently held as this ice, this gas hydrate, because of pressure and temperature in the deep sea, if caused to be released because of a slight increase in temperature … methane is, like, 14 times as powerful or potent a greenhouse gas as carbon dioxide. It's already a factor. Some people are trying to measure the effect of cows and sheep contributing methane to the atmosphere. But compared to what's out there in the ocean that could be released with a modest increase in temperature – talk about a dramatic triggering effect – we sit on the edge of something that means potentially *total* change in the whole way the planet works, if you get to the point of triggering massive releases of methane into the atmosphere.

But what we want for our survival, the things that we cherish, is some kind of stability built around what makes life possible for us.

Apparently (who knows for sure?) there's evidence that maybe 55 million years ago there was an event where there was a massive release of methane, and massive extinction as a consequence, and a long time before things stabilized again. Change is a matter of history, a matter of the future. But what *we* want for our survival, the things that we cherish, is some kind of stability built around what makes life possible for us. And we have the power right now, it appears, to dramatically alter the way the world works through modifying these triggering events, whether it's warming that affects sea level or, more importantly I think, ocean chemistry that has a much more profound shocker in the wings if we don't change our ways.

I'm sorry to keep going on about this, but we don't look at fish as anything more than something to eat, basically. But think of them as carbon-based units, for heaven's sake. Think of what we're doing in a destructive sense to the natural systems that sequester carbon. The destruction of the coral reefs, the destruction of the deep sea reefs, the destruction of that crust on the deep-sea floor even in the Gulf of Mexico where trawling is a way of life and has been for the last 50 or 60 years. As our appetite for shrimp has gone up, the level of trawling has gone up, and the consequences are that the clarity of the water in the Gulf of Mexico has gone down because of the suspension of sediments caused by the trawling, maybe the release of materials that have helped to drive the increase of dead zones.

But more importantly, what about these other cycles? Carbon, carbon, carbon. Look at the ocean as the principal sink for carbon, the principal stabilizer of the planet. We are so focused on trees, and we should be, but we shouldn't be ignoring what's going on in the ocean. For every bit that we can hold in place and stabilize it and protect it, we are avoiding having to go back and fix things once they've gone crazy. If you can keep it in a good state to begin with, you won't have to patch it up after the fact. But we're right now looking at a lot of patching that has to be

done, but also there is a lot of the ocean that's still in pretty good shape, and if we do the right thing *now* we have a chance of achieving that stability.

You have to match carbon trading-related land use change opportunities that are in the preferred direction as far as environment conservation … to investor interests …

ISHWARAN: Carbon actually is part of biochemical evolution; it's a basic element of life. Now carbon-denominated paper is being traded. One of the reasons, from what I understand, why Kyoto started allowing trading only within the industrial realm, and kept even what they call LULUCF (which is land use, land use change, and forestry) outside of the trading regime, is because the data and the precision limits of data in terms of emissions and sinks, and so on, was only good in the industrial part of the equation. So, that is where the trading happens largely now.

For land use, land use change, and forestry, there is some element of possibility for pilot projects and special arrangement under the World Bank BioCarbon Fund and also interested private traders, like some people Albert knows and others who are interested to go into land use-related things, but – correct me if I am wrong, Albert – it's still not sanctioned by Kyoto. It's not allowed under the Kyoto model. What is interesting about this is it *is* possible that this could become a pilot experience for an environmental community to see how to use an emerging trading mechanism to link to beneficial changes with regard to environment, conservation, and other benefits they want to strive for. I think that is where the carbon trading mechanisms give some interesting opportunities. We are trying, from within the Division of Ecological and Earth Sciences, to connect some carbon trading-related investment interests to some of the areas of the world where we have projects or we have biosphere reserves so that the two can come together. You have to match carbon trading-related land use change opportunities that are in the preferred direction as far as environment conservation is concerned, to investor interests in putting money into those kinds of places. So, we are looking for those kinds of matches. They are there. It is not always easy, but they are there.

Though it is not something that happened through our interests, there was an example in Costa Rica where a group called Precious Woods linked to the Chicago Climate Exchange and agreed to pay, I think, about $4 a metric ton. It's much lower than the market price in the Kyoto-approved market. In the Kyoto-approved market at that time you could get $10 a metric ton, but then that was not possible for land use, land use change-related projects because it's still outside of the Kyoto regime. So, this $4/metric ton rate was made available for this part of Costa Rica. The interesting thing is that the investor not only gave $4 for each metric ton sequestered by planted effort (forests being brought back), but for every ton of carbon sequestered he also paid the same amount of dollar value for standing forests. They also agreed to pay for what they call "avoided deforestation." That became an interesting mechanism in Costa Rica.

Numerous possibilities exist … playing around with land use parcels and driving them in preferred directions of biodiversity and rural development changes.

Numerous possibilities exist with regard to combining, particularly in rural areas, energy efficiency measures, rural development related measures, biodiversity conservation measures – basically related to playing around with land use parcels and driving them in preferred directions of biodiversity and rural development changes. I think there is a lot of possibility there, but it's a risky area; it's an experimental area, but I think it's an area where environmentalists and conservationists should make an attempt. You learn by doing, as we said.

Panel 1 – Information, Expert Knowledge, and Decision-making: Ecological Sciences and Biosphere Futures

Plenary Discussion

SESH VELAMOOR (FACILITATOR): What I would like to do at this point is to integrate the next two discussion sessions into a single one. So, the floor is open for questions or conversation based on the presentation and the comments made – including the MAB staff and observers who are sitting on the periphery. Who would like to go first?

What is your approach to the fact that the research agendas are set by the transnational companies – exactly who's taking the lands away from the island people…?

MARGULIS: This is a question to Shekhar Singh. What is your approach to the fact that the research agendas are set by the transnational companies – exactly who's taking the lands away from the island people and everyone else, the land that's so rich? What do you do about the fact that those are the people who actually set the research agendas? The scientists say, "I am interested in something only when there's money to work on it." They have to live, too.

… scientists will have to develop innovative ways to do their research with much less funding than usual, and I am happy to say that this is happening.

SINGH: Well, you're quite right. This is one of the problems, and it's not just multinationals and corporations. The agenda is set by governments, also, who have the interests of multinational corporations at heart. That is why there are two things that I hope are going to emerge out of our discussions: First, scientists must also give up a purist approach of saying, "I'm only going to look at something if I have all the funding required and all the research associates and all the equipment," because if you go for that, very little science will be done by people of science. So, scientists will have to develop innovative ways to do their research with much less funding than usual, and I am happy to say that this is happening.

Secondly, what about the amount of information we already have? I used to be in the Planning Commission and one of the sad jobs of being in the Planning Commission is that you give money to people. They come and ask you for money. Some institute like the Wildlife Institute would come to me and say that so much money was needed. My first question would always be: First tell me what you have done with the research that you already conducted. Once I am satisfied that you used that fully, then I'll be quite happy to support further research.

… there's already enough knowledge floating around. Let's get that packaged in a way in which people can start understanding it, assimilating it, and actually owning it.

My point is that there's already enough knowledge floating around. Let's get that packaged in a way in which people can start understanding it, assimilating it, and actually owning it. Then a public demand will develop for the right sorts of research, which even multinational corporations – at least in those countries that have that sort of space – even they will not be able to block because people will demand as we've seen happening in issues across the world. And that's what we want.

BOTKIN: I agree, essentially, with everything Dr. Singh said. I'm not an anthropologist but my anthropologist colleagues tell me that whenever people have had the

technologies to exploit and overuse their resources, they have, and that the idea of the noble savage living in harmony with nature is only a myth. So, we have to do something that's never been done before by people.

The kinds of places that people have protected have been sacred groves. When Caesar had trouble conquering the southern Gauls, he went in and destroyed their sacred forest and that defeated them. He understood the importance of sacred land. To me, this brings up the necessity to have a new ethical point approach that integrates our scientific understanding, and doesn't exclude it. It also brings up what I keep running across: this hostility towards people among those who want to preserve nature; therefore, the local people are dismissed and not assisted. This leads to the point, as well, about the need to integrate traditional knowledge and beliefs with our modern scientific understanding.

During the work I did with the Tlingit Indians of Canada, the chief said, "You know, we have very specific traditional knowledge. I had to repeat 13 times when I was a child exactly the history of our people. It's very good knowledge but it never will hold up in a court of law. We had to bring you scientists in to tell us what we already knew." So, there has to be a fundamental change in the way we view nature and in our development of a new ethics.

It's different if you use nature to survive or if you use nature for economic growth.

MOW: I think that what you are saying, Dr. Botkin, is right in a sense, but I think that local people use nature to survive. It's different if you use nature to survive or if you use nature for economic growth. The use you make is different, and the tools that are used are also different. Once local people get to know about a new technology, as long as they are still using nature for survival, it will always be on a lower consumption rate than if you use it for economic growth. I think it's about what type of economics: if it's growth economics or if it's survival economics. I think that's the difference.

MACDONALD: Shekhar asked some very interesting quantitative questions in his presentation. He asked us things like: How big does a population have to be, to be viable? How large do parks have to be? There were questions about how much, how big, how many. How much wildlife, how much nature do we want? These were among his questions.

I thought that they were terribly important questions, but I think it's important that we are clear that they can be answered in two very different ways. Part of those questions have technical answers, and although you said correctly that often we don't know the technical answer yet, equally often we do or we have the means of providing those answers.

For example, for those of you who are less day-to-day involved in ecological science, there are techniques and approaches that will give us sensible answers to questions about how big a particular population or a particular species has to be in order to be viable or how large an area you might want in order to give you a certain probability of conserving it for a certain distance into the future. So, while Shekhar is absolutely right that often we don't know the technical answers, I want you to be somewhat optimistic about our capacity to provide those technical answers.

But the much more interesting part of the question that you posed for us is when we get around to the political or judgmental answers to the same questions of how many do we want? And the point that I'm very keen to draw attention to is that this is not a technicality matter. It's a technical matter up to a certain point but it becomes societal or – as you rightly used the word – political question. When we think about Walter Kistler's question to us about what sort of world do we want or at least envisage a thousand years from now, there's a huge political part to that answer. How many of these particular creatures, how much wildlife, how much wilderness do we actually want? That's beyond technology and, I think, very important.

If we want to evolve ethically … out of a fear-based system to some other, then conservationists have to get together and ask: What is that motivation that can replace fear?

SINGH: I'm not sure I agree with your anthropologist colleagues that have said to you that there is

no historical evidence of people not overusing the resources. But I wouldn't get into the very intricate debate on whether it was only because of sacredness or not. I think, as a general thesis, one can say for India certainly and I've also looked at it – in fact, in a MAB study – in other parts of the world that fear-based conservation was a very important part of our tradition. When I say "fear-based," most sacred groves were fear-based: You were scared that the pox would strike you if you went and did something. And there were so many poxes in those days striking so many people, it was a fear that was easy to maintain. And even if you didn't do some sacrilege and the pox struck you, people would say, "He must have gone and done something in the sacred grove."

So, you're quite right that fear-based conservation was the principle then. And don't forget that even today our jurisprudence recognizes that fear is an important motivation. Most of our criminal systems are fear based: fear that we will put you behind bars or hang you, and so on. If we want to evolve ethically – and I think we should – out of a fear-based system to some other, then conservationists have to get together and ask: What is that motivation that can replace fear? Otherwise you have to go back to a fear-based conservation. But I can give you any number of examples from India and elsewhere where traditional communities have, over centuries, conserved their ecosystems in all sorts of ingenious ways because they were scared. And maybe some wise people at that time figured *the only way these people are going to follow scientific norms is if I also bring a bit of God and spirits and ancestors into it*, but it worked. Otherwise it wouldn't have worked.

The other point you made that was very interesting was about traditional knowledge. Whereas I take your point that traditional knowledge is not necessarily subjected to the same sorts of rigors of science or law that modern knowledge is, yet the way we try to distinguish is the distinction between wisdom and knowledge. Just as you cannot subject wisdom to the same rigors of science, you cannot subject traditionality. That doesn't mean that all traditionality is good, and this is a big problem because you can't say that anything that survived a thousand years must be correct. All sorts of absurd things seem to have survived – or at least we think they are absurd at the moment.

Scientists need to build up an interface between wisdom and knowledge, and I'm not sure if we are working on that interface. That's an important thing.

… when you're dealing with policy issues, it's not enough just to have a technical answer. It must be the sort of technical answer that you can convey to intelligent nontechnical people …

The last point that I want to respond to is your point about technical answers. See, when you're dealing with policy issues, it's not enough just to have a technical answer. It must be the sort of technical answer that you can convey to intelligent nontechnical people, and be able to argue with them. I have people who provide me with a framework of what range each tiger needs, but then I have four different papers that dispute that. And I have a cacophony of scientific ideas that say all sorts of things. I have to go to a well-educated policy-maker who's aware of all these things and I have to be able to argue with that person why my people are correct and other people are not, and I don't have that sort of technical basis.

How do you generate evidence-based knowledge that is communicable across disciplinary boundaries? If you could do that, then economists and ecologists could talk.

ISHWARAN: This has been a very rich discussion. One could have a lot of questions and comments, but I would like to come back to Shekhar's emphasis on the information side. There was a recent Noble Prize winner, who was an Indian living in England, Amartya Sen, who related poverty and poverty-alleviation issues to the level of information a person has. I think it's good for UNESCO to think about it because UNESCO is wondering how a UN educational, scientific, cultural organization can relate to improving poverty-related issues. Sometimes there is a tendency to think improving poverty-related situations can be done only if you have money, but there might be other ways of doing it.

As Shekhar knows, there is a World Commission on Protected Areas under IUCN, which had an Information Management Task Force that defined what they meant by four different things: information,

data, experience, and knowledge. They made distinctions between these four categories. These are words! Malcolm talked about the fact that there are cosmic and other evolutions, including semantic evolution. Words evolve, too. So, what is the relationship? Scientists collect data; that's your basic commodity. Then you package that data into information. Then you mix it up with your experience, and then come out with some knowledge that you convey to people.

I personally do think that knowledge, even in the scientific community, is not totally objective in the sense of rigor and other elements we sometimes assume. For example, in Sri Lanka we still don't know actually how many elephants exist in Sri Lanka. The number is still a guesstimate; it's not an estimate. If you really do the estimation using sampling techniques, the standard deviation is about one third of the mean. So, the error is too big. That's the kind of situation with which we live, so there is a range of certainty associated with our knowledge and associated decision-making going from data, information, right up to knowledge. That is where what Shekhar said at the end is very important, because what we need is knowledge – and evidence justifying or supporting the knowledge that is communicable – not to those others who are within our own community, but across communities.

So, how do you do that? How do you generate evidence-based knowledge that is communicable across disciplinary boundaries? If you could do that, then economists and ecologists could talk. Albert [de Haan] and I talk; I'm an ecologist by training; he's a financial person. But I think the necessary condition for that kind of communication across boundaries is evidence-based knowledge. Even in UNESCO – for example, the biosphere reserves – one of the things we are now saying is that we need more evidence to show that the biosphere reserve idea is working. It's not good enough to go on talking about it as a good idea, when it's only an idea.

… in part, the wider public is mistakenly asking for something from science that it can never deliver: certainty and precise answers to what are ultimately political questions.

MACDONALD: Maybe something of what Shekhar said a moment ago and also some of Ish's points track back rather unexpectedly to our conversation this morning about the relationship between science and society and education. Both their remarks may shed some light on why science is not always popular with the wider public. It may be because, in part, the wider public is mistakenly asking for something from science that it can never deliver: certainty and precise answers to what are ultimately political questions.

To very quickly elaborate what I mean, I have enormous sympathy (because I am often part of it myself) with your dilemma of getting what seem to be contradictory, conflicting advice from different people who are nonetheless all authorities on their subject. Of course, there are different reasons why their advice and their opinions may differ. Part of it is that they may have made mistakes; they may be dealing with subjects that are at the border of what science is currently able to pass an opinion about. Different things can be measured with different levels of precision. And everything – I think everything – that science does ultimately must surely be associated with an understanding of probabilities and uncertainties. It's very unlikely that a complicated question is going to have a simple answer that can be delivered precisely and with very high probability.

So, inevitably, science is coming forward with answers that require judgments about probabilities. I still want to make it clear that that is a different sort of uncertainty, different sort of issues of probability and risk, than the more societal and political ones about how many of something or how much of something we want. There are those two categories. One is: What do I do with uncertainty and risk in making my judgments? For example, surveying elephants in Sri Lanka is something that, depending on the techniques used and the money one is prepared to spend and the point in history you choose to do it and thus the technology that is available, can give you variously precise estimates. You would have to decide how precise an

estimate you need, and on what sort of precision you are prepared to take action. Politicians, of course, take action the whole time on imprecise information. That's why they have chosen to be politicians – they are prepared to do that.

So, that's one set of questions. It's importantly different from the question: How many elephants do we want in Sri Lanka? Part of the answer to that is: How many do we need for them to be viable? But over and above that, how many do we *want*?

The point is: We absolutely are dependent on nature for survival beyond day-to-day extraction of goods.

EARLE: I'm a little troubled, not by what I've heard here, but generally speaking about the value that we place on protected areas: thinking of them primarily for the goods that can be extracted with less emphasis on that broad category that some call "services." Increasingly, because of the awareness that our impact on the natural world is causing profound changes of geological magnitude within half a lifetime, decades instead of millennia, perhaps an understanding of the services – production of oxygen, watersheds, just the maintaining of a favorable range of temperature, a whole host of things that we tend to take for granted that are delivered as a consequence of four and a half billion years of fine-tuning. We need perhaps a greater awareness of the value of nature beyond pounds of meat or how much fiber we can extract from a forest. That's not really the point. The point is: We absolutely are dependent on nature for survival beyond day-to-day extraction of goods. So, this is not anything more than a plea to put the balance where it needs to be as we go forward.

FACILITATOR: That goes back to the reference Dr. Singh made about fear. Going along with what Dr. Earle just said, wouldn't it be adequate to emphasize the Precautionary Principle insofar as the fact that subtraction of what exists is, in itself, a great risk, without a whole lot of evidence being necessary to prove it?

… when you mystify something, then the task of taking it to the public becomes even more difficult.

SINGH: I totally agree with you. In fact, I think in many wilderness areas, the ecological services and other services are perhaps far more important, because you could have species that are also found elsewhere, but the services being provided by that area to that particular region cannot be provided by areas in other places.

But in my own experiences, knowledge about services is even less developed than knowledge about species or products. For example, in India we've been trying for a long time to establish that deforestation affects the rainfall pattern. Why are we trying to do that? Because the rainfall pattern is critical in India because India is an agricultural economy. If I could establish tomorrow that deforestation is going to disrupt the monsoons, I've got it made and nobody would cut another tree. But you don't have evidence. That's the sort of evidence we're not able to get. We have looked high and low.

Similarly, if you want to look at specific areas and try to say, "If this area got deforested, what would happen to the streams and the rivers downstream that would finally go into the dam, etc.?" Barring silt flows – and there also we have a problem because if you replace natural forests with grasslands where you can have grazing, it's suggested that they're actually better for silt management than natural forests are. That is the sort of evidence we have today. My point is that it's a very good direction to go in, but we need far more research to be able to use it in policy matters. That's one point.

If I might briefly say something to the point that Ish made, I want to develop that further. It's a very important point but the trouble is that in our present-day context (correct me if I am wrong, but this is what my own experience is), disciplines are becoming more and more mystified rather than less and less mystified. Everybody is developing their own scientific languages, so much so that, though I am a student of philosophy, I find that it's difficult now for me to read papers in philosophy because new technical symbols have been developed that are being used in place of

common language, making such papers understandable to a narrower and narrower segment of people. I won't go into the reasons why. Now, when you mystify something, then the task of taking it to the public becomes even more difficult. That's Number 1.

Number 2, I remember when I started as a young lecturer many years back, one of my wise teachers said to me, "If you want to ever become an expert in a discipline, remember that there is only one characteristic of a true expert." He said that a true expert is somebody who can take as complex an issue as there is in his or her own area of expertise, and be able to explain it cogently to anybody who's reasonably intelligent. This was the definition of an expert. And he used to often say, "Well, that person is good but he's not really an expert because he can't explain his point of view to me." We've lost that.

FACILITATOR: It's gone the other direction.

SINGH: Yes, it's gone the other direction. I think we need to think a lot about that.

Most of the education now – this is widespread in the world – is not educating for values; it's educating for greed, for the benefit …

GUERRERO: As I look at this room, I think that most of the people here are more than 50 years old. (I don't want to offend the people who are younger.) So, we are thinking with the structure of the knowledge, the paradigms, that we used when we were 20. We are using paradigms that are 30 years old, and I think that in the 21st century many things have changed. This is important to consider. I don't say that the changes are good, but things have changed.

I will talk very briefly about three things: democracy, education, and science. Democracy: I have no doubt that the United States is a democracy, but it is the only country in the world where more than half of the schools are teaching or are allowed to teach creationism. This is more important than many situations in other countries that are less democratic, but they have more incorporated modern science.

Second is education. Most of us were educated in a good system; we put in a lot of effort and received a lot of teaching. Most of the education now – this is widespread in the world – is not educating for values; it's educating for greed, for the benefit, and just to pass. This is my impression in Europe. So, education didn't improve in the service of science. When we started in science and we, all of us, we are doing science because we like it. We do it independent of the money. Most of the young scientists here are doing things for power or money. And one thing that is always repeated: In Europe when you name a scientist, you say first the political or academic position that they have. Now it's a merit to be at the same time Vice President in the school and active in Europe as a scientist, but always you are the number of the grants that you have and the many millions of dollars that you've gotten. This is the only way to go up in the academic scale.

So, science is not anymore a thing to do just for humanity, but you're around power and you're around money or the money of your university, so things are not as they were 30 years ago. And we must change. The previous times were better in the case of democracy, education, and science.

ARICO: I have a question for Albert de Haan that relates to what he said this morning about current economic models. My question is whether you think that current economic models act to, if you like, promote social desegregation rather than social aggregation. Let me explain that very briefly.

As much as we know that certain environmental governance arrangements and management regimes have failed in promoting the conservation of biodiversity, and that this is about the metaphor and the example, actually, that our colleague Dr. Singh used this morning about the forest facade that looks intact but inside the biodiversity is gone. You may be able to keep the trees, but if you don't keep the other organisms they are gone and the system gets disaggregated. Similarly, don't you think that current economic models act more in the social disaggregation direction rather than the opposite?

… economists have learned already by experience that models are only there for today, and tomorrow they might change because the circumstances are changing.

DE HAAN: I must say that I think there has been a big change taking place in economic growth, meaning that the big models they knew about for value and risk, and all these kinds of modeling, kept on changing mainly due to the fact that the social circumstances changed a lot as well. I think that most of the economists, although they might be the gatekeepers, as Malcolm said, are there not to design the future but to watch what has happened and figure out how they can extrapolate for tomorrow.

What we see, for instance, in quite a lot of the technical modeling, is that it works until someone fails. For example, last week Amaranth lost $5 billion in a week's time because its model wasn't working. The intriguing thing there is, and I think that's the main issue: Behind every model there is scientific proof or not. If you don't have a constant dialog – for example, Ish and I try to talk very, very regularly about issues. I think that economists have learned already by experience that models are only there for today, and tomorrow they might change because the circumstances are changing. And many of these changes are caused by social events.

FACILITATOR: I have a question for any of the panelists who would like to address it. What about the fact that the time frames for consideration for policy-making or decisions, vis-à-vis time frames that actually are involved in significant changes in the biosphere, are completely out of phase?

… everything that ecologists – and not just ecologists, but also scientists and naturalists – think is important are externalities to economists.

MARGULIS: It seems that everything that ecologists – and not just ecologists, but also scientists and naturalists – think is important are externalities to economists. So, there's a fundamental conflict that's deeper, I think, than anything we've talked about between the standard economic models for immediate profit and for how the biosphere works on its time schedule, which involves developmental timing.

FACILITATOR: Is that gap ever bridgeable?

SINGH: To answer your question, the time frame of policy-makers depends on various factors. For example, in our country, as elections are every five years, they're interested only in what happens in those five years, because their main interest is to get re-elected. But this would have been an important constraint if we were talking about issues that were just beginning to emerge and their impacts were still 50 years away. In such a case, even though there was impending disaster, most policy-makers were not going to be interested. Unfortunately, what we are talking about today are issues whose time has already arrived and the impacts are already upon us. The problems are already visible. So, I'm not sure that in today's world most of the problems that we're talking about are problems that are subject to that sort of a limitation because the impacts are obvious. It is true for some new, emerging issues. For example, even effects of climate change are becoming obvious, but regarding ozone depletions, some countries might still argue, "Well, I don't know when it's going to affect us. We'll see. Something new might come up." But this is certainly not so for the majority of issues.

EARLE: I think the very speed of change is putting a new perspective on these issues. In a single lifetime, half a lifetime, we've seen values for trees, values for ocean systems that we did not perceive, did not regard with a dollar sign before our time. But the cost associated with restoration of places damaged through events such as the tsunami of recent times or Hurricane Katrina – there's a huge cost associated with the neglect of the natural systems. Whether it's coral reefs or mangroves or marshes, there is a value now being placed on the ability of natural systems to gather and sequester carbon associated and traded on markets at this stage. So, new values are upon us just in the last few decades, the last decade in particular, and going forward I think even more – the value of natural systems beyond things that we can weigh or otherwise use in a traditional sense.

FACILITATOR: How much of it has to do with how we locate ourselves? I'm going back to the notion: *Not in*

my backyard. As long as it is not in my backyard, it doesn't matter to me.

BOTKIN: The previous question was about how a society that has short-term planning could deal with long-term dynamics and problems. There are several answers to that. For example, in the United States, museums funded by the United States government are only funded for five years, but the expectation is that they're going to be there forever. The funding period is short, but there is a long-range view. The same with natural parks. There is a park in Maine, Baxter State Park, that was purchased and built by the former Governor Baxter with his own money, and his view was long-term for the people of that state. So, I think it goes back partially to ethical principles.

But also you've raised a question that's not been dealt well with in ecological or environmental theory because we don't have the dynamic models that could look at short-term and long-term dynamics. If you could do that, you could see what the linkages were. It may be that there are linkages in the short run that connect to the long run. We have only informal ideas that they don't connect, so there's a technical necessity there to improve our theoretical models. Then we have to look at the kinds of institutions that have worked for a reasonable length of time in the short run and try to mimic those.

There must be a way to make people think longer and longer term … How do you bring that into current-day decision-making…?

ISHWARAN: This link between decision-making and time, at least in the conservation world, has been always talked about as though the politicians and everybody else is deciding on a very short time frame, except the ecologists, who are always thinking long term. I don't know whether that's true. For every decision-making situation, whoever the decision-maker is, I think that there must be a set of constraints that determine what time frame that person is considering. But the relationship between decision-making thinking and time frames and the long-term frames, like thousand-year frames, is something worth thinking about. I don't think anybody, in terms of actually making a judgment or a decision for acting tomorrow, thinks a thousand years. There must be a way to make people think longer and longer term – the discounting of the future, in economic terms. How do you bring that into current-day decision-making so that your decisions and the resulting impacts on actions have a longer-term horizon? I don't think that's only a problem of the politician; I think that hits all of us: managers, public bureaucrats. A lot of us have to think that way.

MACDONALD: I want to support Lynn's very important remark of a few moments ago about the risks of considering environmental consequences of the human enterprise as externalities in any economic model. We began this morning by some mention of the fact that it might, at least in my view, be appropriate to consider people as part of the biosphere rather than separate to it. Similarly, we should consider the whole human enterprise and its interactions to be part of a closed now-bounded system of using the resources of the world. History is littered with examples of societies that made the judgment that environmental resources were somehow externalities, from Easter Island to Iceland, and more recently the Aral Sea, and look where it got them. We're now living in a bounded, closed system of the whole world because of the global economy. If we persist in considering natural resources and the consequences of our activities as externalities rather than what they really are, which is a prerequisite for sustainability, then we will go the way of Easter Islanders.

Ants handle population in all cases so that the carrying capacity and the population match … in no case is the balance unachievable …

MARGULIS: E.O. Wilson says that if we were to give the atomic bomb to the ants, they would kill themselves in less than a week, in his opinion, because they are very cooperative inside the nation, inside the colony, obligatorily by chemistry, but they are extremely warlike beyond. There are three ways they handle the population explosion that have been studied – and I actually know more about the termites than the ants, but it's the same basic idea. Ants handle population in all cases so that the carrying capacity and the popula-

tion match in all cases. The major way is the eggs are hatched; the children are "born"; and they're not fed. That's the easy way. Just let them die. They're going to die anyway, so you let them die if you're a worker termite. That is by far the most common: just don't feed them; they're going to die.

The second one is even easier. They have a war; they fight; and they kill each other. We have lots of evidence that that happens with chimps, too. The third one, which apparently in termites is the most serious, is that they will banish adult members of the community.

So, those are the three ways: You don't feed them; you kill them; or you banish them. But in no case is the balance unachievable, that is, the balance of the number of individuals to the externalities is always maintained. It's always maintained.

Now, we think we're above that. We have models that we are beyond that. But what do you think this war stuff is about? What do you think the poverty is about? We are failing to feed; we are destroying by direct fighting; or we are banishing. We are using exactly the same techniques, only we think we're not social animals.

FACILITATOR: Right. So, in that sense, maybe in the long term, the solutions are implicit. We are continuing to do what the termites do.

MARGULIS: They're actually inevitable; it's a question of what your timescale is. The details are of importance to us, but very inevitable.

BOTKIN: They're only inevitable if we are ants and termites.

MARGULIS: We are.

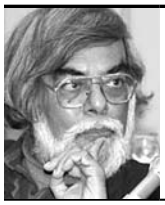
BOTKIN: No.

CLÜSENER-GODT: My name is Miguel Clüsener-Godt. I'm from the MAB Secretariat, working a lot with Latin America. I would like to make a little comment and a question, then, to Shekhar. This is on the decision-making part of this panel this morning.

In Latin America we are facing a situation that some governments are trying now, and I think they will succeed in, declaring the up-to-now protected areas as public goods, that they should be used. So, it is exactly what Shekhar said: They were first fenced and then keep the people out, and then as a political movement it says, "No, we must put the people in because it is a public good; it must be used for the wealth of everybody."

Here in UNESCO, this is a political organization. We are supposed to give advice to our member states. So, one advice is, of course, the biosphere reserves concept of integrating nature conservation, integrating the knowledge, and also the sustainable use. But sometimes I think we are facing a problem on the cultural dimension in that in the past there was a lot of enforcement in these countries of protected areas, and by change of government it's coming to this new situation I'm just describing. This is something that will not happen in the next thousand years; it may happen in the next 20 years. Big parts of existing nature may simply disappear by use.

So, the question to Shekhar in particular, and also to others on the panel, is: What could be done? What is the wisest way, with this information, of reacting or of servicing better our member states by passing the message to the decision-makers? You said that we must get a simple message that must be understood by everybody. I think the biosphere reserves message is relatively simple, but it is still not understood or it will not be understood – I don't know. I want to put this question to the room.



Most governments, perhaps all, are reactive. They don't like to anticipate things; they like to wait and see if anything happens.

SINGH: Your question and, I think, also some of the remarks made earlier seem to question what is the basic nature of governments. I taught for 22 years at the Indian Institute of Public Administration, and one of the things I learned was that governments seek only one thing. If they are a stable democracy, then they seek to get re-elected, to get back to power. If they're a nonstable democracy or a nondemocracy, they seek to stay in power. There is no other objective that governments inherently have. You can have all sorts of incidental objectives, but that is the core objective of government. That is why they're also reactive. Most governments, perhaps all, are reactive. They don't like to anticipate things; they like to wait and see if anything happens.

When I was in the government, sometimes there would be a newspaper article criticizing my department, and I would say, "We should do something." But I would be told: "Relax. Don't react. If the criticism persists, then we'll see." The idea is that people will run out of energy; they will give up and not persist, if you just sit tight. What I'm trying to say is: If you understood that, then the strategy develops. How does one poke this monstrous government in a place where it hurts hard enough for them to move? That is the only strategy. Some governments, for example, are very sensitive to international pressure, so it's sometimes very good to get UNESCO to write a letter or a World Bank or somebody else to write. India is too large to worry about that, so you've got to think of other ways of doing it.

That is the only strategy that works. I don't know enough about the country you are speaking of to suggest strategies, but I know that in each country there must be a strategy that hurts the government where it is most sensitive. That's the only way of doing it.

FACILITATOR: Does any other MAB staff member wish to ask a question or make a comment at this point?

SCHAAF: Yes. I'm Thomas Schaaf from the MAB Secretariat. Just a few comments.

Dan Botkin said this morning that change is natural; better get used to it. We all take it for granted that the environment is changing, and obviously it does change. But aren't also human beings changing? What I mean is the mindset. Aren't there also shifts of paradigms, of beliefs that we took for granted in the past that can change in a couple of years? So, if you look into the future a thousand years from now, perhaps we should start by looking back a thousand years in the past.

I'm from southern Germany. If I picture myself a thousand years ago in my region, say, in a former incarnation, how would I have lived and what would have been my perception of the environment? I would probably have lived in a fairly small city that is walled in because of high insecurity at the time in the year 1000 after Christ. I would have probably been a farmer who would have just plowed the fields outside the walled city, and in case of crisis I would have sought refuge in my own city. Where would I have lived? I would have lived in the river valleys. I would have not lived in the mountains; I would have not lived, say, above 400 meters' altitude, because mountains were dangerous. There were predators; there were wolves and bears; there were witches and sorcerers. I would not go into these areas, so nature was basically feared. And that's what I'm driving at. My perception of nature would have been something like: "This is something I fear; this is not something I need to preserve."

If Thomas-today would have time-traveled and said to Thomas-then, "You need to preserve nature," I would have looked at Thomas-today like he was coming from Mars. "Why would I need to protect nature? Nature is dangerous."

It is quite revealing to look into the past and to recognize that our mindset at the time must have been very different from what it is today. What would I have liked in the past? Again I revert to a German source, the Brothers Grimm, who collected the fairy tales and other orally transmitted legends. They collected one interesting tale about Schlaraffenland, a kind of "never, never land," where people pictured what would be paradise for them, the Land of the Plenty. It's a bit of a bizarre story: You have to eat your way through a mountain of pudding, and then once you have made it through, basically you just open your mouth and a roasted chicken would fly into your mouth; the rivers would be full of wine. Everything would be at your fingertips.

This is a good example of projecting paradise at the time.

What would have been my mindset a thousand years ago for today? Actually some of this has materialized. In Europe, in North America, even in developing countries if you are rich, you go into a supermarket and all goods are at your fingertips. The land of plenty actually does exist, at least for a certain segment of society, which I find quite interesting.

Now, coming back to what David said – and I think that is actually what we should discuss – how would we project ourselves in a thousand years from now, say, in a future incarnation? When we come back in a thousand years' time, how would we like to live? This should be the discussion that we should focus on tomorrow. Today was pretty much a brainstorming session. But tomorrow we should discuss on how we would *like to live* in the year 3000. For me, it would be a world free of starvation, a world free of war, a world where the environment is well preserved; I would like to live in harmony with nature as well.

… as we think about how to manage the relationship between people and the wider environment, we should be aware that there is genuine conflict that is all too often papered over.

MACDONALD: I would like to make two comments arising from the very interesting remarks that Thomas made. First, actually the 1000 BC scenario, where nature was essentially hostile to the Thomas of that day, is something that we have to remember may not be so alien to our experiences today, because actually many of the issues that people face with nature now are to do with conflict and pestilence. Indeed, one area of research I'm involved with is emergent diseases, of which most of the serious ones – HIV/AIDS issues, Lassa viruses, various forms of rabies, and so forth – are all things that threaten human communities in a very big way at the moment and all have their roots in wildlife diseases, so as we think about how to manage the relationship between people and the wider environment, we should be aware that there can be genuine conflict that is all too often papered over. My desire would be to not paper over the cracks, but rather to find solutions where there is genuine conflict, and to dispel myths that damage the human-wildlife relationship unnecessarily.

… many of the trajectories that we are on now are, in a supertanker-like way, such that it would take many generations of humans to begin to turn things around.

So, we're not in Nirvana now, and there *is* quite a lot of threat. But thank you very much, Thomas, for providing me with the excuse – and I hope our colleagues won't find this annoying – to try to drag us back to the idea of exploring some scenarios of this thousand-year future quest that Walter set for us when the Foundation invited us here. I'm probably not alone in that when I was preparing to come here I spoke to quite a few colleagues about the idea: "I'm going to talk to some people about the notion of what the thousand-year future may look like." And quite a lot of them had the immediate reaction of saying, "My goodness, a thousand years! I mean, that's almost crazy because it's so far away." The more I think about it, many of the trajectories that we are on now are, in a supertanker-like way, such that it would take many generations of humans to begin to turn things around. So, actually, I don't think that considering the thousand-year scenario, or at least the several-hundred-year scenario, is as crazy as people might have initially thought.

I'm reminded, and I want to remind you, of some very interesting remarks we heard earlier from Dan, who was talking about the fact that there are already predictive tools available that would allow us at least to simulate with some level of confidence the constraints that might be applied to our futuristic scenarios. I was reckless enough to suggest a world I could imagine being pleased to live in, at least some of the worlds that it is possible to imagine prevailing a thousand years from now: a world in which people enjoy greater equitability, doubtless relying heavily on ingenious technology to deliver high quality of life, and in which they also value protected and restored biodiversity – a scenario which is unimaginable without a radical reduction in human population. Perhaps because people were kind enough not to ridicule my suggestion, nobody said much about it. But nonetheless, if we are looking for examples of a world where there's both nature and people with a high quality of life, I would be intrigued to know, within the sort of scenarios that modeling could allow us to explore now, what socioeconomic mechanisms, for example, are available that would allow us to chart a trajectory from our current situation of overpopulation (as I see it) to one that takes us to a situation that is more agreeable for all concerned, hopefully avoiding the actually probable mechanisms for getting there, which include pestilence, disease, war, and famine. But it would be helpful if there was a body of socioeconomic theory – a colleague in this room may know – that would allow us to see how, over some generations, we could move in that direction. I think it would be an exciting and innovative outcome of this workshop if, at a quite technical level, we could start exploring modeling scenarios.

Today one of the best hopes that I have is that people are living long enough to benefit from their own experience, not just what they hear from their elders …

EARLE: Going back a thousand years when nature, the wild, was largely protected because of the fear people had, and also recognizing that our population was *significantly* lower than it is today or will be in the future, we perhaps took a lot of things for granted – your Thomas of the past and my ancestors as well – about the services that were provided by nature. This includes the water that you could just drink from places that now you wouldn't dream of going to those same sources because of what *we* have done to those sources.

One of the greatest causes for hope, though, is another change that has happened – not just the attitude about nature, not just the accessibility now of places everywhere and the fact that we are taming the wild, cultivating the wild (the wild ocean still is an anchor against much that we have done to the land, but that's quickly changing) – the fact that we're living longer. Your ancient Thomas would probably be gone by now. It was considered that you had lived a good life if you went past 30. Today one of the best hopes that I have is that people are living long enough to benefit from their own experience, not just what they hear from their elders but what they've seen for themselves. The new appreciation for the cause-and-effect relationships of what we're doing to the world around us is an understanding that comes only, perhaps, from having been there, done that, seen that yourself. Magnus spoke about the water: You can remember when it was better, and you now have something to look forward to the future that you would like a standard that you have experienced. All of us have known, either personally or vicariously, the existence of elephants. But we can project a time forward, if we continue business as usual, when there won't be any anymore. Our starting point is looking back to see: Here are the trends. Here's where we're going if we continue business as usual.

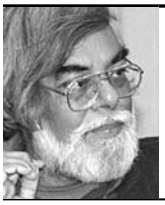
Murray Gell-Mann, the scientist who allegedly has five brains, has done some calculations – this is not scientific; he says this is just "back of the envelope" – that it will take us only 1700 years, population going as per we are right now, for the mass of people on the Earth to equal the mass *of* the Earth. This is pretty stunning and totally impossible, but it gives us some standard to go by if we continue business as usual. Having lost 90 percent of the big fish in 50 years, how many years will it take before there aren't *any* of some kinds that now we have at least 10 percent out there swimming around? Coral reefs: 50 percent either gone or in terrible shape in 50 years. Now, it's not good enough if 50 percent remain in pretty good shape. If we continue that trend, it won't take us a thousand years before there won't be any anymore. Or CO_2 emissions – if we don't *do* something, we can project where we'll be.

We can't calculate all of the unknowns about natural feedback mechanisms, especially in the ocean, in nature generally, but we can certainly do a pretty good job of seeing that we are on a collision with disaster if we continue without making changes in what we're doing. It's partly population, but it's across the board the way we value the natural systems, the wild. It's not to be feared except for the loss of it, at this stage.

… a large part of our population are very desperate … we must also think about having trajectories that tend to provide hope for the human society.

NGOILE: Talking about trajectories reminds me of an experience I had with the King of Sweden. We were having lunch once, and he said, "The environment of Sweden is changing very fast. In the old days I used not to see any graffiti on the buildings, but now there is graffiti almost everywhere." Then he said, "You know, I can see why this is happening. The young generation has no hope because all of what they are hearing is just bad things. There's nothing to live for, and in that case there is desperation."

I think we should consider that as one of the possibilities of what's happening now, that a large part of our population are very desperate, and so consequently there's no message of hope. Maybe as we do the trajectories, we must also think about having trajectories that tend to provide hope for the human society. I think that will help. As you said, whether it is religion or something else, anything that can make a human being independently and privately fear will bring in a positive change.



It's an old question, whether we are now moving towards a more evolved society or we're still in the age where we must come to the brink of annihilation before we turn back.

SINGH: Looking at the program, I'm totally for looking at the one thousand-year scenario, but coming back to the distinction David made, I think we need to distinguish between what we *hope* will be the case then and what is *likely* to be the case then. Those two things don't necessarily always match.

Whereas we are free to hope for anything, and I think we should perhaps let our imagination run wild as far as that goes, when it comes to what we think is most likely to be the case, I think there are two or three points we need to reflect upon and use. First of all, it's very arrogant for us to think that the survival of the Earth now depends on actions that human beings are going to take. There is evidence – I don't know how scientifically well-documented it is – but there is evidence that natural systems themselves take cognizance of things that are going wrong and make correctives. For example, there is evidence to believe that societies when they start getting very congested, fertility rates get affected, and you find that the population starts getting controlled in normal, natural ways. So, there are a lot of processes of nature that need to be taken on board, and we shouldn't think that we own the Earth and therefore what *we* do is going to determine whether the Earth is going to survive or not. That's one thing we need to take into consideration.

The second thing is that there are trends and there are different types of trends. Here I totally agree that you cannot look at the future a thousand years ahead if you only look at the ecological processes. You have to look at *all* the processes: the social processes, the political processes, the psychological processes, spiritual processes, etc. There are linear trends, some of which seem to be reasonably obvious, and therefore one can hope that unless something very disastrous happens, we will keep following the trend. Other processes seem to be cyclic, and we don't know a thousand years later what level of the cyclicity we are going to be in.

And third are trends that are still not well formulated enough. For example, violence is one such. It's not quite clear whether society is becoming more violent or less violent. By some standards it's becoming less violent, but by other standards it's becoming more violent. The jury is out, so to speak, on these issues.

My last point is that there is a belief, which I instinctively share, that human societies always turn back and solve problems. As the problem becomes more and more imminent and becomes more and more obvious, then there's greater and greater motivation, and finally you reach the point when people start solving the problem and moving back. When one lectures to students, one says that the difference is that if you are a more evolved society, you don't go to the edge of destruction before you come back, because a heavy cost is paid in the process by at least some people, usually by the weakest segments. Therefore, in an evolved society, you try to anticipate disaster and preempt it well in advance. It's an old question, whether we are now moving towards a more evolved society or we're still in the age where we must come to the brink of annihilation before we turn back. But I think that trend also needs to be looked at.

So, I think there are certain tendencies that we need to gather together and see, as a collective, as a group of people from varied backgrounds and varied experiences, whether we can actually come up with some sort of an interesting forecast of where we might actually be heading, never mind what we hope. It would be an interesting chart: What are our hopes, but what are the realistic projections that we can come up with?

We need to find ways of transmitting environmental concerns and future environmental scenarios in a narrative that makes people act differently in the future.

ISHWARAN: I was a T.A. at Michigan State for a while, and there was a professor who used to come and talk about Walt Disney's first law, which states: "Wishing makes it come true."

Somebody this morning spoke about narratives. It would be very interesting to think: What should be the narrative of the environmental and conservation movement for the next whatever number of years if they have to be understood and apprehended better

by the broader community, the broader public? From the time I started doing conservation, which was almost 30 years ago, we have continued to use a narrative that is trying to scare people. And people are not getting scared anymore. For example, we know that climate change is something that is apprehended by people at a certain level, but if you go to a rural area in India or even an urban area in Sri Lanka, it's almost becoming television infotainment. They watch news as an interest and partly an entertainment. We need to find ways of transmitting environmental concerns and future environmental scenarios in a narrative that makes people act differently in the future. It would be good to think about that narrative, because I don't think that's being adequately thought about.

As Shekhar said, the future is not only ecologically or environmentally thought through; there are other processes. For example, UNESCO's mission is "to put peace in the minds of men." That is in the mandate; that's in our constitution. Now, have we put peace in the minds of men and women? I don't know. I hope so. I come from a country that has been fighting a war between two groups for the last 23 years. I'm not sure that we have put peace in the minds of those people.

I think there will be a lot of other trends that will determine the final outcome of what the society or humanity will look like in a thousand years. But if the common and shared concerns of this group are environment, biodiversity, conservation, and ecology, it will be interesting to think about what is the narrative that will help better alignment to this cause amongst others.

Another interesting trend to think about is a philanthropic or giving trend. At least in the United States, it's going up, which is good and it's into billions of dollars. Warren Buffet gave whatever he wanted to give to Bill Gates; he didn't give it to the environment. Now, why is that happening? Why is the giving and philanthropic industry evolving? In fact, there is a magazine called *Foreign Policy* in which somebody called it "the morality market." Why is it that the environment or conservation isn't capturing the giving tendency, even in the United States where environment and conservation occupy a stronger niche than in Sri Lanka, for example? In fact, more than 80–85 percent of the giving and philanthropic market is religion, so maybe there's something indicative there.

From my own perspective, and I think this would be good for UNESCO, how do we tell the story outside? If we're saying it right and if we're having all the facts right and if we are so good at being accurate and informative, why are we not convincing people?

We identified eight different dimensions that would encompass the different aspects that one would have to take into account … as to what the future might bring.

FACILITATOR: In response to a couple of comments that have been made about the multiple things that interact to cause the emergence of the future, I might point out that in the process of approaching the Humanity 3000 seminar series that the Foundation For the Future conducts annually – which is not subject-specific like this seminar is, but generally about the future of humanity – we spent six months with a group of people that we constituted as the Humanity 3000 Organizing Committee. We identified eight different dimensions that would encompass the different aspects that one would have to take into account in order to come up with any kind of an idea as to what the future might bring. I would be happy to share what those eight domains are; they're very clearly identified. In fact, when we conduct those Humanity 3000 seminars, we try to make sure that there are participants representing each of the eight major domains.

One of the things that I find, when we are conducting these seminars, is that experts come within a field; they talk to each other; and they leave without appreciating the dynamics of all the other dimensions that impinge upon whatever it is that they're talking about. One can be very confident about what he says, but the minute a political scientist or a philosopher raises an issue on a biosphere question, then it gets muddled and becomes complicated enough where he throws his hands up and says, "That's the end of that conversation." But in reality, that's how the future comes about: Those other things are interacting to cause the future to arrive.

Second, Ish raises a question as to why the United States or the highly advanced societies have a greater degree of preoccupation with conservation or any other issue related to the environment. In response, I would perhaps revert to the very old notion of the hierarchy of needs, going back to Maslow. Maybe advanced societies are far more concerned about

self-actualization, perhaps accompanied by a sense of guilt or conscience about what is going on, that causes them to think more about it than somebody surviving on a subsistence level where the concern is with survival and not some higher value related to the survival of the collective or the future of humanity, even though nobody would disagree that that would be a desirable outcome.

BOTKIN: If we're going to talk about a thousand-year future, we should include not just what we would like and what we expect, but how you do the forecast.

What are the critical issues that one must take into account even to address current issues, let alone look at a thousand years?

FACILITATOR: The reason why the Foundation has not gotten involved deeply in forecasting and visualizing, and so on, is that it runs somewhat contrary to our mission to simply increase the knowledge base and to inform the general public. We have tried this experiment before and it's an extremely difficult proposition insofar as forecasting is concerned. There are models and extensive studies on simulations about the future. There are futures studies methods that have been identified insofar as how one might rationally come to some scenarios. I can go into a lot of the detail on that. Where we have left the issue of the future with regard to our general-subject seminars on the future of humanity is essentially to ask three questions. And I'll repeat them for you:

The first is: What are the factors that a group of people at any given point in time deem to be critical for the long-term survival of humanity? One of the things that we debated at length is that when you get past the notion of survival, then all kinds of implications arise. Some people want to call it "thrival," hopeful futures, desirable futures, and that gets to be a rather complicated matter, whereas everybody can agree on the fact that, at a minimum, survival is a value that we can all subscribe to. Beyond that, what constitutes a desirable future is a matter that people cannot easily agree on.

The second question we ask is: What are the trajectories of these factors, given what we know about the past and present? By *trajectories* we simply mean: What is it that we can see if we were to extend, whether it is linear or nonlinear, as long as you clarify your assumptions? What are the trajectories of these factors?

The third thing is: What are the problems and opportunities associated with addressing these factors?

Those are the three questions we have arrived at, rather than to say, let's describe scenarios or visions of the future. We have tried it, and it really, at the end of the day, has not amounted to much, to put it honestly. That's why the agenda for tomorrow is constructed to say: What are the critical issues going forward that we must take into account related to the biosphere and humanity? What are the critical issues that one must take into account even to address current issues, let alone look at a thousand years? It might be relevant to think in terms of the immediate generation, 25 years; 10 generations, 250 years; and 40 generations, a thousand years. We have attempted that with a greater degree of success.

Where does the power exist in our time that will have the greatest impact in terms of maintaining the integrity of the fabric of what makes the planet work…?

EARLE: Just one observation. As I said in my remarks, I'm not alone in believing that this is a critical juncture in human history, that right now, this little piece of time – ten years, or whatever it is, but the time that we share – will have a magnified impact on everything that follows. It isn't the same as a thousand years ago or 500 years ago or even 100 or 50 years ago, because we've reached a critical point on a number of fronts, close to tipping points that didn't exist before. And more than that, we have a knowledge base that didn't exist 1,000 years ago, 500, 50, even 5 years ago in some cases.

We have people such as Richard Branson just now stepping up with a $3 billion commitment to look at the question of how do we deal with climate change issues because of his conviction that we are at this turning point, that either we are able to keep the options open or we are going to see options that are open to *us* that won't be open if we don't proactively do *something*. What are those things that we can begin to tick off that will make a difference? We can't change sunspots; we can't change the inclination of the Earth,

but we can change our own behavior in certain ways. Where does the power exist in our time that will have the greatest impact in terms of maintaining the integrity of the fabric of what makes the planet work in ways that are favorable for us? What are those critical actions, the action plan, that will at least keep the doors open? Or contrary, if we don't do anything, can we imagine what the consequences will be?

FACILITATOR: I think you're identifying, in a sense, one of the critical issues, which is to say: If we make it past the next 30 years, then we can really think about the next thousand years – if that's what I hear you saying.

EARLE: I think that *is* what I'm saying.

FACILITATOR: Oddly enough, that is quite often what we hear in our seminars, that the next 30 or 40 years are critical because of several transitions that are taking place before our eyes, and also the fact that we might already be at tipping points or are past tipping points in quite a lot of the cases.

MACDONALD: Sesh, I think it might be too late in the day for me to try to convince you now that there is actually harmony between the three major issues you identified from the Foundation's three questions and the sort of ideas that I suspect both Dan and myself are thinking about for looking at the long-term future. I think you were wise, perhaps wiser than you just allowed, in nominating that long timescale as something we should consider in our meeting, because of the supertanker phenomenon. Those issues and the questions you pose could be taken forward by the sort of modeling and forecasting that we have in mind, even if they're only thought games as opposed to computer games. I think they need to be both.

I think the risk that we might share a fear of – and I'm sure you don't intend this – is that the modeling explorations we are proposed do no more than reshuffle the pack of existing information. To do that would not require a lot of innovation. I don't think it's such a big challenge among the group of us to expose our existing beliefs and make them clear. I think it's a much bigger challenge to do something innovative and new with them. I suspect that's what Dan and I both have in mind, and I think that is in accord and resonates with your three questions. But maybe that is for tomorrow.

FACILITATOR: Yes. If we can work with the proposition that the Foundation's three questions are what you construct your vision or forecasts or ideas about the future around, that might form a skeleton around which there is a certain consistency. Otherwise, I assure you, we will go off on all kinds of tangents and it will be quite incomprehensible.

BOTKIN: Could you state the three questions again?

FACILITATOR: Yes. To make it specific to the biosphere, the questions are:

What are the critical issues with respect to the biosphere and humanity over the next thousand years? (Again, I'm implying that it means survival; it means the biosphere is thriving; it means that there is a future and that our future generations are around to experience it.)

The second question is: What are the trajectories of the issues you identify as critical – past, present, and future? What is the information from the past; what do you see happening in the present; and what trajectories do you foresee, extending those however you wish, whether it's linear or nonlinear, leading into the thousand-year future?

And the third question is: What are the problems and opportunities associated with the factors or the issues that you have identified as being critical?

BOTKIN: May I just say: If you talk about trajectories, you are making a mental model, a mental theory. And so you *are* doing forecasting. That's what it is.

FACILITATOR: Yes, if you wish to define it as that.

BOTKIN: It's not my wish to define it. It's what it is; it's a forecast. It's a method of forecasting. It's not the modern method, but it's a method of forecasting.

FACILITATOR: As undefined as possible is how we have kept it.

SINGH: If there is a difference, the difference seems to me that Sesh is more interested in identifying the critical factors that are going to affect the future of humanity and the biosphere, without necessarily going into an exercise of what's going to happen in the next 100 years, 500 years, 1,000 years because that doesn't lead to anything very concrete. For David and Dan, there is an interest to also get into certain sorts of methods of forecasting and see how they work.

This is the real difference, if there is any, that I see.

MACDONALD: But the reason for that difference is that I think we're enthusiastic, as I suspect you are, too (this is why I really suspect that this is largely an issue of vocabulary) – the reason we're interested in the approach we're advocating is, having identified what those factors are, which as you rightly say is an important starting point, I would like to do something about it.

FACILITATOR: And that's the other reason why we shy away from taking this to that logical conclusion. The Foundation is not motivated to then do something about it. Its mission is to inform the general public as to what you all thought were the critical issues, because the information and the choices that they make are what we are after.

There have been a lot of times in the world when people have posed a critical issue without testing whether it mattered, and it turned out to be of no consequence.

BOTKIN: There have been a lot of times in the world when people have posed a critical issue without testing whether it mattered, and it turned out to be of no consequence. So, one of the ways that you determine what a critical factor is, is to make a forecast in a formal way. They're not independent. We can speculate about critical issues based on our experience, but that has some self-imposing problems associated with it. Or you could say: We want to identify them and then ask how we really will know that those are the truly critical ones, because if it's not of consequence, then it's not important.

FACILITATOR: Right. The reason why we are soliciting responses to those questions from a group like this is because you are more intensely involved with the issues relating to the subject at hand. The idea is to represent the tension and the dynamics of this conversation to the general public, so that when they think about these issues, they say, "Here are all the complexities. Now let me understand and think about what it is that I have to think about and choose accordingly."

SINGH: What Dan is saying seems to me to be fair, because if somebody poses something as a critical issue, obviously that person must be challenged.

FACILITATOR: Right.

SINGH: And when the person is challenged, he is free to use any of many methodologies, of which forecasting is certainly a legitimate one, to explain why he thinks the issue is critical. And when you inform the public, the public will also sometimes raise their eyebrows and say, "Why is he saying that this is critical?" At that point it would be very useful to say, "Well, he did a forecasting exercise that indicated that if we don't do anything, this is what's going to happen in 500 years." So, I don't think there's any real contradiction.

FACILITATOR: Exactly. That's what I'm trying to get at. If your semantics say that what I am proposing is forecasting, I concede.

BOTKIN: No, I think it's more along the lines of New Year's Eve in AD 1000. The people attacking Budapest, who were not Christian, decided that it was the end of the world, and they had to convert to save the world and they did convert. From what we know about physics and astronomy and planetary dynamics, they didn't have to convert. The Earth would not have ended, but if you had asked them what the critical problems were at that New Year's Eve, they would have said, "God is going to end the world."

Now, where are we wiser than they? No matter how nice it is that you invited us, with what basis can we feel any wiser than they, except if we have methods to forecast? That's what I'm asking.

FACILITATOR: And perhaps the proposition that we know more than they did.

BOTKIN: But are we any wiser? I'm happy to give you my opinion about the future. But I don't know that what I give you is any better than the Magars did in AD 999.

FACILITATOR: It brings to memory that 100 years or so ago, the most noted scientists on the planet were asked to tell what they thought might occur over the next hundred years. Not a single one of them was correct, including the proposition that one of the scientists made saying that the steam engine could never occur, because at those speeds people's brains would get scrambled because it was too high a speed for human beings.

Forecasts about technology have almost always been terribly wrong.

BOTKIN: Forecasts about technology have almost always been terribly wrong. Oddly enough, *PC Magazine*, the magazine of computers, forecast ten or so years ago that anything important about computers had already been invented. That's their field and they made that stupid prediction. We may be as stupid, no matter how wise we think we are.

There is a carrying capacity. I don't know what it is; maybe we've exceeded it. It would seem that we have, if we want to maintain a certain quality of life.

EARLE: One thing we know for sure is that Earth is finite and that there is a limited amount of what it takes to make it possible for humans to prosper. There is a carrying capacity. I don't know what it is; maybe we've exceeded it. It would seem that we have, if we want to maintain a certain quality of life.

There are some basic perspectives, like seeing Earth from afar, and knowing (though not everybody agrees with this) that we're not the center of the universe and that human beings are not the center of the Earth. These are things that we think but not everybody agrees. Anyway, there are certain fundamentals that set us apart at a level where we can make better decisions, if we have a chance to make them, than those who proceeded us simply because of the knowledge base, if we choose to act on it.

FACILITATOR: Magnus, we'll give you the last word for today.

The critical issues are measured in a thousand years, but in terms of process, individually or group work, you can set up 5-year processes …

NGOILE: I just wanted to provide a way of looking at this: Take it as a process. A thousand years is a long time. What we can *do* is to be able to say: Let us gather the knowledge of a thousand years ago; as we have said, identify the critical issues; and then allow for the brains to help with the projections.

For the projections, I don't think that we have to wait. The critical issues are measured in a thousand years, but in terms of process, individually or group work, you can set up 5-year processes for political issues. Some planning processes within governments you can set for 50 years. There's a document for Tanzania where we set the blueprint at 2050. Everybody rose up and said, "You must be crazy! Who's going to be there in 50 years?" But we raised some very critical issues in there, and one of the things that we avoided was to provide what might be called a roadmap. We said that this is not a roadmap; this is just raising some critical issues. The roadmaps might be many to be able to reach that.

FACILITATOR: Exactly. I agree with you. With that we will conclude the session and go on to the second panel.

Panel 2
Conservation and Extinctions

As the global biodiversity crisis appears set to worsen during the 21st century, what would be prudent ways to choose conservation targets? Should we prioritize our efforts and investments into conserving large charismatic species, keystone species, ecosystems services, or a mix of these targets? What would determine political and policy choices in specific places around the world of our conservation priorities? Will the 21st century see all large animals and extensive areas of remaining, legally unprotected ecosystems vanish, leaving only legally protected islands of parks and reserves as refugia? What are the chances for biodiversity outside of legally protected areas surviving into the 22nd century?

Panel 2 included commentary by Dr. David Macdonald and a presentation by Dr. Ricardo Guerrero.

Panel 2 – Conservation and Extinctions

Commentary by Dr. David Macdonald

… what we can do for the relationship between people and the environment rests on finding out robust, reliable science … to underpin our political and practical actions.

MACDONALD: My understanding of the commentator's role is that I was to listen to what was being talked about and think of a few points that might be raised as a result of what was said and as a result of what wasn't said. I'm going to *ad lib* on those thoughts right now.

I have two points that I would like to make that I think may help our discussions. But before getting to them I would like, if I might, to just take a couple of moments to explain how my personal view of these issues is formed by my day-to-day work, to give you a sense of my perspective.

The sort of thing that I'm concerned with and work with is rather more earthy, if I can put it that way, than some of the topics we've heard about thus far in the meeting. For example, my team and I spend our time in Ethiopia working with the last 300 or perhaps 400 Ethiopian wolves on the edge of extinction, threatened mainly by infectious disease, rabies, and distemper from domestic dogs. We're working in Zimbabwe on the effects on lion populations of over-hunting on a quota system that turned out to be scientifically unfounded. We're working in Namibia on cheetahs in conflict with ranchers, and looking for solutions to resolve that conflict.

El Niño has been mentioned. In the Galapagos we've been working on the impacts of El Niño and the effects of climate change affecting El Niño patterns on the Galapagos penguin, the most northerly of all penguin species, and also in the Galapagos on small mammals, where climate change and the introduction of invasive black rats threaten extinction. We're working in West Africa on bushmeat. And we're working in various parts of Amazonia on emergent diseases.

These are all issues that, I put to you, face us with practical and immediate problems, perhaps some of the same problems we may or may not face in a thousand years' time, where a great part of the solution comes from science. From a few interjections I made this morning, it will be already clear to you that my "pitch" is that a great deal of what we can do for the relationship between people and the environment rests on finding out robust, reliable science with which to underpin our political and practical actions.

That is some of my background, and the theme of science will recur through the two points I want to make as a result of what I have heard today. I want to set my comments in the context of a broader question that I think we've all somewhat touched on, which is: Why bother? I mean, here we are today having inspirational and interesting discussions about the environment, but why are we bothered about it? I think there are quite a lot of different reasons, and quite a lot of them are going to have a scientific, logical foundation. But I want to put up a little plea in passing, and I hope you'll forgive me a moment's sentiment, to say that part of "why bother?" is a matter of emotion and aesthetic and personal values.

One does what one does for many scientific reasons, but in part also to keep the wind in one's face and the mud on one's boots.

I was a little boy once, of whom people said, "He loves animals." I was a little boy who tamed wild animals and was surrounded by them. I'm a person who does what I do not only because of the scientific reasons

I am about to put forward to you, but as a matter of advocacy and ideology and personal position. I treasure wildlife as I treasure art, and I want to make a point to you that quite a lot of this is not just about science; it's about those sorts of personal and sentimental things. One does what one does for many scientific reasons, but in part also to keep the wind in one's face and the mud on one's boots. So, if you'll forgive me that moment of sentiment, I think that however good your science may be, there comes a point where you're into judgment and values.

I came to this meeting, by the way, from Brazil, where I was fascinatingly but sadly in an area many of you will know called the "Arc of Destruction" – the "Arc of Deforestation" – the southern face of the felling of the Amazon, where one sees issues that have huge scientific consequences in terms of climate change. One sees forests that have been treated rapaciously. One sees lonely, (one almost imagines "tearful," if you'll forgive me) Brazil nut trees standing in isolation, the environment of which they were once a part having been felled. There are huge scientific issues about that that we must solve if there is going to be something worth saving in a thousand years' time. But, nonetheless, I think we also weep when we see it happen, as a matter that is not only scientific, but rather in the arena of value and sentiment.

So, what are my two points that I have heard touched on throughout the discussions so far, but perhaps not explored explicitly? The first is about the importance of values and evaluation. We've heard a lot about how politics affects decisions, and this is going back to this issue of why we care about the wildlife we've been hearing about today. Several of the speakers have alluded to the fact that one of the reasons we treasure wildlife is that without it we're all doomed. It's the so-called "ecosystem services" on which we depend. When we look at nature and hear our citizenry who ask, "Why do we want to preserve all this stuff?" part of the answer is, "Without it, you're all dead." That's a pretty utilitarian and down-to-earth argument.

Who knows how many products we haven't yet dreamt of that will be taken from biodiversity? Who knows whether ecotourism will save us all in the end?

The second tier of arguments has to do with other uses and values, less to do with ecosystem services. For example, who knows how many more wonder drugs will be discovered by the pharmaceutical industries in forests? Who knows how many products we haven't yet dreamt of that will be taken from biodiversity? Who knows whether ecotourism will save us all in the end? All these values that we may yet at the moment enjoy from wildlife and from nature, and who knows how many there are still to be enjoyed?

There's another aspect to that value, which is slightly different. E.O. Wilson was somewhere near the origins of the idea known as the "biophilia hypothesis," which can be put one way or another with various levels of technicality, but it essentially says that there's something quite fundamentally important about the relationship between people and nature, that people living in a world without nature are going to be deprived of one of the attributes they need, in the same way as they would be if they had less water or less oxygen, that nature is part of the way we deal with life. I think that is another utilitarian argument, in a sense, for why we might care about nature.

Another reason we care about nature, as we have heard in several talks today, is that understanding the processes of nature is the best hope we have of understanding ourselves. A lot of research some people dismiss as fundamental or "pure" research that doesn't tell us anything; for example: Why do we need to know about African wild dogs or gorillas or even amoeba? In all the processes and lives of these creatures, we can learn about ourselves, and learning about ourselves is perhaps our best hope for having a future.

I'm trying to compile for you a list of reasons for why people might come to value biodiversity and value the environment. Without that value, we will never have the political backing to encourage a sustainable treatment of the environment. But the reason I make this point – and in doing so I've only echoed what others have said – is to take it one step further:

There does come a point where there are probably no foreseeable, utilitarian, monetized values to the elements of some aspects of nature. I suspect that somewhere in the world there is a butterfly flitting through a tropical forest, or a whiskered snout poking out of some mammal's burrow belonging to a creature that will never have any monetary value at all, will never help any of us at all, and we still have to face the questions: Do we care about it? Why bother? Do we want to conserve it? And the only reason that one can answer *yes* is if you value them in the same way that you value a work of art or a piece of literature or something else that you basically treasure.

My point is that whatever we do as science, we have to push beyond that … to try to value nature in a way that will encourage the placing of political power behind that valuation …

My point is that whatever we do as science, we have to push beyond that — if it is our position to be an advocate; it is *my* position in this case to be an advocate — to try to value nature in a way that will encourage the placing of political power behind that valuation, even of things that have no monetized value. That's my first point, that we have to give a lot of attention to why people value things and encourage people to value nature not only for its utilitarian values but for itself.

My second point is about the way in my lifetime, and perhaps in several of your lifetimes as well, an understanding of what "nature conservation" and "concern for the environment" mean has changed radically, in many ways for the better, but it brings with it some hard consequences. There was a time, when I was little, when nature conservationists were a few maverick people struggling to do something that really did seem bizarre, but they seemed benign and harmless; a lot of them had beards and wore Wellington boots.

Nowadays nature conservation has fought its way, and rightly so, to the table of major global issues. This is no longer merely about the interests or the pastime of a small sector of the community. It's no longer the equivalent of, say, stamp collecting or train spotting — some sort of harmless occupation that amuses you. This is something that is on the world agenda. As it has moved to be on the world agenda — and let us all rejoice that it has — as it has become a world in which we understand that every time any of us turns on a light switch, we are commissioning a series of activities that track right through to the biodiversity and the ecosystems that support the generation of that electricity, every citizen has to be concerned about biodiversity as ultimately the engine of ecosystems services on which we selfishly all depend.

As that has come about, biodiversity finds itself at the "grown-up table," where concerns for the environment find themselves sitting alongside, for example, concerns for human development, concerns for the alleviation of poverty, concerns for appropriate governance, and all these issues that are clearly huge and clearly carry huge weight in government and political circles. So, now the person concerned with the environment who is asked, "Why do you care about that butterfly or that tree or that fish or any of those organisms?" has to come up with an answer while sitting beside somebody who's saying, "I care about poverty. I care about starving children."

Sometimes there are win/win solutions, but as we mentioned earlier this morning, a lot of these have gone. Now we face quite a lot of tough/tough solutions. These will be harder to sell than win/win solutions, and generally they will involve painful compromise. So, my second point is that we have to realize that having brought the issues we're talking about today to the attention of the other participants at the table of international affairs, we have to find mechanisms to allow us, if we are advocates for nature, to punch our weight in the company of others who are also prioritizing very, very serious issues. I think that means that we're moving to a world where the likelihood of one view straightforwardly winning in an argument over another, or of simple solutions emerging, is simply fantasy. Rather, what we need to strive for is what I believe in the business community is often called "alignment." It seems to me a terribly important word. That is to say: There are all sorts of issues that have to be considered in every environmental issue. We heard many of them from the speakers this afternoon, which is what triggered me to make these remarks. Many of these issues involve considerations that are measured in currencies that are not easily exchanged. They're "incommensurable," as you might say, and there are many of these issues that require us to face decisions where there is no simple, attractive, single, right answer, rather compromises have to be made. But I believe the

word "alignment" captures the thought that what we need to strive for is some form of compromise – I use that word in a positive sense that gets the best available outcome for the various different and contradictory circumstances that we face.

I think we're looking for a world where these environmental issues have to be considered in an interdisciplinary way.

I think we're looking for a world where these environmental issues have to be considered in an interdisciplinary way. Some people here were mentioning at lunch about the lack of interdisciplinarity in some circles. I think that modern conservation, perhaps as embodied in the creation and structure of this meeting, is about interdisciplinarity and aligning different expertises and values. I'll give you one quick example of that. Before coming to this meeting, I was at a meeting in London to celebrate the creation of a new government department, something that doesn't happen all that often. It's a huge new government department; they call it NDPB – a "non-departmental public body." It's not only a government department, but it's one with some autonomy from ministers, so it can make its own mind up about important policy decisions. The area of this new department, which is to be called Natural England, is to try to make policy decisions about the conservation of the countryside – indeed, the whole environment in the UK.

… in the course of our professional lifetimes, the whole thinking about how conservation of the environment works has turned on its head: about how it can serve people but at the same time, I hope, how people can serve it.

Why I tell you about this is that there is a crucial message in the strapline of this new organization. Natural England will have a budget of 500 million pounds a year and control not only the conservation of endangered species, but all of the agricultural subsidies, and so forth, that are now wrapped up in the broader business of managing the countryside. This is the environmental department of the government. The strapline of this new organization is "People, Places, and Nature." It's important to notice that the strapline starts with the word "people." The well-being of people is seen as the most important function of the government department dealing with nature and the environment. That department replaces one that was established in 1947. I read through the articles for that original body (the Nature Conservancy Council) the other day, and there was scarcely mention of people at all. People simply didn't figure. So, in the course of our professional lifetimes, the whole thinking about how conservation of the environment works has turned on its head: about how it can serve people but at the same time, I hope, how people can serve it.

So, those were my two thoughts that came out of hearing what I have heard today: Something about remembering "why bother?" leading us to consider how we value nature and why, and how we're going it align all the different guests at the table of future thinking about the environment.

I would like to leave *you* with a question, if I may; *you* being my colleagues. We were asked to come here to think about a future a thousand years hence, and I'm not quite sure we've done that, actually. I would like to ask: Are the questions we would be posing and the actions we might be considering if our timescale was, say, a thousand days hence, which is a bit more familiar from my day-to-day practitioner's point of view, are these different questions to the ones we would be posing if we were really looking at a thousand-year spectrum? I'm not sure myself. I think that all we've heard so far has convinced us all – and surely we were preaching to the converted – that the environment is an unimaginably big issue for humanity's future. It *is* humanity's future. But with either a thousand-day perspective or a thousand-year perspective, what are we going to do about it?

FACILITATOR: Thank you, David.

Panel 2 – Conservation and Extinctions

Presentation by Dr. Ricardo Guerrero

Now we control the environment; we control the temperature; we control the place where we live … In one thousand years, I dare to say, we'll control our death.

GUERRERO: Good afternoon. I must tell you that I am very happy to be here. I frequently come to Paris, but not to these premises. Most of all I thank the Foundation For the Future and especially its founder, in all esteem, for this is a good opportunity for us scientists to come together to discuss our ideas.

I know a Sanskrit saying: If you would like to have benefit in one year, you must plant rice. If you would like to have benefit in one decade, you must plant trees. But if you would like to have benefit forever, you must educate and teach people, humankind. So, this is the thing: We are scientists, but as was stated this morning, the most important thing is to communicate. Science is just a thing that we do because it is what we like. This is my job and my hobby; it's the same. But we must teach other people what is the science that we are trying to advance. I was asked just now: What is the future of humankind in one thousand years? I am sure that humankind will be on the Earth in one thousand years, but there will be other differences. Now we control the environment; we control the temperature; we control the place where we live. No other species can do these. But we cannot control life and death. In one thousand years, I dare to say, we'll control our death. And we could be, potentially – well, not eternal, but we'll live for a long time. It will be more difficult, because any time that we know more, we will have more responsibilities. We in the future will control when and how we are living, and when and how we will die, because to die is necessary in any other species.

Many astronomers are here. You know that for many years, the Moon was considered "the wife." It was very anthropological. They said that the Moon was the wife because there were two planets and one was captured by the other. I'm sorry, but this was the theory of the wife. Another theory was that perhaps the Moon and the Earth were sisters, because they were in space and were put together. Another theory was that perhaps the Moon was the daughter of the Earth. I am sorry, but the Moon is the daughter of the Earth, because it was from an impact of a big meteorite in a small part, a minimal part of the Earth. This is very critical for us, because the Earth was spinning very quickly, about every 10 hours, and a year, a long time ago, had many more days, perhaps 500 days, but it was less time to go around the Sun. You must change your ideas. But this constant pull of the Moon with high tides obligated life to make changes. Change is a constant in life. Everything is changing. Change, as we learned this morning, is necessary; it is not bad.

We don't know many things from the start. We know presently with a error of perhaps 20 million years when the Earth started. Probably at 3.9 billion years ago was the first liquid water – on Mars it was earlier – so probably life on Earth couldn't start before 3.9 billion years ago.

… Earth has had microbes most of her life, and will have microbes even if the human species disappears.

The first cells – for me, life is cells; otherwise it is prelife. From the origin of prokaryotes until 542 million years ago (this is the Cambrian time), all was microbial evolution. So, the Earth has had microbes most of her life, and will have microbes even if the human

species disappears.

What about size? We are in a universe that is huge, but depends on the small particles of the atoms. And things happening in the atom are exactly the same as things that are happening in the cosmos that we know. We don't know all of the cosmos, but only one part. But by necessity we depend on atoms and molecules. We cannot be smaller than 0.1 nanometers. This is what physicists call an angstrom. (This is *le Système International*.) So, at 1 angstrom, which is the diameter of hydrogen, they are not alive, and one nanometer is the size of 10 angstroms, or the size of the amino acids. The proteins have 10 nanometers. And we have viruses that are 15, 18 nanometers. This is the smallest life. We have prions, etc. Ten nanometers is the level of something we can call life. As you go up, you have viruses, bacteria – most bacteria are between 0.1 micron and 10 micron. Most of our cells, our red blood cells, are more or less the same size as a big bacterium or a big yeast. Eukaryota cells are bigger. Most of the millions and millions of species that were mentioned this morning are below 10 centimeters. Life on Earth is mostly under one decimeter – 10 centimeters big.

Probably, life originated on Earth several times, but several times was destroyed.

There is a unity of life. Probably, life originated on Earth several times, but several times was destroyed. There are many possibilities. When scientists started to reproduce, to play God, they discovered there are many, many manners in which to make polymers, to make nucleic acid, to make proteins. Basically, our proteins are leftist, and we have all left amino acids. And our sugars are rightist – but this doesn't matter. You can make life with right and with left, with mixture of this. But all present life we know, from the small bacterium three kilometers deep in granite or in basalt are exactly the same as in an elephant or us. This a combination of DNA to RNA and to proteins. All those to the left are prions that can reproduce themselves; they are proteins. DNA can reproduce. First we were RNA because viruses are RNA.

Microbes were unknown just because they are small. They were discovered in the 17th century. One scientist, Robert Hooke, dared to write a book in English, not in Latin. It was one of the first books – the first in biology – one of the first books in English. He was rich. Antonie van Leeuwenhoek was a poor man, a seller of cloth. The biographies of Antonie van Leeuwenhoek are very complicated. I read that he was the mayor of Delft, Netherlands. He was not the mayor! He was the usher, the servant who put in the chairs, but he was very intelligent. He was making lenses for microscopes. In his varied career, he was the epitome of the communication of science. Because he couldn't write in Latin, he sent letters in Dutch. So, he was writing letters, and would say the things he observed: the protozoa, the bacteria in his teeth. And he was observing semen and was telling in the letter, "The semen is come from a marital coitus." One night he was writing to his friends in London, saying: "This afternoon a woman in Delft" [which was a small community] "was looking at vinegar, and the vinegar has small worms." The woman was saying she would never use vinegar anymore because there were small bugs there. And he was smiling to himself and writing, "What would happen if I would tell the woman that in her mouth she has millions and millions of small worms, much smaller than the others!" So, he was communicating. All his books – no articles, just letters were translated into English – are wonderful, and he was really the discoverer of protozoa, or Protista.

Microbes can do many things. Microbes kill people, but also microbes produce miracles.

Microbes can do many things. Microbes kill people, but also microbes produce miracles. Still now in Mexico and Italy and some parts of Spain and also in India, every year are appearances when a goddess cries blood and it's very frequent in a Catholic country to have the form, the body of Christ, with the drops of blood. Well, microbiologists are somewhat accomplices of this, because they say that the pigment of this bug, which they call "prodigiosine," means "making miracles."

What about the effects? The effects are pests or syphilis or smallpox that the Spaniards brought to America. Syphilis, in the first 50 years of the 16th cen-

tury, was very impressive, very quick. Well, tertiary syphilis is not, but primary syphilis is – in only five or ten days. [Referring to slide] Look at this painting by Ramon Casas, who was a friend of Picasso at the turn of the century in Barcelona. Ramon Casas was painting always for rich people. He painted a rich woman with a rich man from Manila, the Philippines. But this is the only picture in which this woman is poor. You can see her face. She's offering a white lily, but she's hiding a snake, because she's syphilitic. When I saw this for the first time, I tried to find out if Ramon Casas was a bacteriologist and if he knew the origin of this, the etiology. The bacterium of syphilis was discovered in 1903. This was painted in 1900. It was for a commercial printing for the Sanatario para Sifiliticos, a sanitarium for syphilis. Even the sanitarium was written with a big S, meaning the snake but also the syphilis. It had a lot of impact.

The difference between the plague in animals and the plague in humans is only one gene.

[Referring to slide] Here is the plague, the most famous one. This is not of a painting. It's from the 5th century, and it is very, very curious. There are three bacteria that are very close: *Yersinia pseudotuberculosis*, *Yersinia enterocolitica*, and *Yersinia pestis*. The difference between the plague in animals and the plague in humans is only one gene. The plague is living normally in rodents, but can go to the lice and also on to humans. And you know the effects. In 1347 the Plague exterminated one third of the Europeans, and also it had a good consequence: Boccaccio wrote *The Decameron*. There are three men and seven women who retire to escape the Plague and tell the tales. But they didn't escape the Plague; they were killed by the Plague.

[Referring to slide] This is Sergio Leone, who directed the film *The Good, the Bad, and the Ugly*. Barry J. Marshall, who won the Nobel Prize in medicine [2005] gave me this; he gave a talk to the Nobel Foundation on this: "Microbes are the good, the bad, and the ugly." But microbes are not good and they are not bad. They are living. What Marshall discovered is that the ulcer is produced by a bacterium. He demonstrated that when you kill the microbe – which you can do with antibiotics – the frequency of cancer of the esophagus can increase. For some reason, the same lines we saw this morning of human dispersion in the last 150,000 years ["The Human Journey on Planet Earth," PowerPoint by Bob Citron], it is exactly the same for the bacterium *Helicobacter pylori*. So, this bug and many others were companioning us as a characteristic of our species.

We are completely covered by microbes … just in the moment that we are dead those microbes start to eat us … Who tells them that we are dead or that we are alive?

[Referring to slide] What we see here is a man and a female – but remember that we are not alone. We are, as a Spanish philosopher says, "one with our microbes." We are *completely* covered by microbes. The good microbes that we have we see on all the skin, the vagina, in the armpits, etc. It's a good combination. And we don't know why – because we don't know what death is – but just in the moment that we are dead those microbes start to eat us. Think of this. Who tells them that we are dead or that we are alive? All of our microbes inside are starting to eat us just in the moment that we are no more. This means a few hours after our official death. When the cells are dying, our microbes recognize that they are not anymore in a good place to live.

We must teach the reality … and the reality is that microbes are inhabitants of the Earth, and in all ecosystems, all the equilibrium. We must consider the role of microbes in the ecosystems.

The division that we have for our microbes is that there are "bad" microbes, which can kill us, and "good" microbes. But if you look at the commercials, they never say that bacteria are good; they say that we should always kill the bacteria. And even when the bacteria are very good, we don't call them "bacteria"; they are called "lactic ferments" (*Lactobacillus bulgaricus*). We must teach the reality, as someone said this morning, and the reality is that microbes are inhabitants of the Earth, and in *all* ecosystems, all the

equilibrium. We must consider the role of microbes in the ecosystems.

There are three ages in microbiology, three ages. The first was the discovery. The second was the glorious time of Louis Pasteur and Robert Koch, and now the discovery that microbes are everywhere. But consider one thing. We were talking about education and the discoverer of microbes. When Pasteur and Koch were working, all the newspapers said that they were heroes of humanity. And it's true: We are here because Pasteur and Koch were saving our lives. But now, all the time, scientists in movies, in newspapers, at least in the south of Europe, are crazy. They have wild hair, and in the movies they are always working with some red liquid that is going "poof!" and they are trying to strike humanity. Isn't this true? We must educate people that scientists are not crazy but are normal people.

Thank you.

Panel 2 – Conservation and Extinctions

Plenary Discussion

SESH VELAMOOR (FACILITATOR): This morning we combined the question/answer and the conversation aspect between the participants and the MAB group, and we'll continue with that practice. Is there anyone who would like to ask a question of any of the participants?

… presently on the order of 12 percent of the land and a fraction of 1 percent of the ocean enjoys some form of deliberate protection.

EARLE: Just one thought: The best hope, whether it's a thousand days or years, is to do everything we can with the time that we have to protect as much of the natural systems and the diversity of life as we have the power to do, recognizing that presently on the order of 12 percent of the land and a fraction of 1 percent of the ocean enjoys some form of deliberate protection.

How much of your heart is good enough? How much of your lungs? How much of your whatever to keep yourself going is enough? We've already seen drastic inroads and the consequences of that in terms of the changes that we are now facing. The best hope for stabilizing is to recover what we can and protect what remains. Not just because these creatures are wonderful, although I totally agree with David that they have a value for their own sake and what right do we have to destroy something we can't put back together again? No matter how much we have in the way of resources, to build a tuna or a tree or a single bacterium, we don't know how to do that. But we're very cavalier about destroying them.

Their beauty is certainly one aspect of it, but in a very selfish way, if we don't take care of these natural systems, we *don't* have much hope.

BOTKIN: You asked a question about reasons for valuing nature. I explored this in some detail in a book I wrote called *No Man's Garden* because I felt that the usual way of dividing these up was apples and oranges. The standard way modern environmentalists divide it is: ecological, utilitarian, aesthetic, and moral – and that's lumping too many categories. People have thought about this for thousands of years. This is not a new topic, and we should appreciate the great thinking that's gone into this. Henry David Thoreau thought wonderfully about this.

I think there are eight or nine categories. The reason there are that many is that when it comes to operational definitions, these become different variables with different parameters. The categories are: utilitarian; ecological (you could say, in the local); planetary, that is, biospheric; moral in an ethical sense; recreational; spiritual; religious; landscape beauty; and curiosity. The reason I list that many is, as I said, they end up with different dynamics and different variables. Otherwise, we're lumping too many things that don't match.

… it's currently the case that there's pressure on us all to find arguments for preserving and conserving nature that are monetizeable, utilitarian, generally beneficial to people …

MACDONALD: I couldn't agree more. I hope it was clear that my comments were meant to be rather superficial, moving quickly over a large topic. I was saying that it's currently the case that there's pressure on us all to find arguments for preserving and conserving nature that are monetizeable, utilitarian, generally beneficial to people, of which many of the categories that you just listed are. But I'm always keen to point out — I believe it to be true and more or less uncontroversial — that there are some creatures for whom it

is quite hard to imagine there would be such an argument, but I personally believe that it's possible still to value them.

BOTKIN: I hear over and over again from biological conservationists who give the four reasons – ecological, utilitarian, aesthetic, and moral – and then they abandon everything but the utilitarian because they think only money counts. But if you look at the history of civilization, ideas are extraordinarily powerful. I mean, what's going on in the world today? We have "Bush Christianity" versus the stereotypic Islamic. What are these? These are arguments over ideas. Great ideas have changed the world. There's no reason that an ecological aesthetic cannot be a great idea. That's a cowardly approach to think that we have to always phrase things in terms of money, because that is not what has driven civilizations.

MACDONALD: I think we're saying the same thing. We're agreeing.

Should conservationists start thinking of how to pose nature as something that is partly an object of fear or awe … and partly a matter of entertainment?

SINGH: If I might look at the same issues, over the last few years, I'm becoming more and more skeptical of the ability to motivate masses of people through rational reasoning. If you look back at the history of humankind, there's probably never been a phase where whole nations or whole societies have been motivated because reason pointed in a particular direction.

I also agree with you that money is certainly not the only motivation. In fact, I would argue that there's also not been any sustained social motivation based on economic factors alone or primarily. Let's look at my own country. I find that there are three things that motivate the masses unbelievably. One is religion. For example, in India you hear a rumor that some idol of a goddess somewhere is drinking milk, and the whole country goes crazy and starts feeding milk to idols. All sorts of things happen without any effort from any agency. So, religion is one. I think this is common with many other societies.

The second is films. The films in India — India is the largest producer of films — are a great motivator. People will miss a meal but will go to see a film. If you are a film star, you can win elections (if you want to win elections) or you can do whatever you like.

The third motivator is cricket. Honestly, these are the three things that spontaneously motivate societies in India. Nothing else; politics doesn't. Nothing else motivates. People work very hard at other things and nothing else works.

Now, if you analyze these you'll find that there are two fundamental principles, and this might be true for other societies. One is fear, because religion to a great extent is fear-based. The more nasty things you do in this world, the more afraid you are of what's going to happen to you in the next world, for example. And the other is leisure or entertainment. Both cricket and films, you might say, are linked to aesthetics, but I think that "aesthetics" is somewhat highbrow. Aesthetics would be art galleries and theater, but those are not what really motivate people.

The question is: Should conservationists start thinking of how to pose nature as something that is partly an object of fear or awe, as it was traditionally and could well become again, and partly a matter of entertainment? Both of them are equally easy to do – it's not that it is difficult to do – but we're not doing it because we feel that we must have better reasons for conservation.

The second point links to the point about what we would think of doing a thousand years down. There is a problem with the arguments that the scientists offer. Suppose tomorrow we develop a technology by which we can mutate genes and produce whatever creature we like. This is not beyond the realms of possibility. Then out goes the whole argument for biodiversity conservation. If I need to develop medicines of a particular type, well, fine, I put this into a nuclear chamber and fire some particles and mutate it — we can't do it today, but I'm sure we eventually will be able to. I'm saying that suppose 50 years or 100 years down the line we have the ability to mutate genes; would we be happy to say, "Now let the wilderness go to oblivion?" Obviously not. Clearly we've got to start building up some other basis, because just the scientific and technological bases will not suffice.

My last point is that what I see a thousand years hence could be two possibilities. One could be that we become so high-tech that nobody links to nature: We don't even need forests and lawns and seas. We

can sit in our chair and plug ourselves into these 3-D machines and recreate whatever we want in perfect harmony. It's similar to the way people don't want to go and watch matches today because it's better to watch them on television than to go and see people playing far off. We would probably find it much easier to sit in front of Mt. Everest by being in a chair plugged into a machine. So, I could see this as one option, in which case the aesthetic and the entertainment argument for nature would fall flat because nobody would require it.

On the other hand — and this is what I hope, but I'm afraid that it is a theme that still needs to be picked up; I have seen elements of it. We are moving in a certain direction. And what is that positive direction? We started in a world where there was so much racism; people of different colored skins didn't have equal rights. There was gender discrimination. At least theoretically now these things are being resolved, but we are still fundamentally racists, because we think the human race is superior to other races.

… the ideal scenario a thousand years down the line would be where we don't have to ask ourselves the question: Why should we protect nature?

I see that the ideal scenario a thousand years down the line would be where we don't *have* to ask ourselves the question: Why should we protect nature? It's like we don't ask ourselves today (at least I hope we don't ask ourselves today): Why should we protect Americans? Why should we protect the British? Rather, these are people who earn their space because we actually respect them, and we don't eat them; we don't torture them; we don't put them up for show. That's one vision of a thousand years down the line, or maybe a hundred years down the line.

CHAISSON: In a somewhat more practical vein, I was struck by Sylvia's comment in her wonderful talk that she was unable to think of a single commercial fishery that was able to sustain itself or police itself.

Sylvia, I wonder if you would consider the lobstering business up and down the East Coast of the United States up to the Canadian Maritime Provinces as a small and localized, but successful example of how, bottoms-up, individuals who are part of the industry are able to police themselves. Lobsters that don't meet a certain minimum size go back into the deep live; lobsters that are egg-carrying go back into the deep live. In a bigger sense, we might well positively and usefully, in a utilitarian way, identify a few localized, bottom-up programs, not only in the fisheries but in many of the areas that we talk about at this meeting, that are clear success stories, stories that could be expanded to larger domains other than the localized lobster industry, but industries that it could be applied to: haddock, cod, grouper, or whatever.

You don't have a complete system anymore; you've got a modified one from which you are continuing to extract a few things that humans happen to like to consume.

EARLE: Very specifically about the New England lobster industry, and to some extent in Australia, with both lobsters and abalone, both have some signs of success in achieving that mystical, magical, sustainable goal. In New England, it's very hard to be able to say with absolute certainty, but there appears a strong correlation between the decline of cod and the ability to have more lobsters than would normally be the case if there were plenty of cod there munching on the lobsters along with *us*. The prime predator on the young lobsters has been systematically removed, along with other predators as well, so that there is a better chance for the lobsters that are spawned to reach adulthood. And we're taking them when they're younger. We rarely do extract the big, old, most-productive ones, contrary to what we do with fish. It's always desirable to get the *big* fish that absolutely are the wrong ones to take if you want to have large numbers of young. That's just one of those contrary policies that we need to get smarter about in due course, or at least adopt what we already know.

In Australia, they have strict limits on how many people can enter the fishery. It's a curious use of words: Lobsters aren't fish, of course, but never mind. The same is true with abalone. You get a license and you have a certain strict number. Even so, you're working with a natural system with its unknowns and ups and downs, good years and not-so-good years.

One modest success story came about on the East

Coast of the United States when it appeared that striped bass, a very popular food fish, were going to disappear. That was in the 1980s. Something drastic had to be done, and something drastic *was* done: For five years *no* take was allowed, either for commercial or sport fishing. Just whole stop. Of course, when you put a hook and line over the side, you don't have a sign on there saying, "Striped bass, you're not allowed to take bait." That's one of the problems with trying to impose our rules on a natural system. So, no doubt some were killed anyway. But generally speaking, there was certainly a slowing down of the number that had previously been extracted. And lo and behold, through a combination of reasons — a good year and also lower predator pressure because we were continuing to take other fish that would normally eat the young striped bass (these are very complicated issues), and the temperature was right, the chemistry of the water was right — after five years the populations had recovered to the point where a limited take, never as large as what had been the case prior to this great moment when drastic measures were taken, but now there is some modest level of take allowed. But it's very strictly monitored. You can't just take as many as you would like at any time.

So, there's some thread of hope about sustainability but, again, consider the cost. There are other species that are being sacrificed – or, at least, because of their sacrifice, the striped bass are prospering. You don't have a complete system anymore; you've got a modified one from which you are continuing to extract a few things that humans happen to like to consume. It's not the same place as it was when your grandfather was around.

I don't think we understand how people value and how people maintain value in relation to current modes of exchange.

ISHWARAN: Regarding a comparison of values of art and wildlife, I read a book some time back that was titled *Pricing the Priceless* [by William D. Grampp, subtitle: *Art, Artists and Economics*, 1989]. The author talks about the art market. The valuation of art in economies with well-developed markets is, at least in part, related to the fact that it can be priced. There is not only aesthetic or other value; there is a way to convert and exchange that aesthetic value in what is currently accepted as currency for exchange, which is money. In fact, there were two New York-based Russian artists who went to Thailand and put canvases in front of elephants and made them draw all kinds of things, then they came and sold the canvases in New York and made more than $400,000. I don't know how that relates back to conservation, but it happened.

To use the example of art in terms of wildlife nature, there has to be a connection to the mainstream currency of exchange, one way or the other. Otherwise it may not happen. I think there is a possibility to use that comparison and do things in the developing world where currencies still haven't become strong in terms of being the only modality for exchange. If you go to a place like Indonesia, for example, there is a big monument in the capital, Jakarta, that is a bit like the Washington monument, and there is almost 600 kilograms of gold right on top of it. Nobody touches it; nobody even thinks of stealing it, but if you put it on your doorstep somebody will take it.

There are ways of maintaining value. It requires some study, perhaps. I don't think we understand how people value and how people maintain value in relation to current modes of exchange. It is not good enough to have values amongst ourselves, but values of exchange. In the famous *Das Kapital* by Marx, it is "exchange value"; it's not only "use value."

The second point is about coming down to the rational. The Man and the Biosphere Programme arose out of a conference in 1968 entitled "The Rational Use and Conservation of the Natural Resources." Today in global debates, we hardly bring up the term "rational use." It's all about sustainability, sustainable use of this and that. Now, the word "sustainable" includes rational but it also perhaps includes nonrational things. But some of the examples Shekhar brought up, and I know the milk example because it was Ganesha, the elephant-headed god that was in the middle of that episode, because there were Ganesha images drinking milk, not only in India, but in New York, in Washington, all over the place. It was "a miracle." A lot of people criticized it and dismissed it as irrational. But why not use irrational things?

I said to one of my friends, "Well, this is a time to run a campaign and make some money for elephant conservation." He thought I was cruel. But, in terms

of doing things for something you believe in, maybe sometimes you don't have to wait until you *understand* everything; you just use opportunities to move the system towards what you think is the preferred direction. And that might have to be a combination of rational, nonrational, and irrational elements.

That has a relationship to what I think is the basis of how we approach a thousand-year imagination. Now, if you had asked that question to somebody, say, 500 years after Christ in India or Sri Lanka, it would be a bit difficult because there were no written records of what happened in the past. But today we know what happened in AD 1000. There are records. In fact, if you go back to AD 1000 and compare what you are now, there are major differences. For example, AD 1000 was the Ottoman Empire. America was a nonentity; it was not even imagined yet. So, there are major differences. It is an interesting question to ask whether the difference between AD 3000 and AD 2000, in terms of what we know or what we *will* know, will it be as different as between AD 2000 and AD 1000? Maybe it will and maybe not. I don't know the answer.

On Dan Botkin's notion about ideas being important to history, ideas will be important only if somebody sticks to and follows it up. It has to have a convincing motor or driver in terms of people. Even economically important things need people. Somebody has to drive it. Economies work because the business community drives it.

It might be important to think about how one would keep something going beyond his own lifetime. In my case, how do I keep elephants going for a thousand years, even if I'm not here?

It might be important to think about how one would keep something going beyond his own lifetime. In my case, how do I keep elephants going for a thousand years, even if I'm not here? How do you do that? For that, you would have to be prepared for all kinds of ups and downs. There might be a situation where there is no natural habitat for elephants, where we maintain them in artificial habitats. But it's doable. There might be another scenario where there might be natural habitats coming back.

So, a thousand-year scenario might have to include thinking that has both rational and irrational elements, but it also can't be just linear or sequential; you can't just project from now to something that would be an enlargement of what is today. Maybe there will be cycles. If you take Sri Lanka's environmental history, today Colombo is the capital, but in the 12th and 13th centuries the southwestern part of Sri Lanka (where Colombo is) was all jungle. The civilization was in the dry zone. So, those kinds of shifts *will* happen. In fact, there is a Google-based website for population-related parameters and how populations will shift in the foreseeable future. As David said in the morning, this is the first year where more than 50 percent of humanity is living in urban areas. Now, that kind of trend will release land or release areas that might be now rural, marginal, etc. It could. If you look at that population website, it shows how some areas will get depopulated, including in places like Indonesia. It may be true, and may not be true, but I think that a thousand-year perspective would require some kind of a flexible imagination that would allow at least 20 different scenarios, and then you think how your particular cause could be pushed through that kind of range of scenarios. I don't know whether that kind of thinking is doable at this time.

Shell does scenario modeling for its energy futures. There might be others who are doing it, but how many of them do it for this thousand-year imagination, and how many of them actually do it for environmental biodiversity? I don't think it is doable for biodiversity; it might be doable for a certain collection of species. There we use the word "alignment" – certain sets of things that would move together.

MACDONALD: If I've understood Sesh, this workshop is about radical ideas and thinking out of the box.

FACILITATOR: Yes, that's correct.

The question might have been asked in one of two ways … How do we imagine the world will be … How would we like the world to be a thousand years from now?

MACDONALD: I think that's why we were set the thousand-year challenge: to try to provoke us out of the commonplace discussions of this sort of issue. I have a sense that we might be slightly like cats around hot porridge–a little bit frightened to stick our paws into

this thousand-year challenge. So, let me be reckless and perhaps even stupid and try.

The question might have been asked in one of two ways. It might have been: How do we imagine the world will be in a thousand years from now? Or it might have been: How would we *like* the world to be a thousand years from now? Either way I suppose we have to think about how to reach that, to either avoid horror or get to nirvana. I think about: How would I like the world to be a thousand years from now? Now, I like people. I would like there to be some of those, so one of the goals would be a mechanism to give people a fair chance to being there a thousand years from now.

I like the wilderness and wildlife. I would like there to be a lot of that because the people that I hope are going to be there are going to need it, or else they won't be there, either. And I want the people who are going to be there to enjoy it. And because I like people *and* wilderness, I would like these people to have a pretty good quality of life. I don't want them to be there a thousand years from now starving or in dreadful circumstances. So, my vision would be one in which there are radically fewer people than there are now, using technology cleverly to have a more or less uniformly high quality of life in harmony with a substantial – and that would mean substantially restored – wilderness. There's a thousand-year thought for you.

… this decade, this little ten-year chunk that we face, may be the most critical in the next thousand years because we have options open to us today …

EARLE: Looking back a thousand years where we were, and where we've come, and where we might be going, there is a perception that I share with many others that this decade, this little ten-year chunk that we face, may be the most critical in the next thousand years because we have options open to us today that won't be there in ten years if we continue business as usual.

Because of the species that you mentioned and all of us have considered and encountered that will be gone unless we change our ways, some really radical thinking is very much required. Our species may be among them – not in ten years, but maybe before a thousand years, unless we change our ways. So, I share your vision for the quality of life, not just quantity of life, recognizing that quantity does not equal prosperity, and that there are so many on the planet already of our species who are not enjoying real prosperity. We know enough to recognize the nature of the problems, or at least some of us have that perspective. The question of how we make that happen is, I think, part of our challenge here.

I love the concept about looking at a single species that's not human, like an elephant, and imagining how you can arrange to have the planet so that there will be elephants a thousand years from now. But that raised the question: Is having *an* elephant or two elephants or ten elephants really maintaining elephants? Do you need a society of elephants in their own surroundings where elephants can be what elephants are?

My mother, who was known as the "bird lady" of the neighborhood because she restored to health damaged animals and baby critters that were strays and then returned them, usually with a fair degree of success, to the wild. But I'm also mindful of attempts (hers included) where it was difficult, because the birds didn't know how to be robins or whatever bird they were. People have tried to restore parrots to the wild, but hand-raised parrots didn't know how to be parrots. They looked like parrots; they had the right genetic composition; but they weren't real parrots. When they were put back into a natural situation, they behaved in a way that made them vulnerable. Even queen cocks in the Florida Keys that have been raised in a cage and then put back in the wild didn't know how to behave like cocks because they had been raised in a cage. They died; they were eaten; they were vulnerable. So, the question of how to preserve elephants and what constitutes saving them is one of the questions to put out there.

The third thing is for Dan Botkin and your many reasons for why it matters to save diversity. You came up with a wonderful list, and there are probably more reasons. But unless we succeed in the basic one of maintaining the integrity of the planet that makes life for us possible, the other options are closed. I think that's one thing that is high on the priority list right now. With the whole business of climate change, we're looking at a warming trend, which brings with it sea level rise, which is high on the list of reasons why we should be concerned about melting ice. But along with

that comes increased carbon dioxide in the ocean, and with that, increased carbonic acid (acidification), and with that, decreased capacity of the ocean to absorb carbon or sequester carbon, and along with that, the ability of the photosynthetic plankton – which has calcium carbonate as part of its basic structure – to generate oxygen.

Going back through the history, we know that Earth's oxygen has been significantly lower than it is today and CO_2 significantly higher. Can we in the next thousand years so modify the nature of our life support system that we make the possibility of life for us at least seriously compromised with reduction in oxygen at a level that might make it inhospitable for us? One of the problems in the Biosphere 2 experiment was that oxygen suddenly became a real problem. When it got below 20 percent, 18 percent, 17 percent, 16 percent, 15 percent, they had to get out of there. And we don't have any other place to go to.

So, all of the matters that we are describing for why we need to protect the natural systems that support us have real merit. Whether it's religion that inspires people to take care of it or a sense of art, poetry, or whatever, I'm for all of them. But fundamentally, if we don't succeed in maintaining the characteristics that we have taken for granted for 10,000 years, 20,000 years and that have been relatively stable and favorable for the likes of us, they are right on the line at this point – if you are to believe the trends that seem to be very compelling about the underpinnings of what makes it possible for us to enjoy not just prosperity but survival in a thousand years.

It's interesting to look at the history of how people respond to crises. Generally human nature is that people muddle through; they don't actually think ahead well.

BOTKIN: In preparing for this meeting I did think about how you would go about making a thousand-year forecast. The primary questions are how to make such a forecast, and then how to validate the forecast.

There are methods well known to economists, mathematical economists and applied mathematicians about how to validate models that have time frames that you can't deal with. There are spatial analogies and other analogies. This tends to scare ecologists and conservationists, but actually you can make forecasts, and there are indirect ways of validating them.

The next point is that there are some variables for which a thousand years is a reasonable time frame. For example, to make forecasts we do have a good estimate of the total mineral resources of fossil fuels, and we do know that when those are all burned up there will be a pulse in the atmosphere that will gradually be removed by photosynthesis, and we can make those calculations about how long that pulse will last. I've done this kind of modeling. So, we can do those forecasts.

Then, we already know that the climate dynamics models can be run for a long time. Again, you have to turn to the methods available to validate them.

The work I've done in forests, we have run thousands of years' simulations starting back in the Holocene and moving forward. I and other people using the same model have done this. So, we know how to do this for forest dynamics. There are other phenomena, such as the population dynamics of short-lived mammals, that would be hard because they're in the intermediate timescale, so they will be less tractable.

What I'm suggesting is that we actually *can* think of how to approach thousand-year forecasts, if that's what we want, under specific scenarios. We can do this in geographic as well as temporal ways. These will always end up requiring that people make certain kinds of actions, which we will expect. And people are always asking me: Can you expect people to succeed? It's interesting to look at the history of how people respond to crises. Generally human nature is that people muddle through; they don't actually think ahead well.

One of my favorite books is called *English Wayfaring Life in the Middle Ages* [by J.J. Jusserand, 1989]. It's a very little-known book about *who* wayfared and also about how it was done: You got to a river and you hired a farmer to row you across, and he made more money from that than he made from farming, so then he built a bridge. And then his sons inherited the bridge and then his grandsons. Slowly the bridge would start to fall down. Some people would complain, but everybody else would say, "It's been there for a hundred years. We don't have to do anything about it; it's going to be there forever." And then it

would fall down, and there would be a big hue and cry, and then they would build a bridge.

There was a newspaper article in the United States about six, seven years ago that said 50 percent of the bridges were in danger of falling down. So, human nature is that we're not very good at solving future problems; we tend to muddle through. You have to take that into account. But for certain aspects of the environment we could do a pretty competent job of forecasting if we really set our minds to it.

Where is the disconnect insofar as on the one hand claiming that we have made all this progress … yet at the same time expressing all of these concerns…?

FACILITATOR: I have a very good friend who does a lot of work in futures methods, and it might be somewhat relevant to talk a little bit about this. The article that he has written about the methodology is a classic in the field and is readily available. I might refer to you that. It's called "Causal Layered Analysis" [subtitle: "Poststructuralism as Method"] by Sohail Inayatullah, who is a Pakistani futurist and a very bright young fellow. Basically the premise is that if you peel layers of causation, at some point you get to the bottom of what it is that actually motivated a group of people or a civilization or a complexity in terms of the actions or the activities that they undertook to result in where we are today. In that sense, looking back a thousand years or looking ahead a thousand years is not that difficult a proposition, because his premise is that if you keep scratching through the layers, ultimately you end up with a set of foundational values that have driven a group of people or a civilization. What those values essentially reflect, to go along with what Dan Botkin was mentioning earlier, is an articulation of the relationships between the entities, such as: humans with humans, humans with nature, and humans with something beyond the realm of the rational, which may be religion or some other ideas that border on spirituality.

So, if you were to isolate what these ideas might have been a thousand years ago or two thousand years ago…. In fact there's one other classic in which the author traces the fact that religion and technology have gone hand-in-hand over the last thousand years. He's a Canadian who has documented the fact that the Church was a stimulant for technology and technology was a stimulant for the Church over the Judeo-Christian era over the last two thousand years.

The point I'm trying to make is that a thousand years ago there were elephants in larger numbers than there are now. And practically in every other sense the same can be said of all the things that we are now talking of being concerned about. But during the same period we also claim to have been civilized, to have progressed beyond dreams, and to have acquired and applied knowledge. Where is the disconnect insofar as on the one hand claiming that we have made all this progress and we are the pinnacle of civilization when it comes to being humans on the planet, and yet at the same time expressing all of these concerns, whether it's the environment or climate change or depletion of resources or ocean? Where is the disconnect? It seems to me that the original assumptions about what motivated us to think in terms of progress and advancement, and at the same time create the destruction that has been caused – that is where you have to examine and to understand and say, "That's where we have to start again; those foundational ideas were perhaps wrong, and maybe they need to be redefined along terms and conditions that make more sense in the light of our experience of having implemented those ideas over the last thousand years."

HADLEY: Implicit both in Ricardo's and Sylvia's presentations was the role of technology. Ricardo mentioned at length van Leeuwenhoek, where it was his discovery of the microscope that opened a completely new world for us. In the context of the oceans, the role of technology has been paramount in such happenings as the crash of the Newfoundland cod industry, where it was the investment in state-of-the-art fishing boats and sophisticated high technology that was the cause of the crash, in that it enabled the fishing fleets to take off practically all of the stock.

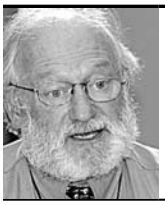
FACILITATOR: But we define it as progress as well.

HADLEY: Coming back to David's reference to "using technology cleverly," I wonder whether there are things that we might wish to think about where in the future we can use technology in a more beneficial way and in a less destructive way.

EARLE: Intelligently.

HADLEY: Yes, intelligently. And if I could take up another point, on the whole question of the oceans and marine systems and what we do with them – I don't think we've mentioned so far "The Tragedy of the Commons."

FACILITATOR: Yes. Brilliant article by Garrett Hardin.



What would we think in terms of the "management" of the ocean commons … Would it be better if we extended the exclusive economic zones…?

HADLEY: What do we think of that, of the oceans largely being the "Wild West" of 150 years ago, where it was for anyone to go and do whatever they wanted? And this continues. When one reads the stories or hears the presentations on what's happening to the sea mounts, of the technology that swipes off the whole top of the sea mounts and the biota there – that is largely endemic to that sea mount – essentially disappearing. What would we think in terms of the "management" of the ocean commons? What are the options for the future? What are the possibilities? Would it be better if we extended the Exclusive Economic Zones, so that more of the marine environment at least comes under the control of a particular country, a national jurisdiction? Or is it better to go the other way and try to work on the Law of the Sea and look at ways where collectively we can perhaps manage the shared heritage of the oceans in a less destructive way?

FACILITATOR: One modification that some businesses have started making – the enlightened ones – is that they are beginning to talk about not just the bottom line in terms of profits, but also the other two P's, which have to do with people and principles. It is the alignment that David was referring to.

… right now the greatest threat to the high seas and the deep seas is unregulated and illegal (to the extent that there is any regulation) fishing, especially the bottom trawling.

EARLE: On this issue of the global commons, 64 percent of the ocean beyond the EEZ, which is half of the planet and more than half of the diversity of life on Earth, when you think about the way we currently regard it, is valued as a commodity. Fish are regarded as pounds of meat, not as elements of life support, nor is virtually everything else, except the potential for deep-sea mining and maybe even oil and gas extraction some time off into the future. But for right now the greatest threat to the high seas and the deep seas is unregulated and illegal (to the extent that there is any regulation) fishing, especially the bottom trawling.

There is a movement afoot right now to get a motion in the United Nations to have a moratorium. This is not a complete ban the way the high seas driftnets were brought into alignment back in 1992, but why not urge the United Nations to bring about a moratorium until we know more, when you consider how little we really understand of the high seas and the deep seas? We know enough to know that that is the prime engine for generating oxygen. It's the plankton in the sea and the other plants in the ocean as well that generate on the order of 70 percent, as far as we can calculate, of the oxygen. It's the great sink for carbon.

There are concerns about dragging trawls across the crust out, even away from sea mounts, on this open ocean that sequesters *huge* amounts of carbon. If you destroy that crust, like the crust on a desert – on the desert, it's the wind; in the ocean, it's the currents – that hold the bottom in check and maintain a certain kind of stability, now really being torn to shreds by these deep-sea trawls. Parts of the ocean in the Exclusive Economic Zones, such as in the North Sea and the Gulf of Mexico, off East Africa, and so on, are being torn to shreds by these bottom trawls.

There are other forms of fishing that are destructive, like longlines 60 or 70 miles long with baited hooks very few feet, catching indiscriminately whatever comes along. But as bad as that is, much worse are these trawls that destroy the entire habitat, not just take the wildlife out of the system. There needs to be an understanding that there's something of greater value – or at least it ought to be on the balance sheet along with the known value of pounds of meat that come at a terrible cost. And you cannot say that this is vital for "feeding starving millions," because it largely goes to feeding the luxury market for high-end, high-priced fish. It doesn't make its way to feeding families in communities; it makes its way to driving a handful of industries in a handful of countries. Eleven countries now engage in the high seas and a fraction,

maybe 2.5 percent, of the world fisheries are currently taking from the high seas.

So, this is the time. If we don't pay attention and realize these values and do something before the vested interests get locked in, we may lose the chance. We're losing diversity of the species every day. We worry about elephants, and I do – and snow leopards, and I do – but what about those species we haven't even got names for yet? We're talking thousands of species that are just being destroyed in these sea mounts and even in the open sea along the bottom that looks like there's nothing there until you get down and really look. In a square meter you might have, again, a dozen phyla represented. This diversity doesn't equate to what we think of as diversity because it's not terrestrial; it's not birds and flowers and insects; it's all those other little critters that are in strange phyla that we know so little about. We should love them, too, for their own sake.

MACDONALD: Exactly.

… what we think is good for other people is not what they think is good for themselves, in the sense of their quality of life.

MOW: There are two aspects I would like to touch on. The first one is adding on to what Sylvia said. I come from an island, and we hardly have fish locally because everything is exported. It's really not feeding people that are undernourished and are sometimes starving, because it's taken away: lobster and grouper and conch.

I also want to say that we tend to believe every creature on this Earth or every human being thinks alike. One of the aspects I have been aware of in the last years is that what we think is good for other people is not what they think is good for themselves, in the sense of their quality of life. This idea of getting everybody thinking alike about what is good … the high standard, this high-tech life, is not what is a good quality of life for people in many places. I think that we have to distinguish between people's survival and what is for other cultures and other people a high standard of life. When we talk about externalities, we tend to say that poverty goes hand-in-hand with environmental destruction, but it is not only poverty; it is also economic growth. So, we need to think about opulence as one side, and we need to think about people that are really happy with the quality of life they have, and they don't need to have what you have in these societies. We need to respect that; we need to acknowledge the existence of this and not try to put everybody on the same level. It's different.

And the third is the protection of nature. I think there are three different aspects we need to take into consideration when thinking about the future.

FACILITATOR: June, I have often thought about this. If you have two groups of people in isolation, you can carry out the norm you suggest. But if you expose one group to what the other group is doing, it is like what has happened in the cities in India. For example, ice cream has been made in India for decades, but now, on every street corner in India is a Baskin Robbins. Guess where the longest lines are to buy ice cream. It doesn't matter what city, the people are prepared to pay exorbitant prices. Another example is hanging a set of earphones on the ears. The attractiveness of some of these "undesirable" things that do not necessarily reflect quality of life *are* attractive to people who have had nothing. In fact, some of these people will forego meals to buy a pair of jeans to wear a particular brand. So, isolating them from all these interactions is the only way, but that is undemocratic; that is unfree.

MOW: Some people are attracted to it, but I have visited communities in the last years that really don't care, even though they have had access. They value the way they are living more than to aspire to these things.

FACILITATOR: Thank you. We'll take a break at this point.

Critical Issue Conversations
Guidelines

FACILITATOR: Sesh Velamoor

PARTICIPANTS: Plenary

What we hope to do this morning is … to see if we can agree as a group on what might be three of the most critical issues pertaining to humanity and the biosphere going forward.

SESH VELAMOOR (FACILITATOR): Let me take a moment now to recap a little bit of what we did yesterday and to give you an idea of what we want to accomplish today. Yesterday was a set of presentations and conversations that followed essentially to see if the elements of the total subject can be identified and placed on record. I might at this point present a quick summary, from the deliberations so far.

There was reference to the three *E*s that Eric Chaisson cited: evolution, energy, and ethics. Malcolm Hadley then added two more, equity and education, as elements that should be taken into account.

Sylvia Earle made a wonderful case for an aspect of the biosphere that has been long neglected and perhaps is of greater and more critical importance than we might understand or recognize at this point, namely the oceans, and how much of what happens on the planet depends upon the ocean and how little we know about it even as of today.

Lynn Margulis made a very interesting presentation that our efforts at understanding things starts with taxonomy. She pointed out the gross and grave errors that we have made in how we have classified and divided up areas of knowledge so that we may go forward to understand, even as she pointed out the one common element in all of this, which is life. It may be convenient for us to divide life up into a hierarchy, which in itself is a rather presumptuous, arrogant, and erroneous set of categories, particularly considering that we have placed ourselves at the top.

We heard from Shekhar Singh, who talked about the right to information, at the same time presenting a graphic picture of the tensions that prevail when it comes to the needs for survival. More than a third of the population of the planet, two billion plus – even as we talk about conservation and preservation and the biosphere – have a conflict that is not easy to resolve, which might be phrased: "Preserve the environment, even as I'm starving."

Albert de Haan spoke of how issues pertaining to the biosphere could be brought into the realm of problem-solving by way of, for example, carbon trading, which seems to be gathering momentum, and whether or not this could be extended to other aspects of the biosphere. If we make it an economic activity or monetize that aspect to where the market and supply and demand can come into play, it might serve as an incentive for people to take into account elements of the biosphere that we might be concerned about.

Magnus Ngoile made a case for perhaps returning to some of the original intentions and statements of the sacred, if I may put it in a very generic sense, and that perhaps the content of those texts might serve as guidance for us to go forward.

David Macdonald made the case for aligning all of the parallel elements that go into the consideration of the biosphere, and Dan Botkin referenced coming up with coherent narratives that might serve as guideposts for us to proceed in terms of the issues that we are trying to resolve. David also talked about what might constitute value besides the monetary or industrial aspects or the aspects of market mechanisms of supply and demand. There are aesthetics. There are other considerations that should be taken into account. Dan also brought up the issue that we did not successfully define what the term *biosphere* actually means.

In one sense, if you step back and look at it, the consideration of the biosphere was fleshed out in terms of multiple elements and this makes a composite of what might constitute the biosphere and the issues and the considerations we would have to take into account.

What we hope to do this morning is – taking all of the presentations into account and the ideas that have been exchanged and the conversations that ensued – to see if we can agree as a group on what might be three of the most critical issues pertaining to humanity and the biosphere going forward. As we have said, already the presentations have put forward multiple propositions that are important elements for the consideration of the biosphere. There is education, ethics, planetary citizenship, the need for a narrative, the need for the oceans to be taken into account. Is it possible that we can say: Here are the three things that have the greatest returns insofar as making a dent in addressing the issue of humanity and the biosphere?

… what do the best minds on the planet think about where we might be going over the next thousand years, based on where we are and what the trends are?

CITRON: I want to add that the discussions yesterday were terrific. It is important for you to understand that the Foundation For the Future is interested in three things: How did humanity get to where we are as a species on Planet Earth? What are the trends for the future? And what do the best minds on the planet think about where we might be going over the next thousand years, based on where we are and what the trends are? Other people will take action based on the fact that we record and publish everything. They may take any action that they wish, but we are not involved in taking action. That's an important point to make when you put your minds to work thinking about the long-term future of humanity and the long-term future of our planet.

Critical Issue Conversations

Determining the Most Critical Issue

We'll take each of your statements, and then see if any consensus emerges.

SESH VELAMOOR (FACILITATOR): I would ask each participant now to take a crack at saying, "I have listened to and considered everything that has been presented, and in my view these are the three most important things pertaining to the issue of humanity and the biosphere in the long term." We'll take each of your statements, and then see if any consensus emerges. If a consensus does not emerge, we will have some conversation to determine where we *can* agree, because those three will become the basis for further conversations during the day.

Who would like to go first? Give us the three that you think are the most important and then the reason or rationale or analysis that you are putting forward to make that statement. Shekhar?

… there are three principles of ethics or justice or equity that we would like to keep in mind as the most critical … first is … equity in the human species within a specific generation.

SINGH: On reflection of our discussions yesterday, I was reminded of a very well-known statement of Plato in "The Republic" where he talks about a just state being one where every element of that state performs its own function and does not interfere with the functions of the others. One would imagine that what he said of a just state 2,500 years ago is relevant today. And what he said of a just state is also appropriate for a just world or a just Earth.

But having said that, the details of what Plato meant get captured by our more modern concept of harmony and that all elements of any whole are in harmony with each other. Therefore, it seems very simple to say that the critical point is that we've got to achieve harmony. But the problem comes: What does *harmony* mean? For example, in different phases of civilization *harmony* has meant different things. There's been a stage where if you were in harmony with the blacks and the browns and the whites, that was a harmonious state of affairs. God forbid there might be a state where there would be harmony in which the whites serve the blacks and the browns. I hope it doesn't happen, but it could happen. So, what is it that we mean by *harmony*?

I would like to suggest that perhaps there are three principles of ethics or justice or equity that we would like to keep in mind as the most critical. They are well known and well recognized; I am only repeating them. The first is, of course, that there has to be equity in the human species within a specific generation. That means in our particular generation there is what we would call an "intragenerational equity," where all elements of the human species are in equity with each other. They're not being looked down upon or looked up on; they're treated as equals.

The second element is to have an intergenerational equity, which is fundamental to sustainability, so that any generation of humans being does not create, through their actions or inactions, situations that deprive future generations of having an equitable situation.

The third, which is more difficult to establish and perhaps would be more debated, is to have an interspecies equity, where all species on Earth are treated equitably. One species is not treated as food while the other is treated as the people who enjoy eating the food, or one species is not treated as a necessary ele-

ment of biodiversity that is important to sustain the well-being of another species, but they're all treated as necessary.

So, I would suggest that if we could move towards an evolved and comprehensive understanding of these three notions of equity, that is what would be critical for the future of human beings and the biosphere.

FACILITATOR: Thank you. David?

… for a future to be exciting I think it has to involve fewer people with a higher quality and a more equitable quality of life alongside wilderness.

MACDONALD: Those are terrific answers.

You asked us a somewhat similar question about three priority areas, of course, before we arrived at this seminar. When you asked that question originally, my feeling was that one issue above all underpinned everything, and that was the consequences of a very large, I would say too large, human population that is also extremely consumptive and increasingly consumptive, although inequitably so.

In my original three answers I saw from a biologist's perspective (because I am a biologist) three areas on which we need to focus and on which we already have some ideas. One was how to deal with the deterioration, the destruction, and the fragmentation of habitat, and the consequences of that. Another was how to deal with the shipping of creatures around the world to places where they cause problems – "invasive species," as they're often termed. A particular category of those is especially important, and that's diseases, including emergent diseases, which strike me as a growing affliction that's likely to damage humanity enormously. And a third of these almost mechanical issues, from a biologist's perspective, was climate change.

After hearing Shekhar and the other conversations here, I wonder if, superimposed on those rather mechanical thoughts that I arrived with, I could overlay three more generic ones, more in tune with what Shekhar was saying.

How are we going to come up with systems of economics that enable people to change their population size? And how are we going to come up with systems of governance and politics that make it feasible to make those changes?

I still harken back to the thought I put forth yesterday that for a future to be exciting I think it has to involve fewer people with a higher quality and a more equitable quality of life alongside wilderness. It seems to me that there are three ways of looking at that, too, all of which could come, again, under a general heading that I would call "managed retreat" or at least "managed change" from our current condition of overpopulation, inequity, and poverty. My questions, in that more generic sense, outside my own expertise, would be: How are we going to manage population control? How are we going to come up with systems of economics that enable people to change their population size? And how are we going to come up with systems of governance and politics that make it feasible to make those changes?

So, my first three issues were practical things almost for the present that at least biologists are already thinking about. The second three are outside my own expertise and more political, but are going to be the mechanisms for achieving the first three.

FACILITATOR: Just to clarify, David. I think you're articulating sustainability in the sense of optimizing the mix of humans and the biosphere?

MACDONALD: Yes. It's an assumption for my vision of the future that it has to be sustainable. Actually, my vision of the present is that it has to *get* sustainable – and fast.

FACILITATOR: That's a good way to put it: managed change/retreat. Malcolm?

… I would start with equity … The second one would be ethics … And the third one is education …

HADLEY: I'm going back to the three *E*s, though I think we mentioned about six *E*s yesterday. If I had to name three, I would start with equity, the different aspects

of equity that Shekhar has said, but also including the equity between genders and the whole question of the role of women in this world and how things would have been different in this world if the two genders had been inversed, if women had charted the history of our biosphere compared with what men have done in charting the history of the key decisions.

The second one would be ethics, which I won't elaborate on at this stage, but it would include the whole question of the importance of spirituality and religion in shaping the way that the biosphere will be in a thousand years' time.

And the third one is education, more particularly, the question of how education has changed over the last few hundred years, how we've changed from being the Renaissance person to one of increasing fragmentation in the specialties that we learn as we go through the education system. Can I quote from an article by Lynn Margulis and one of her sons, Dorion Sagan, written a few years ago for a UNESCO magazine, *Nature & Resources*? They titled this article "Academic Apartheid and the Universal University." The strapline of the article was: "Since the period of the Renaissance, the once-universalizing concept of the university has become increasingly splintered, fractured, and fragmented. After centuries of specialization, it is time to make a more concerted effort at intellectual reunification, connection, and reintegration."

One other quote from the same article is: "Nature, after all, is not divided into atmospheric chemistry, agriculture, botany, cell biology, ecology, geology, microbiology, physics, and zoology – our ways of looking at it are." This comes back to the anecdote that Albert mentioned yesterday of the three people in the tire factory, and that they did not know each other. The crucial thing was joining them up, getting them to talk to each other. Also, Shekhar mentioned yesterday that cricket is one of the three categorizing elements of his country. Cricket is a funny sport in that two teams can play each other for five days and not have a winner at the end of it. It's also a sport that has spawned a very rich literature and a very rich lexicon, including the phrase "it's not cricket" to mean "it's not fair." It also has spawned a phrase by a Trinidadian author – perhaps one of the most renowned writers on the sport of cricket, a chap called C.L.R James – who used the phrase, "What do they know of cricket who only cricket know?" The idea being….

FACILITATOR: … that there is more to it than the game itself.

HADLEY: We've done superbly well as a species in our reductionist approach to some problems. Look at the progress we have made in medicine, for example, or in technology. But in other fields it's not this narrowing of expertise that is required; it's more the broadening and linking up, of joining up with people trained in different disciplines. So, that comes back to the *E* of education.

FACILITATOR: Okay. Magnus?

I've tried to consider three driving forces. One is actually trade … The second is conflict … the third is disease.

NGOILE: We all know about ecology and how we've studied the dynamics of natural populations and how cyclic they are and how we can predict it. I think the influence of humans on those dynamics is what is important. If we are to think about a thousand years and think about a better future, then what we have to do is to consider the behavioral patterns of humans and we have to look into the driving forces into those behavioral patterns. It's fair to be able to say that the behavioral patterns of human beings, for the time being, are not leading us to a better future. So, what are those driving forces?

I've tried to consider three driving forces. One is actually trade. When you look into business and trading, that's where the greediness comes. If there was any equity into trading, then we probably wouldn't be rationalizing issues or things. The second is conflict. Conflict is bringing in some very irrational patterns of behavior of humans beings. And then the third is disease. Yesterday there was also reference made to disease, like HIV/AIDS, which is bringing in quite a different – I don't know whether that's called a fear or whatever – a different consideration of us human beings trying to see and make sure that we combat these diseases.

Now, I mentioned about these driving forces because if we are going to think about the future in a thousand years, if we are to change, then we must look into the driving forces of the behavioral patterns

of human beings, because that is what we can influence in a right way.

… develop methods to increase our long-term carrying capacity … reduce antagonism among our own species … maintain cultural diversity.

MOW: One of the critical issues I can think of is if we are able to develop methods to increase our long-term carrying capacity, because as humans we can do this, instead of just, on a temporary basis, making supplements for carrying capacities. What we're doing now is taking away from the future. If we could develop methods to increase the long-term carrying capacities, then I think we can reduce what we're taking away from the future.

Second, we are creating antagonism even among our own species. Every second we have approximately eight children dying because they're consuming polluted water. So, we also need to reduce antagonism among our own species, which could be in an ecological context, just like yesterday we heard about the bacteria and we know about the penicillin mold. Our species is also producing by-products that are causing the destruction of other persons of our own species.

A third aspect that is critical is to maintain cultural diversity. I think this will be very important. It also has to do with the antagonism, but it's more the emotional part, I think, that causes a conflict. It's respecting the opinions of others and the way of life or the way others make use of the environment. I think that to maintain cultural diversity is critical for the next thousand years.

BOTKIN: In order to explain what I think is important, I need to say that what I've been hearing is a mixture of concerns about the environment and civilization and society at every level, which I think goes back to the point that if this is actually a discussion of humanity and the biosphere, we haven't really focused on what *biosphere* means. *Biosphere* is a term that's been used throughout the 20th century and has meant three things. It has meant the totality of life. That was the original meaning. Then it has meant the place where life exists, the global habitat. That's a minor meaning. And the most important meaning is the planetary system that includes and sustains life.

The questions at the biospheric systems level are different from a lot of the questions we've been hearing. I think the first thing to decide is whether the organizers of this meeting want us to talk about *anything* to do with *anything* in the future, from social concerns and human equity at a local level, or do we actually want to focus on these biospheric problems? Until I know which way we want to go, I can't give you three things. So, I want to hear from the organizers about what you want. I've done research for 30 years and more on the biosphere.

FACILITATOR: The point of view of the organizers is that we have no opinion; you have to tell us what you think should be considered.

BOTKIN: You can remove the word *biosphere* and just say "humanity in the future."

FACILITATOR: No.

BOTKIN: Talking about the biosphere, then, you have a choice of using the term as it is defined and used in language and in science, or not. What I'm hearing is an amalgamation of all sorts of problems at every possible level.

FACILITATOR: I am presuming to speak for the other participants – we have an opportunity to have them clarify what they mean – I think they are implicitly assuming a meaning for what *biosphere* means. Taking into account "humanity and the biosphere," they are identifying the issues that they see as being critical. It's not that they have skipped out of bounds relative to the biosphere in terms of identifying these issues. If I understand them correctly, they *are* thinking about the biosphere but identifying issues that are critical relative to the future of humanity and the biosphere. If you want to focus on identifying the specifics of what you mean by the *biosphere* and the issues thereof, I welcome you to do so.

BOTKIN: I don't think it's useful to make one of the major issues a minor definition of terms. I'm just saying that you can't really deal with choosing the critical issues if you haven't defined your terms. So, you can have an amalgamation of all possible problems that people and the environment face, if you want, and that means that the word *biosphere* is not being used in any meaningful way. That's okay if you want to just

talk about the environment and humanity.

FACILITATOR: What I would suggest, Dan, is that you help us to restrict it, narrow it down, get it more precise and specific, and let's see if the group agrees.

… you want to know the minimum number of species to sustain life for the next thousand years, and the minimum physical and chemical requirements …

BOTKIN: Okay. We're not the first set of people to do this. G. Evelyn Hutchison wrote *Treatise on Limnology* 50, 60 years ago. And there's a book called *The Biosphere* published about a hundred years ago. There's a book, *The Fitness of the Environment*, by L.J. Henderson about the nature of the environment [MacMillan 1913]. These are very thoughtful, intelligent people who spent a long time wondering about these things. They did not sit down on the spur of the moment and come up with ideas, so I think there's a problem with the methodology.

However, if you want to talk about the biosphere, the key questions we really need to know are the minimum number of species to sustain life over a stated time horizon – which I won't state at this time, but you said a thousand years. Then you want to know the minimum number of species to sustain life for the next thousand years, and the minimum physical and chemical requirements of a system that can sustain life like that. The third thing would be the dynamics of a nonsteady-state biosphere system.

In terms of humanity, what's the role of rationality into the future, which is encompassing not only Cartesian rationality but religion and spirituality?

Then there are things about humanity, which I really think needs to be treated somewhat separately. I know you want three things, but I think you need three of each kind. In terms of humanity, what's the role of rationality into the future, which is encompassing not only Cartesian rationality but religion and spirituality? I'm including all of that when I ask: What is the role of rationality?

Then there's the question of the continuity of human civilization – whether it will continue at all, and then what kinds of change would we forecast in the fundamental nature of human civilization?

And the third is the more obvious one of the human population dynamics.

FACILITATOR: Regarding the first category that you have identified as a critical issue, could we restate it a little bit to define and understand the technicality involved in even defining what the biosphere is? You have offered a definition; I'm not so sure that everybody would agree with that.

BOTKIN: I'm giving you definitions that are used in standard literature. If you want to get a group of people who are technical experts on this – climate dynamic modelers or people who do global remote sensing – we could discuss which of these meanings make the most sense. But I think it's presumptive of us to do this as a group, to redefine that term. There are three standard definitions.

FACILITATOR: I didn't suggest redefine, but whether the other participants agree with it or not. Sylvia might have a different view of it. I don't know that the people who wrote the book you referred to on defining the biosphere 60 years ago placed a level of importance on the ocean that we know now to be of consequence.

CITRON: I think one of the problems the planet has is some of the experts on Planet Earth are too concerned with definitions and too concerned with work that has been done in the past. In order to move this forward without belaboring the point of how the biosphere is defined, we should just move ahead with our meeting and assume that we know what the biosphere means.

BOTKIN: But if you were trying to design an airplane, you could never do that. That's not how the Wright Brothers invented an airplane. This is not just academic trivia. This has to do with what we're actually talking about. What I said is if you want to abandon the term *biosphere* and just talk about all environmental problems, that's fine with me. I'm not clear which way you want to do it. If you want to throw out past scholarship, I disagree with that.

FACILITATOR: Let's finish with the three sets of ideas, and then we will open it up for conversations and we

can go back and forth for a limited amount of time about what we've just discussed. Sylvia?

… if there's hope for our species to prosper, it is because we have the capacity to learn and communicate that knowledge to the other members of our species.

EARLE: It's hard to organize things into merely three lines, but let me give at least a stab at this. Certainly high on the list of priorities is that area that some call *education*; we might call it *communication*; we might call it *enlightenment*. Whatever you call it, it means informing the world at large of the knowledge that exists in ways that really make it possible to have informed decisions.

When I think about what we've learned in just the last century, or even in the last ten years, it's been a process of accumulating knowledge that gives us a better capacity every day to make decisions about the future. We need to do much more of this. I think if there's hope for our species to prosper, it is because we have the capacity to learn and communicate that knowledge to the other members of our species. Without that capacity to communicate information and to organize this in ways that enhance the chances of our survival and our prosperity, we would be like any other species that just has to respond to whatever comes our way. We have the capacity to learn, but we need to do better at communicating what is now known.

We need to communicate the reality … that what we do to the natural systems we do to ourselves and to our future … that our survival depends on protecting the diversity of life.

One of the great breakthroughs of our time is discovering the magnitude of our ignorance, of knowing how little we really know. And that needs to be communicated much more widely. For everyone, worldwide, we need to bring up this level of knowledge that those in this room share and that a relatively small portion of the human population understands, which is that humans are a part of nature, not apart from it. That's part of this knowledge base that has to be communicated. We need to communicate the reality that our survival depends on protecting the diversity of life. We need to communicate the reality that some of us are aware of, which is that there are limits to what we can impose on the natural systems that support us. Again, we're a part of nature, not apart from it. We must communicate that what we do to the natural systems we do to ourselves and to our future. All of this is under that big, broad category of enlightenment/education/communication.

I tend to be optimistic because of the new means of communicating that have come about in our time, but we're not nearly as far down the track as we need to be. When you think of how small the numbers of people, given the 6 billion that there are, who are aware of these things that those in this room are aware of, if we could just make *that* breakthrough, all by itself, we would be on a course toward a greater chance for survival because it would lead to informed decisions.

At the same time, a second category has to do with exploration, another big *E* which you could also call *research*. It has many definitions, but it all has to do with that continued inquisitiveness that humans are endowed with, the need to know, the need to continue turning over rocks, the need to explore the depths of the ocean, the need to explore the universe beyond, the need to see where we are in the greater scheme of things. It's exploration in its most basic form. It's what scientists do, but it's also exploration in terms of how we fit in the greater scheme of things. It's continuing to ask questions and not to be content with the knowledge base as it currently exists.

… most particularly at this critical point in time, when we have opportunities that no generation beyond ours will have if we continue business as usual. We are closing doors every day.

I suppose the third big category embraces what some would split into two categories, equity and ethic, because in order to have equity it assumes you have a kind of ethic of understanding that how we live our lives is not just a mechanical thing; it's something that borders on the spiritual. It's understanding, doing the right thing. And it's equity not just with gender, not just interspecies, but I think most profoundly it has to do with intergenerational equity, the ethic of thinking beyond our time, looking and building on the past, but

most importantly thinking about where is this going? How are our actions now impacting all that follows – most particularly at this critical point in time, when we have opportunities that no generation beyond ours will have if we continue business as usual. We are closing doors every day. We are losing options every day. We say that we would like to leave the planet as good as we found it for future generations, but we already are *not* leaving it as good as we found it. We have lost species that we can't replace no matter how much in the way of resources we put to the task.

There's lots of room within these three categories for incorporating things such as using art as a means of educating, using music to communicate, exploration, and research. There's plenty of latitude there, too, to think of how we explore and what we explore, and also with the ethical and equity part.

I think that all of this together leads to "managed change," David's concept, that humans have the capacity to do what most other species, as far as we can tell, don't have the capacity to do, and that is to take what we know and consciously make decisions toward a different outcome than would otherwise be the case if we just went forward based on the natural changes. We are certainly changing the world around us through our actions, but knowing this we can model the potential outcome – if we do *this*, *that's* likely to happen. "Managed change," I think, is a useful term to apply to what all of this is leading to.

FACILITATOR: Okay. Let's use the next 30 minutes to go back and forth on what has been said so far in terms of qualifying it, fine-tuning it, defining it further, clarifications, defense, disagreement, and then we'll see if we cannot reduce all this to three. David?

MACDONALD: I think that in the next 30 minutes there are actually many interesting issues to go back and forth on, but before getting into that, I found Dan's interjection about definitions to be very helpful in clarifying. I think it might liberate us to move forward quicker than some might fear if we returned very briefly to the issue of definitions. My own suspicion is that it is highly likely that nobody in this gathering will dissent from the third and most comprehensive of the definitions that Dan offered us. I imagine that within well under a minute we might agree that that's what we're talking about, freeing us therefore to go ahead down that road.

FACILITATOR: Very good. Dan, would you restate the definitions?

BOTKIN: The three standard definitions of *biosphere*: first of all, the totality of organic matter, biomass. That's obviously the least interesting, but that's one way the term was used. The second one was the global habitat, the place where life exists on the Earth, from the depths of the ocean to the top of the troposphere. And the third is the planetary system that includes and sustains life.

HADLEY: Could I just add a clarification? The original definition was the second one.

BOTKIN: I'm sorry, you're right.

HADLEY: Though the term was evidently first used by the Austrian geologist Eduard Seuss in the late 19th century, the development of the concept came from the Russian scientist, Vladimir Vernadsky. His book *The Biosphere* was published in Russian in 1926 and in French in 1929, but not until relatively recently has the whole text become available in English [Copernicus, New York, 1998]. His definition, from what I recall, was that the biosphere is the envelope of life that surrounds our planet. So, you're quite right that it goes from the deepest depths of the sea to where life exists in the atmosphere.

BOTKIN: You're right. The Americans used it as the totality of biomass, but you're right historically. It's the planetary system that includes and sustains life.

EARLE: Number 3 definition includes 1 and 2, so that's really the comprehensive definition that probably is what we need.

BOTKIN: I think so.

EARLE: That is what it is: The biosphere sustains life and continues to do so. And we are part of that.

BOTKIN: Right.

SINGH: I don't think anybody's going to have any exceptions with that, so I think we should adopt it as the direction of this seminar.

FACILITATOR: Okay. I would raise one issue that is alongside. In the sense of the biosphere, the planet, and humans, is there room for the consideration of space?

SINGH: The moment that life goes to space, it becomes a part of the definition.

BOTKIN: Well, I think the idea is that that's another biosphere. That was the idea of Biosphere 2: Its builders were going to create a little isolated biosphere. Mars would be a Biosphere 3.

FACILITATOR: Okay, as long as the definition will accommodate the expansions that might come about.

SINGH: As a logical point, this particular definition does not allow for a second or a third biosphere, because wherever there's life, it's a part of the biosphere.

… you have one biosphere on one planet. If Mars had life, it would be a biosphere.

BOTKIN: No. This is a planetary system, so it's restricted because you have one biosphere on one planet. If Mars had life, it would be a biosphere.

SINGH: I thought *planetary* meant collection of planets.

BOTKIN: No. *A* planet. That's a good clarification.

SINGH: All right.

FACILITATOR: Since Eric is back with us, let's bring him into this discussion. What we have attempted to do, Eric, is to ask each participant, having heard everyone's presentations yesterday and the conversations so far, to take a shot at identifying what the three most important factors might be for humanity and the biosphere in the long term. This is the list we have so far, and we would like to know your three.

CHAISSON: Let me look it over.

EARLE: While Eric is doing that, could I make the observation that there are some factors outside of the planet that influence this planet, and those factors we don't control and have no immediate or even long-term prospects of controlling, such as the activity of the Sun or the rain of materials and fragments that come from the universe beyond or from our solar system and continue to enter this planet.

I think that what we're talking about is matters over which we *do* have some influence and *can* influence. For example, the magnetic fields even on this planet – we don't have the capacity to change or influence the reversal of the poles. It does happen and it does matter, but we can't do anything about it, at least not so far as we know at this stage. Somehow within this definition, we need to state that it's where we can exert some impact.

BOTKIN: Sylvia has brought up a really good point, which is that there's the unexpected, as in the reversal of the magnetic fields, which a society would be wise to look into. With that particular one, we could be planning how to navigate immediately upon the reversal or the disappearance – it actually can disappear for a while – and we have the devices to do it, but we need a sort of Greenwich center that's going to maintain True North for us in an electronic way. Planning for the unexpected is something we should think about.

EARLE: Or an asteroid striking the Earth.

BOTKIN: Right. Some of these are not completely unexpected. Both of the two you mentioned have low probability but are possible, and we would be wise to plan for those.

Education in many ways is absolutely crucial and underlies everything that we do … Another that is absolutely crucial to much of what we do is energy.

CHAISSON: There certainly are already centers of asteroid-tracking set up, both by the civilian space agency and the military. Of all the impacts that extraterrestrial events have made, asteroids are among the most devastating that we know of, including magnetic field reversal. Sir Crispin Tickell chaired a task force of the prime ministers to study near-Earth asteroid impact and what we could do about it. In fact, the Republicans tend to use this as an excuse to fund the missile defense shield, thinking that we could take an asteroid off target. Generals don't understand that if you hit an asteroid straight on at the center of the mass, all the debris keeps coming in the same direction. You have to hit it at the side, asymmetrically.

These events are very much recognized, though when I was coming up through the system as a young

astronomer, the whole notion that extraterrestrial events could have some impact, to use that word as a verb, on biology was just anathema; now it's an absolute given. I think we *can* do something about it. So, I think, as Dan said, that we ought to have a few think tank studies about these issues.

For my three factors, I'm gravitating toward a few issues. Of course these three critical factors were the ones that we were asked to identify before the seminar, and now you're giving us the opportunity to revise them. In my presentation, I gave three and then I underlined them all with education. I see that Sylvia and others have education on the list. Education in many ways is absolutely crucial and underlies everything that we do. So, education certainly has to be one of my three. Let's make it the second one.

Another that is absolutely crucial to much of what we do is energy. Then, I'm moving toward ethics, again, without being able to wrap my hands around the ethics. By *ethics*, I mean a social upheaval that will be necessary, such as to overturn slavery, such as to introduce the child labor laws, massive changes through social upheaval for the good, either generated by the populace from the bottom up, or by governments top down, but it's in the general scheme of ethics. I'm always at a loss to get my arms wrapped around, in practical ways, how we can address the ethics issue.

EARLE: I believe that the issue of energy might be embraced under the category of exploration and research, looking for ways to power our societies, through whatever means. We need to explore whatever alternatives there are, but certainly that is a critical issue of our time. Making our societies function now is dependent on identifying appropriate energy sources.

CHAISSON: In fact, in drawing out the bigger picture that I was trying to paint yesterday and demonstrating that life forms exist in this larger cosmic evolutionary perspective, I tried to underline, however briefly, the notion that energy is key to whether you're a galaxy, a star, a planet, or a life form. I just don't see how there's any way to get around the energy issue.

Energy is a good thing. It's the ability to do work, by definition. It's an invention of a 19th century physicist, actually, and yet energy, as I used it yesterday, per unit time per unit mass, is ever increasing as systems complexify. I think that's going to continue as we move across the arrow of time. However our future may be, it is going to require increasing amounts of energy, per unit time per unit mass. So, we can lump it in with exploration. We're looking for other sources of power to drive our civilization.

There is a broad academic consensus on two or three values: one is the value of equality; the other is the value of freedom …

SINGH: Dan raised two seminal issues, one of which has been put to rest and that was the definition of *biosphere*. The other point he raised that needs to be addressed was: What sorts of criteria, what sorts of issues are we talking about? Are we talking about things specific to the biosphere or are we talking about things that deal with humanity in general? That's an important point. Perhaps he was hinting at some of the issues that I raised because they *do* seem to be disjointed with the biosphere, on the face of it.

Yesterday there was a very interesting debate – and again Dan was one of the main people involved – having to do with forecasting. The question was raised: If you are going to talk about the critical issues that are going to impact humanity and the biosphere, and if you are challenged, how are you going to be able to justify that these are the three critical issues? Dan and others suggested that one way of doing it is to have some sort of a forecasting, to say: If you don't look after *this*, then *this* is what's going to happen in the future. I, on the other hand, thought that if I was to justify what I think are the three critical issues, the sort of question that I need to ask myself is: What are the things that are most critically endangering the biosphere today? From that would come my answer of what are the things that are most critical to the future of man and the biosphere. That would be the first set of questions.

Now, the second problem that comes up is that when you ask a question like that, what level do you operate at, between the petty and the profound? Do you deal with very specific things, like introduction of species and things like that, which are all true but very specific, or do you go to a very general level where you talk about human happiness and harmony, and nobody

can really question those? Where in that whole range do you pick what level of issues should count?

It's a very difficult debate, and here I'm being slightly mischievous when I say that in the debates on social science, as in debates in ecology, on the question of where does one focus one's attention, the consensus seems to be – very similar to the point made earlier – that we focus attention on things that are doable by us, things that we can do something about. You're quite right that we might be able to do something about meteorites, but we might not be able to do very much about what's happening in the polar field, which is probably even more difficult than meteorites. We're talking only about the biosphere, a thin crust over which we have some impact. However, suddenly the internals might blast and all our discussions become irrelevant.

Similarly in the social sciences there are also debates like this. People argue that if you get into things like the fundamental nature of human beings and primordial genetic tendencies, etc., then these are things that you really don't know how to get your hands on. But there is a general, broad understanding that you *can* get to issues relating to equity. There is a broad academic consensus on two or three values: one is the value of equality; the other is the value of freedom, which people tend to think is something that one should uphold and one should fight for. There are one or two other values that people broadly agree with, and these are elements of equity.

Obviously each one of us comes to the issue from our own perspectives, and that's the great thing about academia. When I was a student I was told that if you are an economist, you tend to look at all problems as economic problems; if you're an ecologist, you tend to look at all problems as ecological problems. And I, being a student of philosophy, tend to look at all problems as philosophical problems. But that adds to the richness of the debate. I would reiterate that whereas one can get more abstract about equity, but then we would get into realms about which we might not be able to do very much: the accumulated history of humankind, how we evolved, etc., I think we need to consider that unless there are these three types of equity, you're not going to have worthwhile education; you're not going to be able to manage your species or your science or knowledge or anything, because all of it is going to be colored by the state of the society.

… there are two levels about factors that most threaten the biosphere: one you could call mechanistic … the other are the social/cultural ones.

BOTKIN: Dr. Singh just made a very interesting point: What are the factors that most threaten the biosphere, and which of these can we affect? I think that's a very interesting way to constrain our questions, but I think that there are two levels about factors that most threaten the biosphere: one you could call mechanistic, like the amount of artificial toxic substances that we put in; the other are the social/cultural ones. Is religion the only way we're going to protect the biosphere, as it's been the main motivation for protecting land in the past? You can divide these into the attributes of human society that are most likely a threat to the biosphere or most likely to save it, or the physical/chemical features of the biosphere, and which of those are a threat.

Those are two very different discussions. I don't know if we have time for both of them. They're both very interesting and I would be happy to talk about either set.

… "interspecies equity," for me, is captured by these words "respectful engagement between the human enterprise and nature."

MACDONALD: Continuing to tiptoe gingerly into the philosophical arena, I thought that when Shekhar gave us his three explorations of equity, the third of those had some matters we should briefly dwell on and that was interspecies equity. Shekhar, you mentioned that in the context of "some things get eaten and some things eat," and there may be undesirable aspects in that from the point of view of the species that's eaten.

I think you touched on something that is actually of practical importance today in the way we face these problems. For example, in Western Europe there's a bit of a blockage between people concerned with wildlife. There are the people, often called conservationists, who are concerned with populations and

species, and there are those called welfarists, who are concerned with individuals. So, there's already a philosophical divide there that is actually hampering progress, thinking of the issues we're talking about.

My own vision, speaking as a biologist, is one where I personally have no trouble with the obvious inequity that some species eat others and some are very nasty to others, and even some individuals are nasty to others as natural biological processes. However, I have a vision that may capture the essence of equity – trying to stick with that word – which in an essay I wrote about six years ago on this topic I called "The Need for Respectful Engagement between People and Nature." That's to say: an engagement that acknowledges that sometimes in dealing with nature we do things that foster the well-being of a given species or its individuals, and sometimes on the balance of pros and cons we are compelled, or decide, to do things that are inimical to certain species or individuals. For example, we decide that a species might be a pest, so some individuals might have to be knocked on the head. It's a pity. Nonetheless, if we approach those decisions with what I call "respectful engagement," it's our general intention to enable biodiversity and life processes to prosper, acknowledging that where we intervene, and sometimes do so in a way that's damaging for certain sectors, we do so, in a sense, with a heavy heart and not in a cavalier way. So, I would like to say that "interspecies equity," for me, is captured by these words "respectful engagement between the human enterprise and nature."

SINGH: That's very helpful, and I'm glad that you brought this up, because one's not suggesting, for example, that in the final stages you tell a tiger or a lion that it can't eat a deer.

I come from the sort of culture or background where on the one hand we have Buddhism, Jainism, and Gandhiji. You probably know that Gandhiji was nearly not allowed to come to the UK because he refused to take inoculations because that kills germs. He actually did not believe in taking antibiotics or any medication that killed germs and bacteria because he felt that the germs and bacteria have as much of a right to exist as he had. That's one way of looking at things. On the other extreme, of course, is the Western education that one has where human beings are the center of the world. I spent quite some years struggling intellectually with this. Perhaps most surprisingly, the sort of formulation that most appealed to me was by Chairman Mao. In his many writings he makes a distinction between antagonistic contradictions and nonantagonistic contradictions. I think that's very appropriate to the world of nature.

So, where for your survival you need to kill or otherwise curb the freedom of some other species, then that's considered an antagonistic contradiction, and there's a certain ethical justification to it. For example, though I believe in animal rights, if I was attacked by a bear or a tiger tomorrow, I wouldn't think twice of defending myself, even if it meant killing that tiger. But where it is not essential for your survival, and I believe, and others do, that a lot of things we do aren't essential for our survival, then ethics comes in. Perhaps that distinction might help us in this debate.

Should we be thinking that human agency is the answer for explaining what happened between AD 1000 and 2000? Does it serve as the guidepost…?

FACILITATOR: As an exercise, if we were in AD 1000 and we knew, to the extent that we do, what has occurred today in 2006, could one identify the processes or the mechanisms or the models that might coherently explain the present in terms of what was in AD 1000? I'll give you an example. On the one hand, you have a set of initiatives where human agency is of primary importance. Marxism or the Soviet system or utopia in general or driving groups of people towards some definition of equity as we have been discussing, where the primary input is human agency, as opposed to a process that has been employed that for all intents and purposes has turned all natural processes upside down, the most important of which might be the very nature of evolution.

Should we be thinking that human agency is the answer for explaining what happened between AD 1000 and 2000? Does it serve as the guidepost for managing the future towards the year 3000? The opposing view is recognizing that we may participate, we may interfere, but at some point it is some other process that takes over and dictates the emergence of whatever the future turns out to be.

EARLE: We do have the power to reverse a trend, based on knowledge of how we have gone down a wrong track. One example is with whales. The attitude up to the point somewhere in the middle of the 20th century was: They're there for the taking; let's take them. But when it was clear that if we continued down that track we were going to eliminate a whole species, a category of animals, basically, through whatever motivations and from various directions, one after another of the big whales became almost universally protected. And today there are still whales. There might not have been had that action not been taken. We certainly have the capacity to destroy every last one of them and many other large animals as well. But it was through positive restraint, a change in our behavior that was widely adopted, not universally but widely adopted across the planet, that kept that particular door open.

So, it isn't that there's nothing we can do. There are plenty of things we can do if we know and if we understand the consequences and feel that it's important to us.

NGOILE: I think we developed the definition of the biosphere. What we, as human beings, are doing within that biosphere is fairly small in proportion to what we know about the biosphere. And what we are affecting is also fairly small. Consequently, to be able to identify what we can bring and change, I think it *is* possible, as Dr. Earle is saying. There are a few trends that we are seeing that are negative trends, and we know the area of impact of those trends within the biosphere. I think those are what we can focus on in terms of changing.

In fact, the change might not necessarily be a thousand years. We can observe the change even within a time frame of 50 years or 100 years, especially to some of the most serious trends. Consequently, if we look at it from that point of view, we can see that human society has the ability to address some of the issues that we have impacted on the biosphere.

… between AD 1000 and AD 2000 … the critical thing that happened … was the subversion of Galileo in changing the thinking of the world.

HADLEY: To address Sesh's point of what occurred between AD 1000 and AD 2000 that was the critical thing that happened, Roger Bradbury, in an article on "Sustainable Development as a Subversive Issue" in UNESCO's quarterly journal *Nature & Resources* [*34*(4), October–December 1998], suggested that it was the subversion of Galileo in changing the thinking of the world. It was Galileo engaging with the Establishment, the Church of the time, to change how one viewed the world and how it worked. Galileo did that by a deferential nod to the Establishment, almost to have permission to be able to speak. From then he developed his arguments, which eventually gave rise to the Newtonian physics and all that *that* led to. He did that work by a very clever method of having this simple man, Simplicio, asking the naive question to be put on the right path. And he asked that question to the learned man, representing the Establishment. He didn't *confront* the Establishment, but he sought to engage the Establishment.

Perhaps if one accepts this point of subversive thinking, changing the way in which the received wisdom has it that the world works, perhaps that is something that we could think a little bit more about: *subversion*, which is perhaps not a very popular term in these years in which we live, but in many other ways it's a very attractive word – in the sense that it means to overturn, to upset, to overthrow. And overturning, upsetting, overthrowing current perceptions and behaviour patterns is something that needs to happen if indeed humanity has any future on this planet.

EARLE: It's a form of communication.

BOTKIN: I thought some more about what Shekhar said. I've made the distinction between the factors that are mechanical, physical, chemical threats to the biosphere, and then the human, social, religious threats. I think that the latter are the real drivers of what we're going to do. So, despite being a scientist, I would vote for those being the key for the discussion.

CHAISSON: Social issues.

BOTKIN: Yes. Social issues.

CHAISSON: I'm afraid you're right.

FACILITATOR: It's really quite odd, but in almost all of our seminars that eventually is where things head. A classic example of this occurred in the United States when people were brought together as a team to deal with the nuclear waste stored at Richland in the eastern Washington area. The issue was how to deal with the very large amounts of nuclear waste for the long term. They brought in all kinds of experts from all over the place to talk about how to deal with it. It didn't take them very long to determine that the technical aspects of dealing with the hazard were the least of the issues, and everything had to do with how to manage it socially.

At this point we will invite the MAB staff into the conversations. So, Ish and Tom and Peter, if you would like to comment on or add to what has been discussed so far, please feel free to do so. Thomas?

SCHAAF: There was some discussion this morning on some of the *E*s that we started discussing yesterday. Out of the four or six *E*s that were mentioned, I think two are particularly important. One is evolution and the other one is ethics – evolution in the sense that the environment is changing, but also that, as I said yesterday, the human mindset is changing as well.

The whole idea of discussing conservation of the environment, conserving the biosphere, is perhaps only 100 or 150 years old. Why should we conserve the environment? This is a fairly new mindset in human history, at least in the sense that we understand environmental conservation today. I'm not talking about sacred sites that are conserved for other, more spiritual purposes.

The question is also how we, as human beings in our own evolution, can contribute to the next thousand years, and our relationship to the environment. A relatively new feature is that humanity has and is becoming conscious, not only of itself, but of its relationship vis-à-vis the environment and the need to conserve the environment. We should address a bit more this emerging recognition of becoming conscious, this act to be willing to contribute to the preservation of the environment, which was not an issue perhaps in the last thousand years but which *will* become a big issue in the next thousand years – this becoming conscious of the fact that we have to act; we have to conserve the environment.

And obviously this is a social issue as well, as the previous speaker just said.

There is a major issue of speaking with one another, and it's complicated by social perceptions of your level in society and what authority you have to speak.

ISHWARAN: Now that you have decided to bring in social, cultural, and other issues on the recommendation of a natural scientist, I think it's a good thing. Malcolm brought up Galileo and Simplicio, and that is an important issue. There's a book called *The Intellectuals and the Masses* [by John Carey, Academy Chicago Publishers, 2002]. In UNESCO we always project ourselves as an intellectual organization. We had a Science Sector retreat last year, and we had a guest speaker reemphasizing how UNESCO should be an intellectual organization. I asked him, "Could you give me a definition of what that means? What does it mean to be an intellectual?" I didn't get an answer; the question was evaded.

There is a book that specifically addresses US society. The title of the book is *The Third Culture* [subtitle: *Scientists on the Edge*, Simon & Schuster, 1995], by a person named John Brockman. This book is about how natural scientists, mainly physicists, chemists, biologists, and computer scientists, are beginning to interpret what life is, how it should move forward, what we should do about it, and so on. Therein John Brockman makes a definition about what an intellectual is. There's another book coming from an earlier time called *The Last Intellectuals* [subtitle: *American Culture in the Age of Academe*, Farrar, Straus and Giroux, 1989], written by Russell Jacoby, who bemoaned the fact that the identity of the "public intellectual" is gone. The definition given by John Brockman is that an intellectual is a synthesizer, a publicist, and a communicator. If that *is* the case, it will be interesting to know why people are not listening to us. And I know what UNESCO should do if it is to become a truly intellectual organization.

There's another interesting website John Brockman started, called www.edge.org. He poses important questions (what *he* thinks important), and he some-

times publishes the responses from a number of scientists to that. There was a publication Brockman edited recently called *What We Believe but Cannot Prove* [subtitle: *Today's Leading Thinkers on Science in the Age of Certainty*, HarperCollins, 2006]. It's not a book in terms of narrative, but it's just one-page sentences or sometimes one paragraph by very famous US-based scientists/thinkers, people like Richard Dawkins, Freeman Dyson, Jared Diamond, Steven Pinker – those kinds of people – saying what they believe but they still can't prove. That's an important question because scientists in general are either protecting themselves or the society is perceiving scientists as people who prove things. But within the scientific community you have this notion of being driven by testing hypotheses that cannot be proven correct; they can only be disproved. So, how do you interact with society? If you are a person driven by a tradition that you can only disprove things, how do you relate to a decision-maker who wants to know what to do next? You cannot go and tell him what *not* to do; you have to tell him what *to* do.

There is a major issue of speaking with one another, and it's complicated by social perceptions of your level in society and what authority you have to speak. We all seem to speak for humanity. That's a lot of things; that's 6 billion individuals, and we all sometimes tend to assume that we can speak for the whole of humanity. Can we? There are other members of humanity who may not be interested in speaking, but just to *do* things.

I don't know what aspect that is. I don't want to call it *communications*; I don't want to call it *information*. It's this exchange between different strata of society that sometimes think differently about how to change things. And that is an issue that I think is important.

CHAISSON: John Brockman is a professional literary agent and public relations expert. Maybe what we need is a communications agent, a spokesperson to carry the word forward.

FACILITATOR: What Ish is raising, I think, is what Sylvia was trying to get her arms around, in one sense, where she was talking about education, not just in the classroom sense but also in terms of communication and enlightenment. Someone else was mentioning the idea of the intellectual being somebody more in the mode of a Renaissance person of old rather than the specialist of the new. I think that is what has disappeared and that's probably the reason why you see gurus having a huge market, like the Esalen people in California.

So, yes, I think there is a crying need for those synthesizers and the people who are able to communicate. Is it a special discipline that has to be brought into the picture, like a PR person such as John Brockman, or should the system of education itself reorient somewhat to the notion of developing individuals who are capable of doing this? Right now that's not in the cards.

ISHWARAN: I think learning is important. One of the things we are trying to do in the MAB Secretariat is to promote biosphere reserves as learning laboratories for sustainable development, because in a sustainable development, you don't teach. We have a UN Decade of Education for Sustainable Development. If I had any authority, I would have called it "Learning for Sustainable Development." Education is something that is done based on things that are already accepted in society, like the law of gravity, for example.

FACILITATOR: But I think you are pointing to something that involves those who are involved in educating and teaching, and how to broaden their range of skills or to enlarge the scope of their involvement in terms of how they communicate.

But it stems from knowing. You can't care if you don't know … I don't think it's good enough to muddle through anymore.

EARLE: One of the reasons I tend to be an optimist is because of the way new technologies have given us new powers to communicate, to educate, to become enlightened, if you will. One breakthrough that helps us see ourselves in context took place when, for the first time, humans were lofted into space and looked back and saw Earth as a whole. We put ourselves in the context of the universe in ways that, with all of the brilliance of atlases and globes, and so on, hadn't had the impact that that perspective of the 1960s and '70s gave us.

And now, through the means of communicating that perspective on computers throughout the world, – it doesn't reach everyone but it has reached a level

of mass that is unprecedented in terms of communicating knowledge quickly, electronically, with the touch of a button – you can see through phenomena such as the Google Earth and the global information systems that layer knowledge in ways that heretofore were simply inaccessible to all but just a privileged few. Now all of us have the privilege of looking at rivers with new insights to see whole water systems, to see the flow of air currents and ocean currents, to be able to, again, look at the planet. Just as one example, the Google Earth phenomenon now reaches 100 million people a year, and it's just new in the last year. All of a sudden, anyone who has access to a computer can call up a view of the Earth and drill down and go with Michael Faye on an expedition across Africa, looking over his shoulder with video clips of what is there. Suddenly there's a new way of communicating. I love books. I will continue to have a huge personal library and to write, and so on, but at the same time I am mindful that we need to harness this new power in ways that will lead to a new understanding, that will lead to an ethic, that will lead to managed ways of going forward and finding a place for ourselves armed with new knowledge.

But it stems from knowing. You can't care if you don't know. This is an opportunity to take the kind of discussion that we're having here and let the world know that these issues exist and that we have the power to shape a future that is positive instead of just this willingness to – what was the word used yesterday? – "muddle through"? I don't think it's good enough to muddle through anymore. We don't have to be content with muddling through. We can take control in a positive way, armed with the new knowledge. We shouldn't stop gathering knowledge, but we first of all have to communicate what we now know.

FACILITATOR: Do the MAB staff wish to comment?

DOGSÉ: If I would have some comments on what has been said, I think a very interesting trend that was brought forward was the trend that people are moving out of nature and into cities. More profoundly, why is that so? And what are the risks and opportunities from that continued trend, which we probably know *is* a continuing trend? I think that is quite fundamental.

Something I haven't heard too much about is ethics of science and new gains in biotechnology and biological warfare. For the next thousand years, I think the management of science in those fields would be pretty important, including from a biosphere perspective. I haven't heard too many comments in those areas.

FACILITATOR: Management of science? Okay. David?

I'm not sure how much less than the current quota of species that minimum for sustainability would be, perhaps not much less, perhaps a lot less.

MACDONALD: Picking up Peter's point about the consequences of populations becoming increasingly and now, in fact, for the most part urban, I think that has tremendous bearing on the remarks I made earlier about the importance of respectful engagement with nature. It does mean that a very large proportion of people nowadays have only an abstract, at best, understanding of the day-to-day business of life and death and process in natural populations, which makes it a much bigger task for them to appreciate what the natural processes really mean. Perhaps our more rural ancestors had a more earthy understanding of these processes.

The point I wanted to make, if I may, is to move the conversation back to another of the topics that came up earlier. Dan drew our attention to what is superficially, but only superficially, a more technical issue of how many species do we need to sustain the sort of world that we might be hoping for a thousand years from now. The other evening I was discussing with Walter, as an aircraft engineer, the very famous analogy of the airplane rivet model in the problems of reducing biodiversity. I'm sure everyone is familiar with the model: Each rivet in itself seems inconsequential, but one of those rivets, if lost, would be the last one lost before the plane disintegrates. That's a good way, I think, of expressing our concern about the loss of seemingly trivial elements of biodiversity.

The point I wanted to make (as Dan knew well when he raised the question) is that the issue of how many species we might need to sustain different sorts of futures is one that is at least partly open to technical inquiry, and already, indeed, subjected to that. There are, I'm sure, many scientists involved in this topic, but one that comes to mind is John Lawton, who has

set up so-called Ecotrons, miniature biospheres in the laboratory, looking at the consequences for the functioning of these biospheres of removing or adding one or two or three different species. I mention this to illustrate that there is an empirical approach to tackling that question. I'm sure what Dan had in mind, though, is not only the empirical answers to how many species do we need, but the actually, I think, shocking consequences if the world moves towards a future that has only that minimum. I'm not sure how much less than the current quota of species that minimum for sustainability would be, perhaps not much less, perhaps a lot less. But if it's a lot less, then we get back to the value judgment issue again of how impoverished humanity's future experience would be if it were based on a minimalist ecosystem rather than the enriched one that we still just cling onto.

… biologists are not able to take inventory better … yet they're still willing to make the claim that we are entering potentially the fifth great mass extinction.

CHAISSON: This raises an issue that has bothered me. When I ask biologists, "How many species are there?" they say, "Millions." Then I push them into the corner a little bit more, because I'm a numerical person and I want a number, and they come around to say, "1.7 million, but there are probably millions more." Ed Wilson will tell me 5 to 10 million; Steve Gould used to tell me 15 million; Robert May used to say 30 million. I saw on somebody's chart here yesterday 100 million. Now, we have a "dark matter" problem in astronomy where we can't find most of the stuff in the universe, but it bothers me that biologists are not able to take inventory better than they can, and yet they're still willing to make the claim that we are entering potentially the fifth great mass extinction.

Let's do the numbers. Okay, let's round it off and give Gould and Wilson the benefit of the doubt: 10 million species, perhaps, even though you can find only 1.7 million. Now, a typical extinction rate of a species is 10 to the minus 6 [10^{-6}]; they'll live on the order of a million years. So 10^{-6} of 10 million would be about 10 species going extinct per year. Are you finding, in actuality, of order of 10 – could be as little as 5, could be as many as 20 or 30 – species per year going extinct? And even if you are, is it not possible that, although some species are going extinct because of what we are doing, other species are emerging through disruptive selection? And so, what's the net effect here? I'm always looking for these numbers, and I'm trying to not be the Republican skeptic – which I'm not. I'm trying to get a handle on whether or not we really are entering, because of what we're doing, a fifth great mass extinction. Because if true, then there ought to be many more than 10 species going extinct per year. I don't quite see it yet.

… I don't believe, personally, that there is a mass extinction happening now, and I don't really believe there will be one.

BOTKIN: I would like to respond to that, because I've been very troubled by exactly that. I'm very disturbed by my colleagues who claim huge numbers when there's no knowledge, and claim that we're on the brink of a mass extinction. So, in response I'm going to say something very contrarian, which will upset all my colleagues in biological conservation. I think that the number we know is the number of *named* species, and that's the operational number. The rest of it is speculation. Some of it is based on the fact that in very localized situations there are tropical beetles that live in trees and have very local distributions … and I can't believe that the biosphere is going to disappear if those species went extinct.

I'm also concerned about this claim of mass extinction. I'm working right now with the curator of mammals, Ross McPhee, at the American Museum of Natural History. He is one of the great experts on Pleistocene extinctions. There is evidence now that there were short-term climatic events that *were* very abrupt. In the last two million years no amphibian went extinct, no reptile went extinct. There are now 4500 known species of mammals. In the Pleistocene, 80 went extinct. There was not a mass extinction. If all we are doing is changing the climate in a way that has happened before – and contrary to popular mythology now, it seems to have changed that way – then we are *not* and we don't see those extinctions. In fact, there are very few extinctions.

Another thing that's important is that *rarity* is dif-

ferent from *going extinct*. For example, the whooping crane was reduced to 14; it is now several hundred. We treated that as a stochastic process of birth and death because it has complete census and we did the calculation of the probability that its population curve would cross zero; given the fluctuations, it was less than one in a billion if the sources of variations in the past are the same in the future. One sharpshooter could do away with the entire species.

So, I don't believe, personally, that there is a mass extinction happening now, and I don't really believe there will be one. I have not said this in public because I know that it is so contrary. But I agree with your concern. Coming at it from physics, which I really like, you're asking the real questions: What are the numbers? What do we know? That's what we have to do: We have to deal with the numbers.

CHAISSON: Why is it that so many colleagues in your biological community have embraced this or jumped on this wagon without real evidence? This isn't biology.

BOTKIN: Sylvia is going to respond contrary to this, but my reading of this was discussed in my book *Discordant Harmonies* [subhead: *A New Ecology for the Twenty-first Century*, Oxford University Press, 1992]. Cicero said, "Who cannot wonder at the harmony of things and the great diversity of life?" It is a fascination that people have had in Western civilization for 4,000 years. There's a great love of the diversity of life. Therefore, I believe, a lot of this is the extrapolation from our love of the diversity of life, which I appreciate, to the belief that it is essential, for which there's very little information.

FACILITATOR: So, based on this last exchange, we don't know that there is an extinction?

BOTKIN: A mass extinction. There's no evidence of a mass extinction.

FACILITATOR: So, we're discussing an issue that doesn't exist? I'll bet there are other opinions at this point. Is this a critical issue or not?

… people are prepared to make judgments about an extinction crisis … when perhaps the majority of species remain undescribed, so how could we possibly know?

MACDONALD: I would agree that the question that Eric phrased and that Dan responded to is just the sort of question we should be tackling. I would like to add a little bit of flesh to those bones. I think what Dan was saying is that we may be making a mistake in focusing too much on extinction, which is a convenient and easy end point for us to measure – an incontrovertible end point – but it may not be the main barometer that we should be looking at in this conversation. This leads me around to quickly say why I think people are prepared to make judgments about an extinction crisis at a moment when perhaps the majority of species remain undescribed, so how could we possibly know? I think that is an issue of extrapolation.

In the past the literature has been prepared to accept that there has been a succession of extinction crises, based on exactly the same sort of evidence. Of course, it was the case in the Cretaceous that nobody had any idea how many microbes there were and how these microbes were affected by the supposed meteorite. So, the level of ignorance hasn't changed. By barometer analogy, it may be that one could make a judgment about a certain proportion of a given tax on vertebrates, for example, changing then and now, and say that both might fit the same operational definition of an extinction crisis. So, I think the quality of the information is perhaps not good, but it's no worse than it was when people have used those terms before.

More interestingly, a lot of the analyses that were associated with the perhaps too lightly used expression of *extinction crisis* or *mass extinction* come from analyses of the IUCN's [International Union for the Conservation of Nature and Natural Resources] criteria for endangerment of different organisms at the moment. I'm sure everyone in the room is familiar with those, but, very briefly, this is a categorization of the status of different species in terms of whether there is *any* or *extreme* concern about the probability of their going extinct. Now, the probability of their going to extinction is what people focus on because it's easy. But what's more interesting is the rather high

proportion of species for which such analyses have been undertaken where there is a shift from a situation of less concern to a situation of more concern.

Personally, I think it's a convenient distraction that we talk a lot about extinction, and we should perhaps talk more about the trends in large number of species from situations of a greater probability of viability to a lesser probability of viability, and whether we're content with that. I don't think that's at odds with the answer that Dan gave you.

FACILITATOR: I want to ask Ish about elephants. What are the numbers?

ISHWARAN: Which one, African or Asian?

FACILITATOR: Both.

… what is important is to think of a constructive engagement … and commit yourself to showing some results that are measurable …

ISHWARAN: I said yesterday that in the estimations of elephant numbers, at least in Sri Lanka, the standard deviation is more than one third of the mean, so the accuracy or the precision is way off. I shouldn't say things about African elephants because there's nobody in the room who will speak for African elephants, but some of the statistics I have seen for African elephants are similar.

You've asked the question: Should we worry about extinction at all? I think that is an issue in the relationship between humanity and biosphere. Is extinction the only issue? Is it possible to construct a humanity/biosphere relationship where we engage and do things to prevent activities in local spaces, in countries, to let certain species survive? You might have to choose. When you don't know how many species are out there, how do you do it? Maybe you should choose what you know, and try to show that it is doable.

If you asked a businessman, "How long does it really take to build a business – invest, build a business, break even, and start making profit?" from what I hear from friends, he would say, "At least seven to ten years." I don't know any international project adequately financed, sufficiently backed up, which has run for seven to ten years. MAB has run for 35 years, but it is a program that has a broad outreach and message.

So, I think that what is important is to think of a constructive engagement with regard to the humanity/biosphere relationship, and commit yourself to showing some results that are measurable, and that hopefully will be successful. That way we might convince people more. Somebody said yesterday "learning through doing"; that doesn't happen enough.

Some say that the greatest biomass on the planet is below the bottom of the sea, in the cracks of the rocks … I believe that the diversity of life has yet to be defined …

EARLE: I won't get into the big philosophical question: "What is a species?" although I could, I suppose, as a part of this discussion. But if we assume that we know what a species is and that we're trying to enumerate how many there are, I'm of those who would say that we have barely begun to scratch the surface, particularly since we have barely begun to scratch the surface of the ocean, where the greatest diversity of life on Earth actually resides. We only in recent times have begun to appreciate the magnitude of diversity among microbes. What's a species there?

Going back to the age of ZoBell in the 1950s, it was thought that the ocean was sparsely populated with microbes, and that you had to really look to find bacteria in the sea. Well, look at what we now know, that in a single spoonful you might find more than a thousand different kinds of microbes, some in very small numbers, a few that are dominant. Change the chemistry, and all at once those that are dominant are suppressed and a few for whom the circumstances are just right prosper. We didn't understand that not long ago. We didn't understand the importance of microbes in the deep sea. It wasn't until 1960 that people were finally convinced that there's life in the deepest sea, seven miles down. The perception from our terrestrial perch that where it's cold and dark and oxygen is low, there can't be much alive, if anything, has been demonstrated through personal observations of the two people who, in all of history, have been to the deepest sea, that there is likely to be life wherever there's water. And even below the bottom of the ocean: Some say that the greatest biomass on the

planet is below the bottom of the sea, in the cracks of the rocks where the microbes are flourishing.

I believe that the diversity of life has yet to be defined, except that it's far more than 1.7 million species. I know for sure that very few of the annelids have been analyzed, that there may be as many annelids as there are known insects, just for starters. Most of them, of course, are in the ocean, not in your backyard garden. And the diversity of arthropods in the sea may surpass the known arthropods on land, despite the diversity of beetles that we know about. I am convinced that despite the probability that there are 30 million species, as we think of species – 100 million is not out of the question when you put microbes and the little guys in the ocean on the balance sheet.

But I will go back to the question of whether it's really species that we should be enumerating and thinking of as the most important units of life. Some species carry the burden of great wedges of genetic information that is greater than others. There are only four species of horseshoe crabs that represent an entire category, the class of arthropods. There is only one, maybe two, kinds of coelacanths that carry the weight of all of that great wedge of genetic information. When you think about squids and octopuses, we only know about 300, maybe 400 species in that entire class of cephalopods. Maybe there are a thousand – once we've got the final tally in, according to species. There are 9,000 kinds of birds, plus or minus a few; 500,000 perhaps kinds of insects. Well, every insect is programmed in a certain way to have three pairs of legs, two pairs of antennae, wings or some manifestation thereof.

But what about horseshoe crabs? If we lose one, we've lost a quarter of the diversity of that entire wedge of life, so some species have greater responsibility for carrying genetic information forward into the next millennium than others. If we lose all of the horseshoe crabs – and we're perilously close to doing that – we've lost *forever* that entire line. Somehow we aren't thinking quite straight when we think just about species; we have to think about genetic diversity.

Also, it's not just like species in a can, one after another. When I think about restoring an ecosystem – I had a chance to observe Prince William Sound after the big *Exxon Valdez* spill. I remember thinking: If it were my job to put that system back together again and if somebody gave me barrels and cans and buckets filled with the polychaete worms and the clams and the sea otters, and so on, I would be hard-pressed to know how to put them back together again. I don't have several million years of fine-tuning, of figuring out how to place this and put that and getting the chemistry just right and the social systems that have evolved, and they're ever-changing, of course.

We don't know how to put a species back together again. We couldn't recreate an elephant. We might have the genetic material in a test tube, but we don't know how to put this to work in a sense that builds a biosphere …

We are so arrogant in thinking that we can do these things, that we can put a marsh back together again if we just have the right ingredients. I don't think we have quite the skill. We don't even know what we don't know about how these systems work. We really need to have respect for maintaining the integrity of what remains, knowing that we can't put things back together again. We don't know how to put a species back together again. We couldn't recreate an elephant. We might have the genetic material in a test tube, but we don't know how to put this to work in a sense that builds a biosphere, which is what we're partly concerned with here. So, Dan, we *are* in the middle of a wave of extinction that is comparable to, perhaps, what took place 65 million year ago.

BOTKIN: There are no numbers. Give the numbers.

EARLE: All right. When I don't know how many species there are to start with in a heretofore unexplored sea mount, but knowing that there is diversity that is unique to that particular sea mount, and that when it's trawled or when it's exploded that we've lost species we haven't even named, what do you do there? Or trawling the sea floor – we know that life in the deep sea is patchy. We know that some life occurs over a wide area, but we also know that there is a high degree of endemism around sea mounts, in the deep sea, on islands – and we can extrapolate, based on what we know, to the unknown.

When you lose a coral reef, how many endemic species have gone along with it? Some attempts have been made to do just that, but they are educated guesses because we don't know how many were there to start with. But we do know how many are in this

adjacent area that is still intact. When you've lost a place through dynamite, climate change, or a slight warming trend – everyone now buys into the thought that a warming trend is hard on coral reefs, that we get this bleaching effect. I think that is a pretty sound conclusion, but it is not the only factor that's causing coral reefs to be stressed around the world. It's the combination of a warming trend with chemical changes in the ocean that favor some things and not others. By dismemberment of these fine-tuned food webs, because we have extracted huge numbers of predators, the large fish, and even the grazers, the parrotfish and the like, we have altered the very way these natural systems function.

FACILITATOR: Sylvia, in response to Dan's point, "give me numbers," it seems to me what you're suggesting is that that may not be possible, but processes are in play that are distinct and different from anything we have known in the past, which clearly imply extinctions of magnitudes that we should be concerned about. Is that a fair way to state it?

EARLE: Yes, I think you're absolutely right in that assessment. But one thing that seems clear is that diversity tends to provide stability of a certain kind. In a coral reef situation, again, if you take out one predator, eliminate it, there are others that fill the gap. It's not the same, but that role has been assumed. If you take out *all* the predators, which is basically what we're now doing, you have created a totally different and dysfunctional system.

FACILITATOR: Okay. Dan?

We do not know about the connection between the diversity of species and the functionality of most ecosystem processes …

BOTKIN: First of all, Eric, you're hearing from Sylvia what is the major thrust of the defense of biodiversity. That's the way it's phrased and it is heavily qualitative. So, you can choose that. However, there are a number of things she said that are not defensible. There is very little, if any, demonstrated connection between diversity and stability, neither theoretical nor empirical. First of all, ecologists don't define *stability* in a meaningful way. Now we're getting into the kind of thing that I've heard you don't want to talk about: models and forecasts. But from the point of view of good theory and good observations, there is no connection between diversity and stability – that we *know* of. It doesn't mean it doesn't exist, but operationally we do not know.

We don't know about endemism. There are coral reefs now, and whatever happened in the past, there are still coral reefs. We do not know about the connection between the diversity of species and the functionality of most ecosystem processes, but we have this qualitative argument.

The other point I wanted to make I've written about in my book *No Man's Garden*. I think that there's plenty of justification for the desire to have high diversity. I gave eight reasons yesterday for why we value nature. The weakest of those, because the information and science are the weakest, is the biosphere and ecosystem dynamics, because we know too little. The strong ones are the classical ones; for people, the spiritual meaning, the religious meaning, the meaning of beauty, are very important, and they are perfectly good justifications, and those kinds of justifications have changed the world in the past. People love diversity. The classic definition of *beauty* includes the idea of variety; all you have to do is read Alexander Pope. Landscape beauty has been studied by philosophers in this field (no longer popular) of aesthetics and ethics. The one I know best said that landscape beauty is generally considered to have three qualities: complexity, coherence, and mystery – mystery in the sense of something undiscovered. Now, a multitude of species fit into that. This is what people really like. It's a wonderful justification.

So, when I say that there isn't much science to defend biological diversity, I still believe that we should have high biological diversity because it means so much to us. But as I say, I'm the contrarian. I've looked at this, coming from an undergraduate degree in physics and think about it in terms of operational models, and theories and experiments, and talking with people like an expert on Pleistocene extinctions. You have very little in the way of operational definitions, but you have qualitative arguments that make sense and you have the history of the feelings about nature. And it's a choice; it's an important choice.

SCHAAF: The point I am driving at is we *need* the diversity because we don't know yet *why* we need the diversity. Some people are arguing that the entire world population, or 90 percent of the world population, eats food from vegetation that comes from 20 species only.

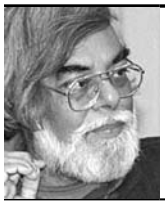
EARLE: Right.

SCHAAF: In a way, you could argue that we need only to preserve 20 plant species for the diet of the world population and that would enable our survival. But the question is: Is that really true?

Coming back to the Biosphere 2 project, which I think was a very interesting experiment in the way it failed. It was interesting because we thought we could control a livable environment by reducing it to a few parameters, and the experiment failed because we didn't *know* why it broke down. The livable environment for human beings simply could not be reduced just to a few controllable parameters. So, because we don't know why we need the diversity, we need to protect it for our own survival.

CHAISSON: I was just going to come back to the images of the stromatolites I showed yesterday up around the glacier that I was exploring in the Glacier National Park. The stromatolites well preceded the Cambrian or any kind of an explosion in diversity of species. The stromatolites were embedded in that rock dated 1.2 billion years old. The fossils of the stromatolites go back to at least 1.7, and chemical traces of stromatolites to 2.7 billion years ago. Those stromatolites existed and sustained a way of life without any diversity for billions of years, at least a couple of billion years.

I was asking yesterday, being a *provocateur* during my talk, whether diversity *is* good, whether there is too much, whether there can be too much diversity. With too much diversity comes complexity or complications or nonlinearities. I'm thinking as a physicist. But I see those fossil records; I see the data; I measure the stromatolites. I see them myself as the glacier is receding at nearly the top of the world there. Those stromatolites eked out a living, however simple and stupid they may have been, for a long, long period of time – much, much, much longer than any timescale we're considering here for humanity.



… probably ecology is the only discipline that I know of which says that what is in nature must be right …

SINGH: I was listening with great interest to this debate between ecologists and paraecologists. What struck me as very interesting was that probably ecology is the only discipline that I know of which says that what is in nature must be right and, therefore, the real threats to nature are the sorts of interventions that human beings pose, and we must minimize those. For example, why don't we have a thesis that if humanity is to survive we must quickly bring down biodiversity to a manageable level? Why is that not a part of it?

Take any other science. Take medical sciences. Medical scientists don't assume that all the germs and bacteria and diseases on Earth have been put there for a purpose and, therefore, human beings should not intervene. They go around very aggressively with the best of science trying to control everything they can. They make mistakes, but the assumption is that nature is not benign; nature has its own purposes and those might not be in keeping with the objectives of human society. You can talk about any other discipline. Sociology does not assume that if societies are left to themselves, they function beautifully. They say that, no, there must be laws; there must be regulations. The *only* science that says, "If nature is left to its own, that's the best," is classical ecology. Now, what evidence do we have for that? How do you know nature is not designed to make us all suffer and die a horrible death, and unless we can actually get hold of nature and get rid of all this horrible biodiversity that is evolving in the depths of the sea, it will one day come up and swallow us?

… while the data may be few to indicate that there's an extinction crisis … the data are numerous to suggest that there should be … an "impoverishment crisis" …

MACDONALD: In passing to Shekhar, a point that may just be semantics but is nonetheless important, I would remind you that ecology, as a science, actually

makes no value judgments whatsoever about what is right, desirable, or otherwise. Those judgments may be made by people using that science, but the science itself says nothing about what is right or wrong.

To Sylvia in passing, because she mentioned, helpfully, the importance of cephalopod genetic considerations in what we should prioritize: Others in the room who are less familiar with this field will be heartened to know that there's a huge literature on these issues of how you might prioritize in nature. Phylogenetic considerations are one amongst many bases for prioritization.

To Dan, whose point about "show me the data" is always the right question to pose, I just repeat again that while the data may be few to indicate that there's an extinction crisis – I think it's right that that point is made – the data are numerous to suggest that there should be either an "impoverishment crisis" or a "contraction crisis" on the basis of this sort of IUCN data that I mentioned.

Finally, I think Eric was right to raise the question of extinction and how much we should be hanging our hat on that one. I wrote a paper recently in which the point was that while extinction is an interesting and important thing to consider because of all the irrevocable things that we know, another way of looking at the state of animals and plants and other organisms at a moment is what you might call a natural benchmark of what we have already lost, rather than the probability of losing the rest of it. Although it's often hard to quantify that, if you look at what has been lost, it's often a rather radical amount during the Anthropocene, during the era when people have been involved. For example, Sylvia mentioned the percentage – well over 90 percent, wasn't it? – of large fish species that have gone in less than a generation,

BOTKIN: It's not the species; it's the population. No species have been lost.

MACDONALD: You're quite right, and thank you for correcting me there.

Similarly, to take a species-cluster example, I work a lot on lions at the moment. One would have thought they were so charismatic, that surely we will manage to conserve lions. If we can't do that, for god's sake, what can we do? Recent evidence suggests that there may be about 20,000 lions left scattered around in different, rather fragmented populations in Africa. Perhaps at an earlier stage 100 years ago there may have been more like 120,000 lions. That may be a trend that we take concern over. But much more interestingly, if you look at the distribution of the lion genus complex across both Africa and Europe and, indeed, North America that has *probably* been affected by people to a reasonably large extent, then again the restriction of their range and, probably, population during the time of their association with people has gone down by at least as much as has the populations of those fish that we were just mentioning.

So, I put it to you that rather than our being too preoccupied with extinction – important though it is – the trends and the rates of loss and what is gone already might be called a natural benchmark of where we might have been had there not been human intervention. That is, perhaps, another useful way of looking at it.

I maintain that a more simplistic system is more vulnerable than one that has more options available in the face of changing times.

EARLE: I'm troubled a bit by this perception that there's no evidence of diversity yielding some greater resilience. Let me give you an example. When I was a young botanist, a population of asters growing along the highway was pointed out to me. Some were in full bloom; some had already bloomed and were past; some were still in bud. Within that one small population there was diversity that provided a recipe for resilience against changes in season, changes in temperature, changes in whatever. You could just see it very graphically. Not all were just lined up there blooming exactly alike. You had diversity within that group. It was impressed upon me at the time that that diversity was critical to survival, that when you have a population that is whittled down to a very small number of options or choices, you're more vulnerable. When humankind has zeroed in on a few dozen plants and animals as the primary source of our sustenance – four grains provide 50 percent of the calories that drive the world – we are making ourselves vulnerable to, say, a virus that goes after rice and eliminates rice. There are lots of variations of rice, fortunately, because if there weren't, we probably would be in

worse trouble than we are now.

I maintain that a more simplistic system is more vulnerable than one that has more options available in the face of changing times. If everything is stable forever, then you could make these choices and be sure that you're going to have enough calories to consume. But it's the great unknown of what's going to come along that's going to wipe out something that we're now relying on. Wouldn't you like to have some options out there that would see us through? I love the stability of stromatolites, but we're talking about stability that would support *us* through the next millennium and the millennium beyond that.

There are places where coral reefs have existed through warmer periods and cooler periods going back several hundred thousand years, but nothing like the changes that have taken place in the last 50. And it isn't just climate change; it's climate change plus these other factors that we are imposing on the system.

It's not just species that matter; it's the integrity of systems; it's what makes the biosphere work for our survival, not just the survival of life.

So, I don't know what your rules are, Dan. If you insist on quantification, then let's get at the business of quantifying it, but let's make sure that all the facts are inserted in the system. It's not just species that matter; it's the integrity of systems; it's what makes the biosphere work for *our* survival, not just the survival of life.

… when you actually look at what has happened to populations that have been brought down very low, some of them have come back remarkably well …

BOTKIN: That's very important. That's a very lovely story. I'm trained in botany and plant ecology, and I can give you many examples of that kind of diversity, that is, within-species diversity. Let's look at some other information. The elephant seal was reduced to about a dozen. The British Museum tried to extinguish them all because they believed that it was better to be dead and mounted in the British Museum than to die an ignominious death on the California coast. They failed to find them. That is a very genetically limited population; it's around 200,000 now. You can claim that it is vulnerable – and it may be vulnerable – but it sure is doing well.

There are other examples that are contrary to your example of the asters. So, you can have an emotional storytelling that's very attractive. I could argue the same way you're arguing. What I'm saying is that when you actually look at what has happened to populations that have been brought down very low, some of them have come back remarkably well and are still supposed to have very limited genetic diversity. So, it isn't that simple. I have studied ecosystems and biosphere dynamics, and I have written and studied a lot about what stability can mean in ecology. It's much more complicated than the story you just told.

See, I can argue from facts in opposition. The question is: What are we really going to tell the public? And what, honestly, can we say to the public? Are we "crying wolf"? What are we really going to do?

It is dangerous to keep on taking this aspect of talking about the humanity/biosphere relationship easily or lightly. I think it's very important.

ISHWARAN: I would like to make a plea that whenever you go into deeper territory as to what you want to get out of this conversation, to take seriously the problems in conversations from science to the broader society, whether that is a conversation with this abstract entity called "public," or whether that conversation is with another abstract entity that I use very often called "decision-maker" or "politician." The morning meeting I was at with the Director-General was with the Secretary-General of the Convention on Biological Diversity [CBD], who was visiting UNESCO. The CBD has a 2010 target to minimize biodiversity loss.

These are becoming conversations with people who make judgments and decisions. Ecology as a science, as David rightly said, doesn't make any value judgments, but then there are loaded terms in ecology, like *stability*, *resilience*, and so on, and these are being taken into conversations in the broader world where they might be used glibly or taken out of context in all kinds of ways. There's a quote I remember

from Pascal. He's a French philosopher, but I like to think of him as a French mathematician – nothing against philosophers; I know Shekhar is also a mathematician and has some mathematical background. Pascal said, "The beginnings of an intellectually honest life start with a deliberate effort to speak clearly." I think it's very important in international business. It's becoming more and more difficult to have a conversation and get messages across.

It is dangerous to keep on taking this aspect of talking about the humanity/biosphere relationship easily or lightly. I think it's very important. Being in UNESCO, which is an organization for education, science, and culture, I think it's very important.

FACILITATOR: That raises a question in my mind: If we were to imagine a group of people sitting around this table – decision-makers, politicians, public, students, youngsters – what would they conclude from just listening to what has transpired so far? I think they would say, "I don't think there's anything I've heard that we should be really concerned about to do anything about." Maybe that might explain the indifference and the disinterest that you run into.

SINGH: I disagree, because I think if there were students who had been properly trained in the disciplines – whichever discipline – they would recognize that this is the way in which thought progresses legitimately. If there weren't differences of opinion, if people did not raise questions about everything, we would have stopped thinking a long time back. So, I don't think it's a negative thing altogether.

BOTKIN: I would also say that if it comes to public policy, I think Sylvia and I would probably be very much in agreement, because I will defend the maintenance of biological diversity. This is a discussion within our field in response to a very legitimate question. If you put us in front of Congress, I think we would say the same thing. I really think we agree on the overall goal. We're talking here at an intellectual level.

FACILITATOR: I see. That's very enlightening.

… we should be careful not to confuse the belief that they have some value we want to treasure with the proposition that they're somehow vital to the functioning of the universe.

MACDONALD: Several people have said that we perhaps shouldn't be too hung up on species as the unit of consideration. It might be helpful to introduce the thought that species and their changes in numbers and, indeed, even their existence are all part of processes. So, a modern view might be to say that we should be concerned about the impact of human activities on the *processes* of nature and evolution, as well as the units within those processes, which are just the species – on which topic over the last 10, perhaps 20 years it's become fashionable to somewhat mock people who were concerned with what is characterized as preservation as distinct from conservation.

I think common usage at the moment is to say that *conservation* is about concern for those processes in which species are wrapped up, and that there's something small-minded and anachronistic about too much concern with *preservation*, which might be, for example, some particular rare species of butterfly flitting about in a forest glade somewhere of which there are only 10 individuals left, and people go to extremes of effort to preserve those 10 butterflies and who cares? That would be the preservation model, which, as I say, has been somewhat ridiculed – perhaps wrongly, because in the same sense that one might treasure the Mona Lisa, one might want to treasure those butterflies. But we should be careful not to confuse the belief that they have some value we want to treasure with the proposition that they're somehow vital to the functioning of the universe. So, I'm not sure it's right to ridicule preservation, as has been the fashion, but nonetheless processes are probably the more important thing.

… while in the science of the ecology and the transference of that towards policy matters, there has been an assumption that it might be appropriate to treat all species as equal in value, that assumption is, at least at one level, patently ludicrous.

Finally, to link this back to the conversation about education and communication, it seems to me that while in the science of the ecology and the transference of that towards policy matters, there has been an assumption that it might be appropriate to treat all species as equal in value, that assumption is, at least at one level, patently ludicrous. Because if one asks the world community of people – indeed, *any* community of people – whether they value equally all species, it's conspicuous and clear that they don't. How many people, for example, would value a gorilla or an orangutan or a certain species of whale the same way that they would value an unnamed soil microbe? So, I think we should, when we get back to thinking about education, remember that at the moment it's quite clear that society doesn't value species equally.

FACILITATOR: Thank you.

I'm going to simplify this next step. I'll go around the table and ask each of you to tell me, of everything that's on the board, which three do you think are of consequence. Malcolm?

HADLEY: If one takes the position that we should be talking about the future of the biosphere and not the future of humanity, then probably we need to be looking at the sorts of questions that Dan raised. In the question of biodiversity dynamics in its broadest sense, including from the landscape through the species to the genetic diversity, that is the central question. In the whole question of changes in fluxes of energy, fluxes of minerals, fluxes of elements, perhaps there's a second one. I think probably we need to be looking at that rather than the more generic ones of ethics.

FACILITATOR: And a third one, Malcolm?

HADLEY: Now, I'm mixing apples and pears if I'm thinking of other things that I think are important, but my third is this whole question of joining up, linked up with education and learning.

FACILITATOR: So, for purposes of moving forward, can I mark you down for education in the broader sense with the modification?

HADLEY: Yes.

FACILITATOR: Okay. Sylvia?

EARLE: Well, my three are there: the categories that I expounded on earlier [education/communication/enlightenment, exploration/research, equity/ethic] – with the understanding that equity/ethic leads to managed change. It's how we manage change.

FACILITATOR: Okay. Eric?

CHAISSON: Education, including what Ish was driving at: communications and learning. That's one.

For the second, I'm not sure if I can distinguish between the driving forces and the behavior patterns of humans to be discovered from Sylvia's exploration/research.

FACILITATOR: I think that exploration/research had to do with continuing the scientific research aspect, whereas the other had to do with the driving forces in a social sense. Magnus amplified it with "specific to trading and conflict and disease."

I want to emphasize the continued need for exploration to take further inventory of the biosphere.

CHAISSON: I want to emphasize the continued need for exploration to take further inventory of the biosphere. Then third, I don't want to lose sight of the ethics, though I'm not sure what to say about it, so give ethics a check for me.

FACILITATOR: Would that all fit into this more general category of equity/ethic?

CHAISSON: Yes.

FACILITATOR: Okay. June?

MOW: Education, communication, and learning. Second, social aspects or social/cultural aspects. And the third one would be managing changes.

FACILITATOR: Okay. Magnus?

NGOILE: I'll take the driving forces, first. Second, equity within the social context. And then third, the whole issue of education, communication.

BOTKIN: Ethics. Then, second, driving patterns. And then the one that I had on the systems and dynamics of the biosphere.

SINGH: I would go with equity but I would go with the new formulation, which was equity and ethics. Second, I'll go with education, and third, I'll go with managing change.

MACDONALD: Towards the goal of managing change towards a reduced human population, I would make three: One would be innovation in the ecological; the second would be in the economic; and the third would be in the governance approaches in thinking to managing that change. Managing the change is the goal, and it seems to me to have three components. I suppose "equity" captures my interest in governance.

ISHWARAN: Well, I will go for that big block that has education, though I don't like the word *education* because it gets used in very stereotyped ways. Then equity/ethic, though, for me, as David said, the equity part is much more important – not that I am anti-ethics; ethics can be there, but equity is more important. And then I'll go with managing change, also.

EARLE: I just wonder if *all* of what we're doing is leading to the issue of managed change, if we have three categories with the overarching objective of managing change – because we are talking about *our* relationship with the biosphere, which implies the question: What are *we* going to do? This is not an issue of how do we react to things over which we have no control. What can we do to manage *ourselves* relative to the changing world? So, rather than a separate category, all of these things are funneling into managed change.

FACILITATOR: So, a way to state what Sylvia is saying is that managing change/governance, economics, retreat – whatever the elements might be – is inclusive of education and notions of equity and ethic.

EARLE: All of it.

MACDONALD: That's exactly what I was trying to say, that the management of change – initially coping with our situation getting worse, as there are, for some years to come, going to be many more of us, but the goal is, latterly, hopefully directing that change towards a better situation. The other things are mechanisms for achieving that, which is where I think ecological, economic, and governance systems are important.

ISHWARAN: It's all words, but I might adapt myself to a lot of change, but that's managing *myself*. But then if you want a change to come out of social response, which is me and numerous others, that would require management that would have solid short-term, medium-term, and long-term goals and objectives. I look at management as a thing one does for a group.

FACILITATOR: You are referring to this in some top-down sense of managing, isn't that correct, David? What Ish is stating as an option is adaptation and change at an individual level without any formal structures imposed.

MACDONALD: I'm merely using the word *management* as mechanisms for achieving a specified goal.

FACILITATOR: Right. And those would be both top-down and bottom-up and everything else in between.

EARLE: Also in the interest of trying to find the right way to gather these thoughts under certain logical categories, what was intended by the category of "exploration and research" is not just, for example, taking expeditions to new parts of the Amazon or to the deepest sea, but to look at exploring new ways of thinking. I think it could encompass the category of the "driving forces behind conflict." It's a kind of research, exploration into ideas or analyzing the fundamentals behind conflict or Dan's point about looking at the dynamics of systems. That's a form of exploration and research.

FACILITATOR: I understand. So, it's not strictly in the scientific sense, but also societal and all civilizational driving forces.

EARLE: Yes.

FACILITATOR: What emerges, then, is to look at managed change inclusive of education, equity, and ethics – that is one issue. The second one is exploration/research inclusive of science and other aspects such as societal and also taking into account driving forces – that would be the second issue.

… we manage change to make sure that society becomes more equitable and ethical … to make sure that there is more universal learning and exploration …

SINGH: Whereas I agree that managing change is an overarching theme, you have to put more substance into it; otherwise it is a very empty statement. What did we all come to Paris and decide? That we want to manage change. We didn't have to come here to decide that. Therefore, I think we have to be more specific and say "managing change with specific focus," and then these components come in. For example, we manage change to make sure that society becomes more equitable and ethical. We manage change to make sure that there is more universal learning and exploration, etc.

FACILITATOR: Exactly. It's managing change with sub A, sub B, and other elements that are incorporated.

SINGH: Well, I'm not happy with subs. I'm suggesting that we specifically say that we're managing change with specific focus. The term *focus* or *priority* needs to be somewhere along the line.

EARLE: Do we need four categories then?

FACILITATOR: No. The first issue is managing change with specific focus on education/communication, equity and ethics.

EARLE: But then we have exploration and research.

FACILITATOR: Well, exploration and driving forces form a second set of combinations, so that's a second issue.

SINGH: I would agree with Sylvia that actually managing change doesn't become one of the three at all. It's the overall heading, and then we have three sets of focus. To put it very simply, the first focus could be that we want to learn more; we've got to discover more. The second should be that what we learn and discover must be proliferated, so that's where education comes in. Then all of this must be in the context of an equitable and ethical social system. That's how it tends to cohere. And managing change is the overall umbrella.

EARLE: Yes. That makes sense.

CHAISSON: Could I ask Magnus to rearticulate what he means by "driving forces" and "behavioral patterns of humans"?

NGOILE: When I proposed that, I was looking into what we said yesterday: You go back a thousand years and you see what was then. And then you take where we are now. The change that has happened between a thousand years ago and what we are now, with regard to behavioral patterns of human beings, those will be the driving forces. So, you consolidate at that point.

Now, if you are going to go for the better, then you take those elements that are negative and then you strategize in order to bring in a change so that you go for the better instead of the worst.

FACILITATOR: To throw out a proposition, if we stay with "managed change" at the top with what you have just articulated, does that imply that we carry forward with the driving forces, whatever they might be, being still the same? Managing change might require a better examination of what those driving forces are and, therefore, reorienting what the driving forces ought to be.

SINGH: I think that was the great advantage of the formulation we agreed upon, because it has that flexibility. See, you study the driving forces because you talk about understanding, etc., and as and when they need to be changed, you change them. The context has been given there: They must be ethical and equitable. That's the overall context, and flexibility is given. It doesn't bind us down. It doesn't give us the arrogance to say that in the year 2006 we know exactly what we need to do for the next thousand years. It gives us the flexibility to say that we're going to learn; we'll figure out what's going to happen, maybe five years, ten years later when new things come up.

It was, at least when I proposed it, managing change in the direction of diminishing human population and the associated footprint.

MACDONALD: Just to remind you: When I suggested originally the managed change, actually what I said to start with was managed retreat, using the word *retreat* to capture the thought of shrinkage or dimi-

nution of the human population and its footprint. It seemed sensible to slightly generalize that to "managed change." What I absolutely did not mean, and I believe we do not mean, was managing just any change. It was, at least when I proposed it, managing change in the direction of diminishing human population and the associated footprint.

… a learning sort of approach to life in general should not go to the level of refraining from action when you have to do something.

ISHWARAN: Shekhar's formulation is fine, but does it include, in terms of managing change, those moments when, even though we are learning all the time, we might have to act with imperfect knowledge to meet specific goals and targets? In that case, maybe it is okay that we have equity/ethics in terms of the process we would use to arrive at those targets and goals, but a learning sort of approach to life in general should not go to the level of refraining from action when you have to *do* something.

FACILITATOR: What I'm going to do is ask David, having heard everything now, since you were the person who suggested that language, to now incorporate this and make one single statement, please. The statement should encompass the conversation on what we have agreed on to be the issue. Several points have emerged as a consensus. I would like you to articulate it, or maybe Shekhar can, or maybe both of you can put your heads together, because that will become the focus of the conversation in the afternoon.

Once you formulate the statement, we'll allow two minutes for edits that the others might suggest.

MACDONALD: With the goal for the benefit of humanity a thousand years hence of ensuring a sustainable and high-quality life for our descendants then, we will tackle issues under the broad headings of the functioning of the biosphere, thinking particularly of ecological principles, the management and *modus operandi* of that hoped-for population in terms of an equitable system of governance, promoted through the intelligent use of communication, which might be called education.

SINGH: I'm sorry, but first of all, I don't want to focus this only on the well-being of humanity, because that goes against one of the principles of equity that we were talking about. I was hoping that as one evolves as a species, we would start looking at the well-being of *all* the species and not just the well-being of humanity. This point has been made by many others, apart from me, that we must start recognizing that other species have value in themselves.

Number 2, I don't think we should talk about equity only in governance because governance is a very limiting factor. We should talk about equity in general, because why should there not be equity in social relationships? Why should only the government be equitable? These are the two points I have, and we can reshape the statement around that.

EARLE: I was hoping that the "managed change" category would be overarching rather than one of three. That's the headliner, and these other three, or whatever it is that we choose, would be elements of it.

MACDONALD: Yes.

FACILITATOR: Yes, we've come down to a single issue, enlarging the scope of what is constituted under it.

MOW: Initially exploration was not in the "managing change" category, and I think it was left out.

MACDONALD: I hope that the one thing I got right was that managing change in a specified direction is the overarching goal. I'm more than happy for equity to be used more generally than I tried to express. The exploration point was meant to be embraced in the formulation that Dan offered us of understanding the functioning of the biosphere. I think that was swept up.

FACILITATOR: In addition to that, it was inclusive of what Magnus was saying: exploration or understanding of the driving forces.

SINGH: Can I just restate: What I understand is that "managing change" is the overarching category, under which we have three different foci, one of which would be a proper formulation of the point about exploration, because we are putting in this point that we have to constantly seek out and go and understand.

The second one is a proper formulation of the concept of education, which is really a concept of dissemination or sharing of knowledge, etc. And the

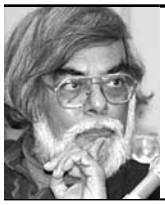
third is the concept of ethics and equity in a larger sense than governance. This is how I understand it.

FACILITATOR: That is correct, with one minor change again. What I think has been agreed to is that exploration is not strictly in the scientific sense, but exploration/research/understanding driving forces.

ISHWARAN: Just a question: Managing change, the focus of all this – is it in the biosphere or the humanity/biosphere interrelationship?

I can't conceive, personally, of human well-being being satisfactory in the absence of a functioning biosphere …

MACDONALD: When I originally stumbled toward saying "for human well-being," that, to me, presupposes a functioning and sustainable ecosystem with all the elements of biodiversity. I had attempted but failed to capture that wider thought. I can't conceive, personally, of human well-being being satisfactory in the absence of a functioning biosphere, but maybe it needs to be made explicit.



… if you put the interest of humanity up front, then it creates a certain logical ripple that could lead you to all sorts of problems.

SINGH: We can debate forever, but I think this is where Dan's point comes into play. The term *biosphere*, as we agreed, includes the human being, so, in fact, UNESCO needs to change its title to "Humanity *within* the Biosphere." Since the biosphere includes humanity, we don't have to specify.

The well-being of the biosphere is one thing. But if you put the interest of humanity up front, then it creates a certain logical ripple that could lead you to all sorts of problems. So, why put it up front? Why not be gracious for once?

FACILITATOR: Okay. We'll break for lunch, then reassemble to go at that statement.

Critical Issue Conversations

Discussion of the Most Critical Issue

… we have zeroed in on just one issue that is somewhat large in scope and encompasses other elements that participants have identified.

SESH VELAMOOR (FACILITATOR): Normally when we arrive at this stage in our seminars and conferences, we have three issues that have been identified as the most critical going forward for the next thousand years, and we then conduct three fishbowl discussions, one for each issue. Invariably participants are assigned to the topic that they like the least. A key element of the fishbowl is that it promotes listening – something I have found to be somewhat rare in the framework of conferences – and it promotes conversation, give and take, among participants. The individuals within the fishbowl discuss the issue with the remainder of the participants seated around the outside, listening, then later interacting with the participants inside on what has been said.

In this case, we have zeroed in on just one issue that is somewhat large in scope and encompasses other elements that participants have identified. Because our group, as it currently exists, is rather small, we won't attempt that exercise. Rather, what I propose to do for the remainder of the conference is to simply take the subject of the issue that we have identified and have a freewheeling conversation sharply focused on this one issue.

If anyone would care to suggest a modus as to how we might approach the subject, because it's large in scope, I would like to hear some thoughts on that. Then, once we conclude this discussion, anyone who wishes to take part in forecasting or envisioning the future, putting together some scenarios, we will make time for that. When we did this some years ago in one of our conferences – Eric was a participant in that seminar – participants were required to draw up visions or scenarios. I still remember that Eric's idea of the thousand-year future was to colonize an asteroid where he would be lord and master running a baseball team.

Who would like to suggest, as a guidepost, a way of attacking this large issue?

If 100 or 500 years down the line, we have all of this in place, let us be devil's advocates and ask: What else could have gone wrong in the meantime?

SINGH: I think that the first thing we need to do is once more discuss and agree on the formulation, because certain new elements have come into this.

Having done that, the second thing we need to do is ask ourselves: If 100 or 500 years down the line, we have all of this in place, let us be devil's advocates and ask: What else could have gone wrong in the meantime? So, these could be the two things we could consider doing.

These are global problems; they're unlike any problems humanity has faced before … and we must solve every single one of them.

CHAISSON: This may be too early to raise it. I did push a hot button this morning unintentionally, but now I would like to push a hot button intentionally and raise an overriding issue that you may or may not want to entertain, and it's a dilemma that I've had for my entire professional career. I trot it out every spring in my course hoping my students will help me

solve the dilemma, but no one's ever been able to do so. The problem is this: As we move over the next 10 centuries we will confront, no matter what your list of important factors may be, a series of global problems. These are *global* problems; they're unlike any problems humanity has faced before. My parents would say that World War II was a global problem, but it was *not* a global problem; it was a very serious regional problem. By contrast, we will now begin to face true global problems, and we must solve every single one of them. If we fail as a civilization to solve one of them, then that's the solution: We have failed; the meek do inherit the Earth. Lynn Margulis' microbes win.

The hope and the aspiration is that we do, like walking through a minefield, ever so slowly manage, with optimism or technology or cunning, to solve each and every problem in turn. But the problem and dilemma I have is that as we solve each and every global problem, we must be, as a civilization, willing to take on a little bit more restraint, a little bit more constraint. To solve a global problem, we simply will not be able to do whatever we please to do. There will have to be certain regulations and rules imprinted on society to make certain that we have solved that problem so that we can continue along the arrow of time on into the future.

As we continue to survive, it seems to me that we accumulate more and more restraint … if curiosity and freedom die, does intelligence die with them?

As we continue to survive, it seems to me that we accumulate more and more restraint, more and more constraint, more and more inability to do what we want to do. It's as though we lose freedom and dignity (without being too "Skinnerized"). Although we survive and we make it out in front a thousand years, is it worth having achieved that goal when to solve these problems we have taken on such an irreversible and inevitable amount of restraint, that we've lost a great deal of freedom and curiosity? And if curiosity and freedom die, does intelligence die with them?

How can I get out of this dilemma? Regardless of what you have on your list, no one's ever been able to help me escape this dilemma. You either are down the crack because you fail to solve *one* problem, or you solve them all successfully and you inevitably move toward a state of stagnation, or at least a state of ever less and less and less freedom and dignity and curiosity. Help me out.

FACILITATOR: Eric, is there a direct correlation between solving of a problem and an inevitable constraint in the sense of restricting the extent of the freedom that we're talking about?

CHAISSON: I think so.

… society ought to be more like Mont Saint-Michel, which you walk up with no OSHA barrier to protect you from falling off. If you fall off, fine.

BOTKIN: There are two lines of thought. First of all, Joseph Campbell's books are very interesting on this point. He says that there are really two kinds of societies, the hunter-gatherer and the agricultural, and that we would be very uncomfortable in the Egyptian agricultural society where everybody has to work together and there is little room for individual creativity – but that's been most of civilization. Because we have ample energy and we had the Cartesian revolution and Adam Smith and Jefferson, etc., we have this freedom and opportunity to be creative, and that is what we're comfortable with. Most of the people who have lived on the Earth historically, not numerically, wouldn't notice those constraints that we would feel if we were to go back to classical Egyptian society thousands of years ago. We wouldn't like them because we have the freedom to be creative as a hunter-gatherer.

The next thing is that what you're really getting into is risk analysis. American society seems to believe that nobody should ever have any risk, and if they do, it's the government's fault. I think society ought to be more like Mont Saint-Michel, which you walk up with no OSHA barrier to protect you from falling off. If you fall off, fine. What you're saying is that if we want to be free and creative, we have to accept risk-taking. I think that's inherent in modern Western civilization, at least. So, you don't really get rid of the dilemma, but you have to say, "I would rather be a risk-taker and have freedom than to be a peasant farmer and be secure." That's a fundamental choice.

FACILITATOR: But I thought Eric was implying that if the necessity is to solve the problem, then you don't have the choice of taking the risk of *not* solving it and remaining a hunter-gatherer.

BOTKIN: I'm saying that then solving every global problem does *not* become the primary goal. Retaining the freedom to be innovative and creative is the goal – with risks. So, you can be a Thoreau with some risks, or you can be the guy that leads the life of constraint. That's the fundamental choice. It may not be that we want to solve every problem.

CHAISSON: If you don't, then you fail.

BOTKIN: No. Why do you fail?

CHAISSON: Because you *must* solve every global problem.

BOTKIN: No, no. What's going to go? People? I don't think so. All of this life? No. Civilization won't go into temporary decline.

CHAISSON: All of life will certainly not go. There is a great resilience there, and the meek *would* inherit the Earth. But I think there is a possibility that civilization would be so seriously damaged that, even though it might rise like a Phoenix from the ashes again, it would be a testimonial that we cannot, without technological sentience, go beyond our level of expertise.

Civilization as we know it depends on ample energy, and if we don't have that ample energy in the future, then we could be in decline.

BOTKIN: See, that's a level of projection. I think the real dilemma here isn't people's ability to be innovative. According to my anthropologist friends, the Eskimos who do the whaling invented whaling very cleverly, using devices very similar to what the Yankee whalers used, only made out of bone and horn. They were very creative and innovative, and they conquered the other Eskimos. They didn't start with very much. People are capable of a lot.

But I think that the big dilemma is that if we don't get good, solid alternative sources of energy in place that are long lasting and we run out of fossil fuel, then our civilization is going to be in big trouble. This is the point you were raising before. That's where there may be no going forward. Civilization as we know it depends on ample energy, and if we don't have that ample energy in the future, then we could be in decline.

CHAISSON: I can think of many other issues: nuclear warfare in the Northern Hemisphere, diseases that affect humankind….

BOTKIN: Those are *some* problems, not all problems. Yes, you can make a list of specific problems.

CHAISSON: But they're global problems that must be solved, in my mind.

BOTKIN: But I would say that there are *some*. You said *all*. I think you could get it down to *some* problems. I think you could get five or ten. Maybe you are saying that there are so many that we have an unsolvable dilemma. I think there's a small, finite number, but I could be wrong.

SINGH: Without in any way belittling the complexity of the issues, especially the ecological parameters, if I might just look at it as an ethical dilemma, the sort of proposition that you have put forward is the sort of proposition that could be put forward in other areas of concern. Essentially, unless I misunderstood you, you either have a choice to do something that will save humanity or much of humanity, but in the process of doing that you have to give up some very fond values like freedom, etc., or you could say, "I'm not giving up my value of freedom, no matter what that means for humanity." This is, to my mind, the sort of dilemma, if I have understood you properly.

CHAISSON: Yes.

… this dilemma could be looked at perhaps with greater hope if you didn't look at the linearity – either this or that – but started looking at the complexity …

SINGH: This is a dilemma in which there has been much historical debate. I find that the most convincing way of looking at it was put across by a British philosopher, G.E. Moore, who in his *Principia Ethica*, came up with the notion of an organic whole and said that ethical dilemmas should not be looked at in a linear fashion. The organic whole he defined as a

whole whose value was not the sum total of the value of the parts or was not in any direct correlation to the value of the parts. When we teach this to undergraduates, we give crass examples of hatred and violence both being negative, but hatred *of* violence becoming positive. That's a crass example; the concept is more sophisticated than that.

What I would say is that this dilemma could be looked at perhaps with greater hope if you didn't look at the linearity – either *this* or *that* – but started looking at the complexity: I'm going to have an option of a world that has lack of freedom but the existence of certain things, lack of this, lack of that – how does that organic whole seem to me as opposed to another organic whole?

Moore went on to say that all ethics is intuitive. Therefore, once you look at these two organic wholes, if you understand them, intuitively you will know which one you prefer, so there won't be any moral dilemma. But I'm not going that far. I'm simply saying: Look at it as an organic whole, and then the problem becomes not simpler but more interesting than just an either/or problem.

… I could imagine a sort of liberating regulation … it seems to me that not all regulation is suffocating.

MACDONALD: It's a very interesting question you raised. Others – Shekhar particularly – will have more educated views on this sort of thing than I, but I wonder whether regulation can sometimes be suffocating and sometimes be liberating. So, I wonder, therefore, if it is the *sort* of regulation that we have to swap for our survival solutions and the circumstances under which we make that swap. For example, it seems to me, living as I do in a country under an institution that is bedeviled by a lot of regulation, that each additional bit is actually quite expensive in terms of the creativity that Dan referred to and it's becoming suffocating. It seems to me that if we solve the problems that you allude to by going with increasing population, increasing problems, and trying to constrain ourselves out of them, that that regulation will bring with it a lot of costs.

On the other hand, I think I could imagine a sort of liberating regulation where we've got ourselves to a good position and enlightened self-interest left everybody with a better life by following what I can only describe as "benign regulation." That might be a naive distinction, but it seems to me that not all regulation is suffocating.

It leads me to a slightly different point on our thousand-year scenario. We started out by asking: Are we talking about where we think – I suspect rather morbidly – we might be a thousand years from now or where we would *like* to be? It's possible, I suppose, that in either case we end up with many fewer people scattered around the world with a smaller footprint, either because we've suffered a disaster that has fragmented those people and destroyed many of them, or that we have managed, in the positive sense, our way into that better circumstance.

… if we get a thousand years from now and we have suffered all the blights we're quite likely to suffer, there might be … a damagingly low-tech world …

It seems to me, therefore, that those two end points could have very different descriptions on the parameters we're talking about. I could imagine that if we get a thousand years from now and we have suffered all the blights we're quite likely to suffer, there might be a low-tech, a damagingly low-tech world with fission between people and not a global system of governance at all, but people retreating almost back to the Stone Age, as someone was saying earlier. On the other hand, if we get there by technology, intelligently, getting ourselves out of the problem, I think we would be looking at a global community with that sort of governance and the sort of regulation that might be liberating – but that is very futuristic.

HADLEY: On the risk-taking point that Dan mentioned, don't we have a whole range of different attitudes toward that, even within a particular geographic part of the world? Just taking Western Europe, different societies within the European Union have very different perceptions and very different sociopolitical systems in terms of risk. The Scandinavians are prepared to pay 50 to 60 percent of their salaries to the government in return for a certain social security and

protection from risk. Yet in *this* country [France] one would never get the population prepared to pay that. So, even within a relatively homogeneous culture, there's a great difference in our perceptions of risk.

On the subject of *global* problems, what global problems has humanity faced up until now?

… there are now issues that would go well beyond a conflict even as large as World War II to affect much of, if not indeed all of, humanity.

CHAISSON: Well, I mentioned that when I shared this with my parents many years ago, they immediately pointed to World War II, which was a huge issue for them that they interpreted as a global problem. I interpreted it *not* to have been a global problem because it could not have affected humanity as a whole, despite the magnitude of the war. Whereas severe overpopulation, disease that was unchecked worldwide, all-out nuclear warfare in the Northern Hemisphere – there are now issues that would go well beyond a conflict even as large as World War II to affect much of, if not indeed all of, humanity. Humanity would not necessarily be able to escape from it. Or if it could escape from it, in a rise from the ashes, it would imply that it's possible that humanity would not ever be able to go beyond our level of technological development, in that it would repeatedly fail one global problem.

I maintain again that only one global problem might be enough to seriously harm humanity. I'm not saying that life gets wiped out; I'm talking specifically about humanity.

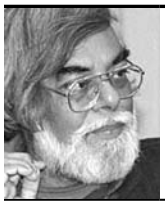
BOTKIN: Isn't that a definition of a global problem? Haven't you just defined it as one that wipes out civilization?

CHAISSON: I was trying to give Malcolm an example of a difference between a global problem and a serious regional problem. Does that help?

HADLEY: I'm not convinced entirely.

… I would challenge anybody to tell me what is anything of consequence, anything of significance, that is not a global issue …

FACILITATOR: In fact, I would challenge anybody to name a problem that is *not* global now, even as we were trying to define a problem that was strictly regional just a little while ago. For instance, the issue of climate change or global warming is not restricted to any region. I would submit that governance in all its complex varieties is a global issue. Of course, warfare and weaponry and security of humans on the planet are global issues. In fact, I would challenge anybody to tell me what is anything of consequence, anything of significance, that is not a global issue, with complex linkages and variables that interact so completely that it, in fact, almost seems insurmountable.



… for the first time humanity has the obligation, which it didn't earlier, to plan for and do something about these global problems, and I think this is the issue.

SINGH: I think that most of the issues you mentioned aren't global issues. They *could* be globalized, but there's a difference. For example, if there's a war going on between India and Pakistan, it's not necessarily a global issue. It could become a global issue, but that's a separate issue. It could be globalized. Unless one takes a sort of a philosophical point of view, which certain philosophers have taken, that every pebble on the beach is connected to the sea, which is connected to the other shore – that then makes nonsense of any distinctions whatsoever.

The important thing is that we are now in an era where we are beginning to recognize global problems. Earlier there *were* global problems. There was catastrophic climate change, apparently some meteorite that struck the Earth, etc., but we did not have the ability to understand or anticipate – and that is what has changed, in some sense. Therefore, for the first time humanity has the obligation, which it didn't earlier, to plan for and do something about these global problems, and I think this is the issue.

Let me put it in concrete terms: Suppose today we come to the conclusion that the only way to save the planet from climate change is to change the system of governance of the world and make the United States of America the dictator of the world to tell every country what it has to do. Now, maybe that's true, but do we want that? Or would we rather go through climate change and finish with it?

So, in a very stark sense – this is a caricature, but one could come up with scenarios like this, that unless everybody gives up their political freedom and is willing to stand in line, we're not going to be able to save humanity from this particular thing. What does one do at that point? I would humbly submit that at that point, democracy should be activated and people should be asked: "Do you want to die or do you want to live and be not free?"

CHAISSON: "Live free or die."

FACILITATOR: I think the question of asking and finding out the result isn't going to be anything different from what we're already seeing as a small example within the United States, where with the war on terrorism, there is a direct tradeoff on personal freedoms. A majority of the population in the United States has already stated that they are willing to forego and compromise on the extent to which their liberties are affected in exchange for security. There is an example that already exists.

SINGH: Not just a majority of the population of the United States but the majority of the population of the world, because you either get bombed or support that.

FACILITATOR: So, in that sense I don't know that one needs to go find out what the choices will be.

CHAISSON: About a year ago in *The Atlantic Monthly*, which is a literary magazine published in Boston, there was a fictional essay as to what the United States would become in the context of your example after the Patriot Act III was passed. Patriot Act I is the one that's in effect now. The author projected ahead that with increasing terrorist attacks, with many more restrictions placed on us, a decade out, there would be serious issues about whether we were willing to accept that much constraint. I recommend that article to you ["Ten Years Later," by Richard A. Clarke, *The Atlantic Monthly*, January/February 2005; www.theatlantic.com/doc/200501/clarke]. It was a very telling article about the very same issue we're discussing.

… infectious disease is the one that seems to me to be literally terrifying at the moment because there are so many of us and the networks are almost complete.

MACDONALD: Following up Eric's point about global problems, it seems to me that although certainly there have, throughout time, been some global problems, like the meteorite, there are certain categories of problems that are conspicuously higher risk now and more likely to be global. An obvious category are things to do with networks of communication, in one sense or another, amongst all people, and infectious disease is the one that seems to me to be literally terrifying at the moment because there are so many of us and the networks are almost complete.

I think that in communications-type problems it is the same. The potentially regional war that Shekhar mentioned between India and Pakistan – in a sense, such regional or localized things surely have a much greater risk nowadays of moving to global issues because of the almost complete continuity of contact. So, I think there are whole categories that are much more likely to be global problems than once they were.

FACILITATOR: We were trying to address how one might go about this, and Shekhar had started to outline a method, but I think it got lost in the ensuing conversation. Shekhar, would you care to repeat it, please?

SINGH: What I suggested was that we should look at this formulation and finalize it, because I still have some doubts about the formulation, though I don't want to reopen the debate. Second, if this is a formulation of what we think are the three or four most critical issues affecting humanity and the biosphere or humanity *within* the biosphere in the next thousand years, perhaps it would be a good exercise to now put ourselves into a "time capsule" to go into the future and play a devil's advocate: Does it look like these *were* the right issues, or can one come up with a scenario that there were certain issues that were more critical? I agree with the point that there are other

things that *might* go wrong, but are there things (from the point of view of the future) that *have* gone wrong that are more critical than this, just as a double-check of this. We would all become devil's advocates. That's what I suggested.

FACILITATOR: Well, let's attempt that. We'll look at the formulation in terms of amendments or modifications without rewriting it completely, then position ourselves a thousand years from now and ask, "Would this have accounted for what we were attempting to do, or is there something else that could have occurred that is not included in this?"

SINGH: Could there have been something more critical?

BOTKIN: I would like to mention that the word *ensure* is kind of an arrogant word. It assumes that we have all power and control. In fact, we have a world of chance and a system we barely understand. So, we're managing change to – not *ensure* but *foster* or *promote*. *Ensure* is the American OSHA rule.

FACILITATOR: Do we have agreement on that? There is no terminal connotation with *foster*. There is some way to know that we have arrived if it's *ensure*.

ISHWARAN: As I mentioned in the morning, I'm not comfortable enough with the word *education*, dissemination of knowledge. We might be just telling people what we already know. I don't know whether – if you want to maintain the *E*s – something like *experimentation/learning* should not be more important.

EARLE: How about *enlightenment*? But with a slash, because I think education is a valuable component. That's where the communication of knowledge in a more traditional fashion perhaps is embraced, but I think what's intended here is in the broader sense, communication of knowledge.

FACILITATOR: Might I suggest the words we use in the mission of the Foundation For the Future: to increase and diffuse knowledge?

MOW: Can I ask if we are missing what we talked about yesterday: learning by doing? Somebody gave a good example. Should we try to recover *learning by doing*?

EARLE: But that's not all of it.

CLÜSENER-GODT: This is Miguel Clüsener-Godt from MAB Secretariat. I think we face these days in learning and education that there are some groups of societies in all countries that get more education and get a higher profile, and some groups are getting less and less education. I would say that it should be an equal education – a basic education for everybody – because when you want to increase the knowledge of the people, *all* must get more. I think the general feeling is that we go for elite societies that are very well skilled but pay this price by having part of society not well skilled. So, I would include here *equal society or basic education for everybody*.

Dissemination of knowledge is fine, but I really think that what's needed is an entirely new worldview.

BOTKIN: *Dissemination of knowledge* is fine, but I really think that what's needed is an entirely new worldview. That's what we're talking about. We have to come to really appreciate diversity and life and the system that sustains life in a spiritual way. We need a revolution in our whole way of thinking about the world, which is different from *knowledge*, which is very rational. I don't know what words we want to attach to this.

MACDONALD: *Human enlightenment*.

BOTKIN: *Enlightenment* is too intellectual. That's Cartesian. No, I'm talking about essentially a religious revival or something of another kind. I don't know what word to attach to it. Thoreau would say *spiritual*.

MOW: I think we're trying to put too much in one concept, *education*. I think everybody means something different when they're talking about education. Maybe we should try to see what everyone is trying to say.

HADLEY: Well, it's the awareness-raising, isn't it? I have no objection to *enlightenment*. Perhaps that's a cultural consideration.

MACDONALD: New worldview.

CHAISSON: I think the word *enlightenment* is a throwback to a Cartesian time, so I think it's an elitist word. I think it's a word that the general populace will not relate to, with all respect, Malcolm. I think *education* is a good generic term. It's understood by everybody; it's a general term; it can encompass your hands-

on activities; it can encompass your reaching out to the public by way of dissemination generally; it can encompass your John Brockman communications. Why do you want to invent a new word for *education*? They did that a few years ago with *edutainment*, and it just reeks!

BOTKIN: I think we're really talking about reverence or love for the biosphere.

CHAISSON: Yes.

BOTKIN: We're not talking about knowledge; we're not talking about classroom education. It's something entirely different.

EARLE: But we *are* talking about knowledge. You're right, but there is a profound lack of basic information in the population as a whole, even about the history of Earth, that the Earth is old and we are young.

BOTKIN: Agreed. You need that, but I'm saying we also need this other thing that is more revolutionary.

EARLE: Absolutely. Again, we're not in disagreement – amazingly.

FACILITATOR: I think we can leave the word *education*, but highlight it as the elements that we are all implying are included in it.

BOTKIN: *Spiritual revival*.

SINGH: One of the ways of solving the problem is that there seems to be a feeling that we should also bring in something about our attitude towards the rest of the biosphere. If you want to bring that in, you can put *education* with *exploration and research*, because they can go together and that becomes one consolidated point. You can have a separate point about evolving and developing and sharing in certain attitudes or a certain perspective of the biosphere.

EARLE: Is that under *ethics*?

SINGH: No. I'm suggesting that *education* be linked up with *exploration and research* and be made one point, because they are linked in some senses. As you explore and understand, you also educate yourselves. Then you have a vacancy for a third point.

I'm a little worried about talking about equity and governance and social rule. I had suggested three different aspects of equity: intragenerational equity, intergenerational equity, and also interspecies equity. So, either just say *equity*, which is well understood, or, if people agree, put in those three types of equity as subclassifications.

Ethics in a larger sense is a very unsatisfactory way of framing it. It's like putting *etc*. up there. We don't really know what we mean by *ethics, etc*. I think we need to be a little more specific about that or just say *within an evolving and all-encompassing ethical framework*.

EARLE: I somehow see a synergy with ethics and the equity, because that's where there should be perhaps expansion. Equity issues are a matter of morality and ethics, so it could be expanded under that heading.

I'm feeling a tiny bit awkward about the well-being of all species, because actually there are quite large classes of pathogens that we don't always want to prosper.

MACDONALD: I was very attracted when Shekhar mentioned originally that we should be talking about all species in the opening phrase of this. That having been said, I'm feeling a tiny bit awkward about the well-being of *all* species, because actually there are quite large classes of pathogens that we don't always want to prosper. So, would it catch the essence of your species concern to say *to foster a sustainable and biodiverse world*, or something like that?

CHAISSON: I like that.

EARLE: Except *sustainable* is pretty squishy.

MACDONALD: I'm just trying to capture the thought that it's not only about humans.

BOTKIN: No smallpox.

MACDONALD: Well, we don't want all species to prosper all the time.

… when we talk about "all species," at the back of our minds we always say "except man."

NGOILE: I have also a perception problem with *all species*, and the perception is simply that when we talk about "all species," at the back of our minds we always say "except man." It becomes *those species other than us*. So, maybe we should use a very strong term there, and I can't figure out one yet that really takes us all instead of that exclusion that we have always been talking about.

FACILITATOR: Well, we could say, *foster the well-being of humans in the biosphere*.

SINGH: No, I would suggest just saying, *well-being of the biosphere*. Then we can decide whether the well-being involves pathogens or not.

EARLE: I go along with that; I think it embraces the concept.

We can evolve and adapt to change in the biosphere, and manage certain aspects of it, but managing the well-being of the whole biosphere – that's a tough call.

ISHWARAN: Again, it's all words, but I don't know that we can *manage* the biosphere, leave alone *manage change* in the biosphere. Shekhar used the word *evolving*. We can evolve and adapt to change in the biosphere, and manage certain aspects of it, but managing the well-being of the whole biosphere – that's a tough call.

FACILITATOR: We did talk a little bit about the polarities: Are we merely participants or do we have conscious control? I think there was strong implication that we are at a point where we do have the ability to control, and that would imply change, manage, do whatever we wish.

ISHWARAN: There is an evolution of consciousness happening – there is enough being written on that. If you are talking about control, what are you going to control? There you are getting into problems with the ethics and equity objectives of your broader mission.

Phrasing this from the point of view of an individual who is part of change in the biosphere, who is conscious more and more of some of the changes, maybe not others, but who would also like to influence those changes towards particular directions, one can only say that you work to influence change in the biosphere towards better recognition of all living dimensions of the biosphere. But I don't think you can ever control it. Even if you are a dictator, you won't control it, because the moment you are a dictator, immediately there will be subversive elements starting up.

SINGH: Dan said earlier that fundamentally we are talking about social issues and social change. So, we can just say the *overarching goal is managing social change to foster the well-being of the biosphere*, because that's all we're going to manage: the change of human beings, how we act or don't act.

EARLE: I agree in principle, but it's not just the social. Maybe we should say something about managing human actions, because you're right that there are some things beyond our control, but there's no question that our impact on the natural world is at such a scale that we are changing the basic, fundamental nature of the biosphere through the toxins, through accelerated warming, through the depletion of diversity on a broad scale, ecosystems and species and the like. So, maybe it's managing human actions for the well-being….

FACILITATOR: Or human impacts.

SCHAAF: Just as Ish said before, *evolution of consciousness* is the key where things actually come together. Human beings are both the victims of change but also the agents of change. We have always almost come to a point where we are both destroyers of the environment but also conservers and protectors of the environment. We are almost in a God-like position, perhaps like never ever before in human existence, because we can consciously act upon the environment as we could never do before.

Now, we are evolving. I referred to this earlier. But our evolution so far has not resulted really in assuming full responsibility. Evolution of the consciousness of our acts must be key. But evolution of consciousness without spirituality – that's where I come back to

Dan – is perhaps not possible. There has to be a certain spiritual underpinning in order to go in the right direction. I'm not saying what is good and what is bad, but without any spiritual underpinning, I think we cannot evolve our consciousness in order to manage or change the biosphere to what we would like it to become.

In essence, I would simply add another topic or *E* – in order to be in the line of the *E*s – *evolution of consciousness*.

FACILITATOR: I think that encompasses everything to do with education and learning and teaching.

SCHAAF: To some extent, yes, but it's wider.

I'm not comfortable … with encouragement of spiritual values being brought into anything we do today.

CHAISSON: I'm beginning to feel a little uneasy that spirituality is creeping into our discussion more than I'm comfortable with. If there are any problems in the world today, I might make the argument that religions in part seem to be front and center. I'm not comfortable so far in the discussion with encouragement of spiritual values being brought into anything we do today.

BOTKIN: I want to make a distinction between religion, especially formalized religion, and spirituality. Thoreau was very aware of this. Although he was a Transcendentalist, he wasn't part of a formal religion in our sense, but he had a great spiritual sense. So, when I'm talking about *spiritual*, I mean in his sense. As a very direct example, Thoreau said, "They say that when an impala in Africa is shot and eaten, you can tell what the impala had grazed on from the scent of the flesh. Oh, that I were as much a part of nature." That's a spiritual statement.

CHAISSON: But Thoreau, Emerson, Alcott, Hawthorne – all of the Transcendentalists were pantheists at heart. They were nature lovers.

BOTKIN: But that's a spiritual statement, and it's distinctive from formal religion that ends up producing wars. This is the spiritual connection, which is intrinsically different, a different part of human experience. There is a direct connection to nature, yes, and a sense of rising above ordinary existence through that contact. That's what Thoreau was talking about. It is an important human experience, different from formal religion.

FACILITATOR: Why could not spirituality or that realization that Dan is talking about be a consequence that would logically ensue if we were successful in doing this? It doesn't have to be a precondition because then there would be no distinction between spirituality and religious systems that establish these to be the values. Spirituality is something you get to, not start from – that is what I'm trying to say.

BOTKIN: I think that you don't get to that through what we call *education*. I think you get to it through exploration. I would think, Sylvia, that you felt something like that when you were down 900 meters. Don't you get that kind of direct sense?

EARLE: Absolutely.

BOTKIN: That's more important – but it's not rational education. I'm just making that distinction.

FACILITATOR: One thing that crossed my mind here is: If this overarching goal is managing change to foster these things [evolution of consciousness, exploration and research, education, ethics/equity], with the intent of getting to the well-being of the biosphere, that sets in motion a process and a set of things that *are* under our control, *can* be managed, *can* be done, which results in the well-being of the biosphere – rather than starting with a statement that says *foster the well-being of the biosphere*, and then struggling with what the elements are that would get us there. So, maybe we should restate this to say *managing change to foster* these things.

MACDONALD: No, these were means to an end.

FACILITATOR: Exactly. That's what you're fostering: the processes by which we get to the objective.

MACDONALD: I think you foster the pursuit of the goal by means.

FACILITATOR: That's what I'm getting at, too. I'm simply saying identifying the means resulting in the objective of the goal, rather than stating the goal and then having a difficult time attaching the means to get there.

SINGH: I think Ish's point was slightly different, if I've understood him: that we shouldn't set it on ourselves to manage the biosphere.

FACILITATOR: Right.

SINGH: So, by putting it at the end I don't think that problem would be solved. I think the important thing is either to take on board Sylvia's suggestion that we are managing human impacts or human actions, or managing society.

EARLE: Somebody suggested saying *influencing change* instead of *managing change*. *Influencing* means that even those things over which we have no control we *can* influence, to some extent, through our actions.

CHAISSON: An even better possibility, incorporating Ish's remark, might be *adapting to and influencing change*.

EARLE: … *for the well-being of the biosphere*. That is the overarching goal.

DOGSÉ: I would have some concern. I think you have moved from looking at the species perspective to a very collective perspective of the biosphere. I would not know what the well-being of the biosphere would look like.

CHAISSON: I agree.

DOGSÉ: I could imagine that from the biosphere perspective, the well-being of the biosphere might exclude people all together. So, I'm not sure who can speak on behalf of the biosphere, saying. "This is good for me."

EARLE: We know what's bad, though, from our standpoint.

CHAISSON: Peter is suggesting that *well-being* is a value-laden term. Peter, is that fair?

DOGSÉ: Yes. And it's a bit difficult to assume a specific state of affairs that would maximize the well-being of the biosphere. It would be difficult to say that this state of affairs serves the well-being of the biosphere better than another state of affairs.

FACILITATOR: So, other constituents of the biosphere cannot articulate what *well-being* means to them.

DOGSÉ: There must be trade-offs there.

CLÜSENER-GODT: It's a definition of biosphere. I think Peter is saying: Who defines or what is defined as the biosphere? Is it as we know it now, with the species we know now? For example, we're speaking only of extinguishing species, but day-by-day new species come in. So, what is the *status quo* we're talking about? Who defines it? Species evolve from subspecies to species. This is the normal way of evolution. Where are we to say that this is the well-being of the biosphere that we want to preserve or live in harmony with – if you want to take out the word *manage*.

MACDONALD: Several of the things we're saying are indicating a little difficulty or awkwardness with subjectivity in the goal as set out in the opening clause of this remark. I would remind you that it was a deliberately subjective statement. We started out by saying: What are we trying to achieve as an overarching outcome of our discussions and our view of the future? When I started this particular hare running, I was saying that what I personally wanted to achieve – others may not choose to sign up to it – a thousand years from now was a world where there were fewer people, living a higher quality of life more equitably, and in a sustainable situation that is biodiverse. So, it was a deliberately subjective judgment. We're asking now: Who's going to make these decisions? I'm just reminding us that it was a decision that we made that this is our goal.

You're right in saying that the biosphere hasn't got an arbitrator to judge whether we have it right or not, which is, in a sense, saying if it's our goal, I rather prefer the wording of what we want is to foster a world that is sustainable and biodiverse. *We* make that judgment. And it is a judgment. That's where I think we came from in this conversation.

NGOILE: This is an issue of communication. I am just imagining here that we are crafting the words and that I have to take that statement and put it in a newspaper in Tanzania. How many people will actually understand it? We have to use language that is easy enough to communicate that it will make many people understand. Let us not craft a language that only makes us in here understand it, because at the end of the day we'll have lots and lots of problems translating what we actually meant.

BOTKIN: Are we trying to understand our discussion

or are we trying to phrase it in a way that communicates to the public? I think those are two separate tasks. First we have to understand what we're trying to agree on, so for right now, the verbiage doesn't have to be communicated to the public. That's an important stage, but it's not the present stage.

While we are one species among many, and while species do come and go, it does appear that they're going faster than coming at this stage.

EARLE: While we are one species among many, and while species do come and go, it does appear that they're going faster than coming at this stage. The goal is to find a place for ourselves within the natural systems that sustain us. The near-term and the long-term goal is that we want to be among those species that are still around and prospering. Am I wrong? Isn't that partly what this is all about?

We are, of course, concerned about all the other species, for selfish reasons and for ethical reasons. But we're most concerned about *this* species. We need to somehow make that clear. Maybe it's inherently clear. We are human beings writing this, after all, and we are the human beings causing these destructive matters that threaten the biosphere.

Coming back to this overarching goal that we're aiming for, it's not out of line to put ourselves in the picture, because that's what it's about. We want to find an enduring place for ourselves within the natural systems that sustain us. It requires respect for the rest of life; it requires all these backups that we've talked about. That's the goal, I think: The well-being of ourselves within a healthy biosphere or a functioning biosphere.

What will we try to say to the outside world? … that has to be thought through while we try to formulate our intentions and directions.

ISHWARAN: I think that what Thomas pointed out must be taken into consideration, because we *are* part of the biosphere, sure, but there are moments we might have to say that we have a special role in the biosphere. And we might decide to keep components of the biosphere and ourselves separate in certain locations, certain places. Why not? So, if your current state of consciousness evolution is one where you recognize that you're part of change but also have some responsibility to guide change, then *adapting to* and at the same time *influencing* and *steering change in the biosphere* is the way I would go. Maybe because I have been in management situations, I would not put the word *management* in that. That's the first point.

Second, I think that Magnus had an important point. I don't agree that you formulate an idea, clothe it in words, and then start thinking about how to tell others. We are about 15 people here and we are trying to come to an "intersubjective" agreement among us. It is good to think about, at that same point of time: What will we try to say to the outside world? What does it mean? I think that has to be thought through *while* we try to formulate our intentions and directions.

… as a public dialogue with something bigger than us, I think we have to say things that are shareable.

I agree with everything that was said about spirituality. For me, it is an individual experience. I have had spiritual experiences sitting in the river, watching elephants as if I were in a Parisian bar, but I cannot bring that as an element in communication with the broader public because it is difficult. I think Ken Wilber wrote about it and there has been writing equating Eastern mysticism and some elements of physics. But the fact that there are parallel outcomes does not mean that they all start from the same point. Physicists deal with things that Eastern mysticism couldn't even imagine. So, I think the spiritual side is something that in our adaptation, as individuals, we can take part, but as a public dialogue with something bigger than us, I think we have to say things that are shareable.

FACILITATOR: So, where are we at this point? Do we think we have our arms around this?

SINGH: If you take on board all of the comments that have come, I think we've reached a point where further discussion is not going to improve the draft. There are these critical points in the process of humanity that

we reach once in a while, so I think we should run with it as it is now.

FACILITATOR: Okay. Participants, after this conference, if you have a leisure moment, you might attempt to write this statement with the modifications and/or language and terminology that either reinforces or states what we are trying to state here, and also – to go along with what Magnus is saying – prepare a statement paralleling this for communicability to the general public. Those of you who undertake this and want to share that with us, we would appreciate that very much to receive and to incorporate in the proceedings as contributions from the individual participants.

The core issue determined by the scholars to be the most critical, going forward into the far future, was the overarching goal of influencing change to foster the well-being of the biosphere – a goal with four main facets: (a) evolution of consciousness, (b) exploration and research into the driving forces of change, (c) education and communication for dissemination of knowledge, and (d) ethics/equity, including intra-species equity, inter-species equity, and intergenerational equity.

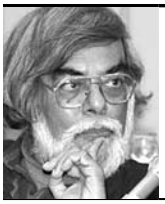
Post-seminar note: As an alternative to the above wording, Dr. Daniel Botkin developed the following statement of the core critical issue pertaining to the subject of humanity and the biosphere for the long-term future:

As long as people have written, they have written about nature and the relationships between people and nature. In our time, we share these interests and concerns, including an appreciation and wonder at the variety and beauty of life on Earth and our desire that life continues. But in our times, several things have changed that require a new statement about people and nature. The changes are: since Descartes, a belief in the value of rationality and in the scientific method; since the middle of the 20th century, a recognition that life, including people, can affect the environment globally; and since the rise of modern democracies, a belief in democracy and equality of opportunity, including the rights of all the people and of all living things. Therefore, we believe that the most critical goals for the future are actions that people can take to increase the persistence of the biosphere within conditions that promote a high level of biological diversity as well as equality and a high quality of life for people.
— Daniel B. Botkin, March 9, 2007

Critical Issue Conversations

Participants' Thousand-Year Scenarios

FACILITATOR: This is the last stage of the seminar. I'm going to ask Shekhar to please restate the exercise that each of us will undertake over a two- to three-minute period each, and that will conclude the seminar. Shekhar?



… it is a thousand years down the line, and I'm sitting in a virtual reality where … I can create any visual or sensual experience I want.

SINGH: What I suggested was that each one of us play the devil's advocate and challenge the rest of the group with a scenario of one thousand years down the line, and ask the group whether the critical things that we've decided on are adequate for that or do we need to put something else. If you all agree, then I will go first and give you my scenario, which I already mentioned in passing earlier.

I'm thinking that it is a thousand years down the line, and I'm sitting in a virtual reality where I have a little remote in my hand. I can create any visual or sensual experience I want. I have a bottle of tablets, each one of which is a full-meal tablet or a half-meal tablet. So, I take out the tablet, put it in and press a button, and it becomes the size, the texture, the shape, the smell of a fish or a chicken cooked the way I like it. And when I eat it, it tastes just like the real thing, but it's all simulated. Therefore, who needs the biosphere? Who needs the ecosystem?

If I want to look at a lovely forest, I don't have to travel by air and get jetlag; I just press a button and I have it there in front of me. It's all virtual reality. In that scenario, are we going to be able to save the biosphere or not? That's my scenario for one thousand years down the line.

Now, you are being challenged. Are these values and critical issues that we have identified adequate to save the biosphere in that scenario, or are you going to say, "No, we've got to think of something else?" It's a game. You don't have to take it too seriously.

FACILITATOR: Or you *can* take it seriously. Who would like to go next?

If we don't have to travel and if we can fabricate foods without having to cultivate large areas, maybe there's more space for wildlife …

ISHWARAN: I'm going to take the same scenario of Shekhar's description and ask the question: If all that is doable, then maybe there is a lot more space for the biosphere then than now. If we don't have to travel and if we can fabricate foods without having to cultivate large areas, maybe there's more space for wildlife and we will be in a better shape. In fact, this is something some of us talk about, because Peter Dogsé in my division does urban ecology.

I'm trying to say that we should look more into that because it might be interesting. Maybe the number games have to be worked out, but if more people are moving into cities, is it possible that more rural areas might be left fallow? That the amount of agricultural land might be less, so there is more land for other purposes? I think those are things that would be worth looking at.

FACILITATOR: You were suggesting earlier, outside in the corridor, that we put fences around these urban areas and leave everything else to the rest of the biosphere.

SINGH: Could I complicate it further by saying that I forgot to mention that the population has gone up to 1,000-billion? Every individual has only a six-foot-by-

six-foot space on Earth, and everything else is virtual.

BOTKIN: That already is a nonfunctional system. We know that.

FACILITATOR: I think Sylvia would challenge you: How can you say that it's nonfunctional and that you know it?

EARLE: No, I agree with him.

BOTKIN: In terms of oxygen exchange and food production, the energy flux on the Earth is one kilocalorie per minute per two square centimeters – on that order of magnitude. You can do the calculations. Plants are on the order of 1 percent efficient. You can work it out that you could no longer have enough food produced. With the Sun's energy at that density, you couldn't do the oxygen exchange. The chemistry wouldn't work. You have to do the calculations.

FACILITATOR: But in his world a thousand years from now we're not talking about any agriculture or anything like that. He's taking pills for everything except perhaps breathing.

BOTKIN: No, you have to have a source of organic compounds that are edible, and that requires a fixed amount of energy. The biochemistry is very well established about what the energy content is. It's five kilocalories basically per gram, so you can calculate how much energy you need. I've done this kind of calculation; you could never have people at a density of one per six-foot square. You couldn't do it.

EARLE: Is that in the ocean as well as on the land?

BOTKIN: That calculation is not hard to do. We know enough about photosynthesis and chemical dynamics of the Earth that that's not possible. You can set an upper bound on the possible number of people. That's fairly straightforward.

FACILITATOR: So, what kind of an alternative to his scenario would you construct, Dan? You were the one who raised the issue yesterday of looking ahead and perhaps making an attempt at forecasting, using models. Would you care to do that now?

… a thousand years from now … We would have closed life support systems on Mars, and some of us would be there.

BOTKIN: I don't actually want to do the modeling, but a thousand years from now, if I were in charge, we would be on Mars. We would have closed life support systems on Mars, and some of us would be there. And I think that a lot of the rest of the world is going to be like Huxley's *Brave New World*, where we're very, very safe, to the point that normal people don't have sex, even; it's too risky. And then they would have nature reserves where they would let a few people run around naked and be normal, as in a zoo, so I would opt to be there. And we would even play baseball.

… a thousand years from now we will put our technological advancements to the use of us as human beings so that we can reduce the pressure on the ecosystems.

NGOILE: Of course, when we do the forecasting, we also must be able to forecast what technology can do. What Shekhar has said is something to think about. We laugh at it, but imagination will be that a thousand years from now we will put our technological advancements to the use of us as human beings so that we can reduce the pressure on the ecosystems.

Talking about the tablets, if we can think about tablets, then we don't have to work a lot of farmland, so you can leave the land fallow and I think that would be much better. Of course, with how human beings are, such technologies will not be favored by many, but it could also be their survival, so we really must also think of the role of technology in providing us with the solutions. And especially on some of the practices that we have that have very negative trends, the innovative solutions could take people out of those, and that would be okay. Then, of course, we must put in the ethics and the equity, so that whatever those innovations are, they are at least accessible to all of us.

… we have developed ways to go over these limits of carrying capacities … we have some solutions for energy, for food, and it's sustained in the long term.

MOW: Well, I would like to think that in one thousand years we have learned to manage, in this case, exceeding carrying capacities, and that we have developed ways to go over these limits of carrying capacities. So, I see that we have some solutions for energy, for food, and it's sustained in the long term.

FACILITATOR: So, you don't see any contradictions in terms of what was written down in that it's feasible; it can be enacted; it will be enacted, resulting in the outcome that you are talking about.

MOW: Right.

… we will be in a thousand years so reliant upon machinery … we will have entered as carbon-based life into a symbiotic relationship with silicon-based machinery.

CHAISSON: I'll not be as facetious as I was at a previous meeting when I had the aspiration of being the Commissioner of Spherical Baseball on an asteroid belt. Nor will I be as facetious as some of the earlier suggestions, with all due respect. But I'll try to paint a picture of something that I think really *could* be the case in a thousand years, yet includes something we haven't discussed much about at this seminar at all, and that is increasing reliance upon machinery.

If I think back, I began sending email only in 1990. I began surfing Mosaic, of the Web, in about 1996. That's only 10 or 15 years ago. If you extrapolate our increasing reliance upon machinery a thousand years, it seems to me – appealing to the symbiosis that Lynn Margulis would be championing if she were here still – that we human beings will have entered into a symbiotic state with machinery. We will not yet be, nor will we ever perhaps become, a catalytic enzyme for the ultimate dominance by machinery in a transferral from carbon-based life to silicon-based life. But I think we will be in a thousand years so reliant upon machinery that we will be, perhaps, even recognized as a different species, a subspecies, in which we will have entered as carbon-based life into a symbiotic relationship with silicon-based machinery. And I'm not being facetious when I suggest that.

… we will, a thousand years from now, have gained full working access to the deepest parts of the ocean, the most remote places of whatever the planet is at that time …

EARLE: You mean we're not already there, in some respects?

The past is prelude, and you can extrapolate from what has been, to some extent, into what will be, but with limited success. Having said that, I recognize that as organisms we retain much that we were a thousand years ago, or even 10,000 years ago, emotionally, physically, spiritually – all the things that make us human. Knowing that is part of what is necessary to keep on the balance sheet as you project what we will do going forward: We will fight; we will care; we will want to have a future; we will want to have families. The basic things that make us human will be retained even as we increase our love affair with machines inexorably, inevitably.

I do believe that this is a critical point in time that will determine our success or lack of it going forward, our prosperity or lack of it going forward. I believe that we will succeed in maintaining a viable biosphere from *our* perspective, not from the perspective necessarily of stromatolites but life as we know it – or we'll fail. I'm going to put my odds on success, that we will, a thousand years from now, have gained full working access to the deepest parts of the ocean, the most remote places of whatever the planet is at that time, and that knowledge gained will not just be satisfying our curiosity but will be used in a way that will enable us to more successfully manage ourselves going forward, and that we won't manage nature as much as we will manage ourselves. I think we understand that.

Respect for the natural systems is already on a growing trend. We now embrace something like 12 percent of the land and an increasing part of the ocean, for whatever reasons: for its own sake, for practical reasons, for survival, whatever. I think that is on a growing trend, and I suspect that a thousand years from now the remnants of the wild will be even

more precious, more highly regarded than we now generally regard such places.

I think our numbers will be smaller, not greater, although inevitably we will go through a growth streak. We're going to be caught in the next 50 years with this upswing in population, but inevitably, I believe, the numbers will come closer to 1 billion than 6 billion if we are to sustain ourselves going forward a thousand years and beyond. I don't know exactly what the numbers are, but that is even more than what Ed Wilson proposes as the optimal number for humankind within the natural systems that support us. He says that about half a billion is about right.

Armed with new knowledge of genetics, while I don't think we can get meals from pills, I am mindful of some science fiction speculations that, after all, the basic elements make up a steak and make up lettuce and make up us, and if you had a pool of all basic ingredients, maybe you *could* synthesize something. But it takes energy to do it. It's not going to just happen because you push buttons or swallow a pill. There are limits to what we can do. We're already doing biosynthesis of certain desirable things that we want to have, and going forward I think the revolution that is in the offing is on a genetic scale. Thus, there is the appreciation for the natural systems that are currently at risk of being lost because of our complacency and our lack of appreciation for how special they are. Even the saliva of Gila monsters has turned out to be so special that it's used medically now. There aren't that many Gila monsters around, by the way.

I believe that we can get it right on a basis that has fewer people and more of the natural world either intact or restored, not less.

I believe that we can get it right on a basis that has fewer people and more of the natural world either intact or restored, not less. Our hope of survival is going to be dependent, into the next millennium, on our understanding of our dependence on the natural systems and our ability to manage ourselves so that fresh water, food supplies, reduction of toxins – the many things that haunt us now – will become common knowledge, not uncommon knowledge, and it will be common practice, not uncommon practice. I hope that that will be the reality.

Who was it who said that we're going to have a wrap around the cities? In a way that is already emerging, but we aren't at the same time seeing an expansion of the wild; we're seeing a shrinkage of that while we expand our dependence on concentrated cities. We are perilously close, I think, to a tipping point toward either success or disaster, and I'm going to bet on success.

"Don't Confuse Me with Facts; Just Confirm My Preconceptions" … if we are still to be here as a species in a thousand years, that attitude … has got to change very quickly.

HADLEY: Twenty-five years ago, about a quarter of a century ago, at a scientific meeting here at UNESCO, the head of a research institute addressed the whole question of communicating with decision-makers. John Jeffers was Director of what was then known as the Institute of Terrestrial Ecology, in the United Kingdom. He entitled his presentation: "Don't Confuse Me with Facts; Just Confirm My Preconceptions." That was his perception of what his political bosses, his policy-makers, wanted of him. Perhaps if we are still to be here as a species in a thousand years, that attitude, that sort of statement, has got to change very quickly. The sorts of actions that we set up on the board there in the fields of education, dissemination of information in the fields of equity, ethics, and a new knowledge, including recognition of the value inherent in some traditional knowledge – not all traditional knowledge, but some – will that take us towards that path where a statement such as "just confirm my preconceptions" is no longer said or even thought? I don't know.

David said yesterday that we've gone past the phase of easy solutions to problems where the scientists could do stitches around a problem and solve it – that essentially we're at a phase where for many of the issues it's the scientists working with a whole range of other stakeholders. To add one issue that I don't think we've mentioned, there is the whole issue of genetically modified organisms and genetically modified crops, where just within the scientific community there's a great range of different opinions.

A few weeks ago we had a visit here of David Dickson, the head of a new Internet service called Science

and Development Network (SciDev.Net), which some of you might know. The interesting thing is that he has an agreement with the two major scientific journals, *Nature* and *Science*, to have access through his reporting, which is principally geared to the advisor to the policy-maker in Africa. That defines his primary audience. He addressed a question from the floor of what was his position in the field of genetically modified crops, and he said that there was this great range of scientific difference of opinion for the moment, but the thing that clouded everything was that many people use genetically modified crops as a reason for making other points in their perception of the world in which we live. He took the example in this country [France] of the move against genetically modified crops as an outlet for criticism of the multinational organizations and the dominance that some of those institutions seek to have on this world. That is an example of how the science is not a thing in a glass jar; it's part of the broader world in which we live.

I would close with a phrase of one of Ish's predecessors as Director of the Division of Ecological Sciences of the MAB Programme. Thinking of the environment, of the change in perceptions of the environment, he said that he thought that this would no longer be perceived as a fixed resource, but rather a multi-purpose, dynamic service. That's how he saw the whole change in our perception of the environment of the biosphere in which we live.

… my guess is that we will crash and that we will reemerge. I see a cyclicality to human civilization rather than a linear trajectory to bigger and better things.

FACILITATOR: For my two cents, I'm going to rely heavily on the past and what we know until now, rather than to go forward into the future as to what's going to occur. I think the records indicate that great civilizations last about 300 years to 400 years. Secondly, I think there is no doubt that there is a tremendous amount of complexity that has been introduced into our daily lives, but along with that complexity goes a certain fragility, as is demonstrated on a daily basis. For instance, one accident on a four-lane freeway blocks traffic for miles on end, or, as occurred in Seattle some winters ago, electricity was gone for six days due to a winter storm, and there was utter chaos that seemed almost like the end of the world.

A participant who has often come to our seminars in Seattle is a gentleman by the name of William Calvin, who often states that the rate at which change is occurring is outstripping human ability to cope. He uses the analogy of headlights on a car, in that we are moving so fast that the reach of the headlights on the cars is not adequate to illuminate enough for us to know what to do next. History has also shown that even as we are able to anticipate, discuss, elaborate, and point out all kinds of problems, the best we have been able to manage is to adjust and to react. Our capacity for preemptive planning, implementation, and execution to avoid and solve problems on a large scale is less than satisfactory.

So, while it has been pointed out in these conversations that if we make it past the next 30 years, maybe there is some chance that we will progress and thrive, because of the criticalities that are being reached in so many dimensions and the magnitude of the problems becoming so complex, my guess is that we will crash and that we will reemerge. I see a cyclicality to human civilization rather than a linear trajectory to bigger and better things. Perhaps the question then is: Is this cyclicality a progression upwards in terms of an arrow or is it a regression downwards? I will think about that some more later on. I don't know.

That brings this seminar to a close. I will let Walter and Bob and Ish officially close the proceedings.

Closing Session

I would like to thank all of you participants for coming … I personally enjoyed these meetings and learned a great deal.

SESH VELAMOOR (FACILITATOR): Before I hand the microphone to Walter, I personally want to thank Ish and Natasha, Salvatore, Thomas, Peter, Ana, Miguel, Edwin, and the other staff members of UNESCO, as well as the Foundation film crew and staff, without whose support and tremendous assistance and coordination this would not have been possible. I personally am deeply grateful for the assistance of all of these people in making this happen.

I would like to thank all of you participants for coming. You are a distinguished group of people. I personally enjoyed these meetings and learned a great deal. This is one of the wonderful things about having the job that I have, which gives me the unique opportunity of interacting every few months with a tremendous group of new people who come through the doors of the Foundation. That is something that I don't think can easily be duplicated anywhere in terms of a working environment. So, thank you all. And at this point I would like to hand the meeting over to Bob and then to Walter.

These last couple of days have been very valuable to us at the Foundation.

CITRON: I want to thank Ish, particularly, for responding to my idea of a jointly hosted seminar on the future of humanity and the biosphere. These last couple of days have been very valuable to us at the Foundation. We have recorded every single word, and we also have gavel-to-gavel videotapes of the two days. Also, all of you were interviewed about your ideas about the future. We keep those interviews in a permanent archive and some of them are on our website.

Now, I will ask Walter Kistler, the benefactor and President of the Foundation, to say a few words.

… a crash is very likely, I would say, but there's no doubt to me that both humanity and the environment will survive.

KISTLER: Before we close this meeting, I would like to make a few remarks about the matter we have been discussing these past two days. After listening to the different statements made, and the worries and feelings expressed, I would summarize my feelings about the matter. There is a saying: "We have finally encountered the enemy, and we have found that it's us."

We talked quite a bit about managing this and managing that. My feeling, Number 1, is that we will have to learn to manage ourselves. At one end is the profligate consumption, specifically in the United States, of course, a bit less in Europe and less in the Third World, but humanity is consuming more and more, and, in the United States, quite recklessly. People will have to be more conscious, realizing what they do, what they consume, even when they consume just a Kleenex tissue or newspapers by the ten pounds every Sunday. These things should be reduced.

Then, there is a very important point concerning humanity as a whole. Humanity will *have* to control its tendency to multiply like a bunch of rabbits. If humanity wants to continue and to be in equilibrium with the environment, it will have to stop reproduc-

ing like there is no tomorrow. No race of animals or insects or plants can do that. Those who have tried have crashed eventually. If there is a curve that goes up exponentially, there is just one way it can go, and that's a crash. It will not go to infinity; that's for sure. So, these are the things humanity should most of all consider: humanity itself, *its* bad habits, *its* destruction of the environment.

On the other hand, I can see that there will be a constant clash between humanity and its environment. They don't work nicely together. Maybe some day they will, but right now it's definitely a clash, a confrontation between the two. I think this will go on for quite a while, and both parties will have to give. Even the environment will have to give somehow. There *will* be more highways; there *will* be more cities; the Third World certainly will want to have the First World's comfort of living, which means much more electricity, even more food, more power consumption, and all that will clash with the environment; there is no doubt. So, the clash can't be avoided, but I think it can be managed – and that's what we mentioned many times: managing change.

I see that eventually things will rearrange themselves, as they always seem to, although I somewhat agree with what Sesh said about a 400-year cycle and crash. I indeed see a certain crash ahead of us. I think the biggest danger humanity has ahead is global warming, which according to some views is not going on steadily, but increases ever faster, because as there is more warming there is more methane going out of the ground in the northern tundra. Methane is 20 times worse than CO_2, so it's bound to make things get worse quite rapidly. So, a crash is very likely, I would say, but there's no doubt to me that both humanity and the environment will survive. The environment has survived up to now through hundreds of millions of years, so it will surely survive, but not without taking some abuse and some hardship. But in the long range, I am quite positive that, whether there are atomic bombs or global warming or whatever, nothing will destroy humanity. It's very rugged, very tough, and will survive any difficulty in the future – that's my positive ending.

We have appreciated your presence and your contributions.

So, thank you all very much for coming. We have appreciated your presence and your contributions. And I would especially like to thank Sesh, who did a terrific job. Thanks, everybody, and have a good trip home.

… on behalf of all my colleagues, I would like to thank all the participants for coming and sharing their views with us.

ISHWARAN: I would be remiss in my obligations if I did not say "thank you" to Walter, Bob, and Sesh, and their team at the Foundation For the Future. To all of you, thank you very much for taking us on and trying this out. Hopefully we will be moving to doing more things in the future. We have already talked about the possibility of another seminar for the Year of Planet Earth in 2008, and we will discuss that in much more detail with Bob to see what kind of a collaboration is possible.

From the Division of Ecology and Earth Sciences and on behalf of all my colleagues, I would like to thank all the participants for coming and sharing their views with us. There were some interesting ideas that came up, so we will see whether we can integrate some of your thinking into the reform mood in UNESCO, where everything is trying to change. We don't know how it is going to change, but definitely some of your insights and ideas will help us to guide the future here. Thank you.

Appendix 1

Seminar Agenda

September 20, 2006

UNESCO Bar Miollis
Paris, France

- **Cocktail Reception**
- **Welcome Address**
  — Dr. Walter Erdelen
  Assistant Director-General for Natural Sciences
  UNESCO, Paris
- **Welcome Address**
  — Walter Kistler
  Co-founder and President
  Foundation For the Future
- **Video Presentation: *Cosmic Origins***
  — Bob Citron
  Co-founder and Executive Director
  Foundation For the Future

September 21, 2006

UNESCO, Paris

- **Opening Remarks**
  — Natarajan Ishwaran
  Director
  Division of Ecological and Earth Sciences
  Secretary, Man and the Biosphere Programme
  — Sesh Velamoor
  Deputy Director, Programs
  Foundation For the Future
- **Participant self-introductions**
- **Presentations**
  "The Human Journey on Planet Earth"
  "The Human Impact on Planet Earth"
  — Bob Citron
- **Keynote Theme 1 Presentations**
  — Dr. Daniel B. Botkin
  — Dr. Eric J. Chaisson
  — Dr. Lynn Margulis
  — Dr. Sylvia Earle
- **Keynote Theme 1 Discussion and Interaction with MAB Personnel**
- **Keynote Theme 2 Presentation**
  — Albert de Haan
- **Panel 1 Presentations and Commentary**
  — Dr. Shekhar Singh
  — June Marie Mow
  — Dr. Malcolm Hadley
  — Dr. Magnus Ngoile
- **Panel 1 Discussion and Interaction with MAB Personnel**
- **Panel 2 Presentations and Commentary**
  — Dr. David W. Macdonald
  — Dr. Ricardo Guerrero
- **Panel 2 Discussion and Interaction with MAB Personnel**

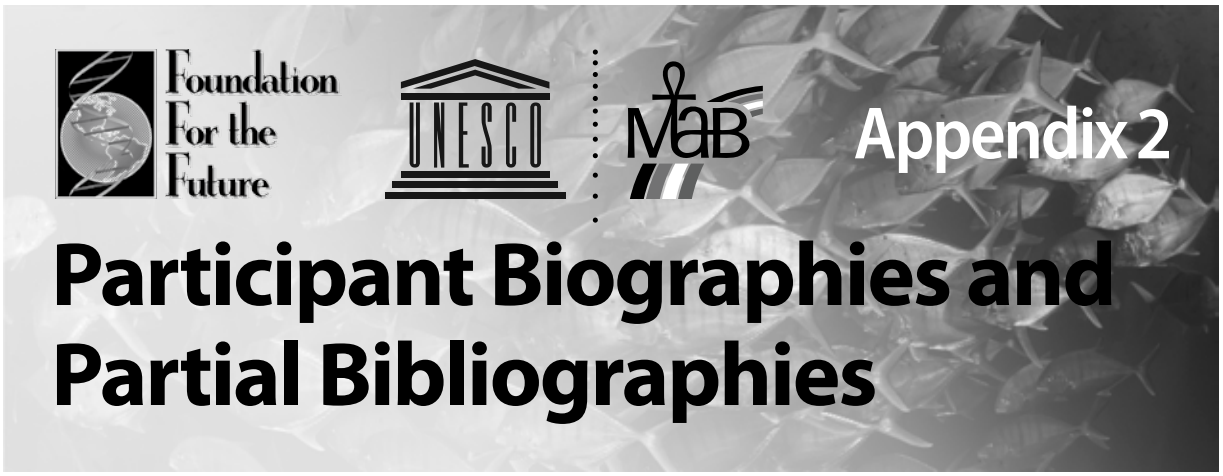
September 22, 2006

UNESCO, Paris

- **Critical Issue Conversation**
- **Consensus on the Most Critical Issue**
- **Participants' Thousand-Year Scenarios**
- **Closing Remarks and Adjournment**

Le Bistrot de Breteuil, Paris

- **Group Dinner**



Appendix 2

Participant Biographies and Partial Bibliographies

Daniel B. Botkin

Daniel B. Botkin is Professor (Emeritus), Department of Ecology, Evolution, and Marine Biology, University of California, Santa Barbara, and President of the Center for the Study of the Environment, New York and Santa Barbara. He has done a variety of pioneering research in ecology, including studies of wilderness forests from Canada's far north to the rain forests of Costa Rica and the savannahs of East Africa. A major part of his career has been helping to solve environmental problems, including how to conserve and manage salmon in Oregon and Washington; elephants in Kenya, Tanzania, and Zimbabwe; and bowhead whales in the Pacific Arctic. He was one of the first to use satellite remote sensing to study forests and to develop computer software to forecast changes in forests and to predict the chances of extinction of endangered animals.

His first major book, *Discordant Harmonies: A New Ecology for the 21st Century* (Oxford, 1990), considered by many ecologists to be the classic text of the environmental movement, has had a strong impact on government policies about the environment. *Forest Dynamics: An Ecological Model* (Oxford, 1993) is the definitive treatment of the JABOWA computer model of forest dynamics, which Botkin originated and is in use worldwide. The 6th edition of his prize-winning textbook (with co-author E.A. Keller), *Environmental Science: Earth as a Living Planet* (John Wiley), was published in January 2007.

Botkin has advised the World Bank about tropical forests, biological diversity, and sustainability; the Rockefeller Foundation about global environmental issues; the government of Taiwan about approaches to solving environmental problems, development of nature preserves, and devising data systems for environmental monitoring. He was the primary advisor to the National Geographic Society for its centennial edition map on "The Endangered Earth." He served on a State of California scientific advisory panel concerning the recovery of the California condor, and the scientific advisory panel for the US Marine Mammal Commission. Other academic appointments include: Professor of Biology and Director of the Program in Global Change at George Mason University; Professor of Systems Ecology at the Yale School of Forestry and Environmental Studies; and Research Scientist, The Ecosystems Center, Woods Hole, MA. He earned his Ph.D. in biology from Rutgers University.

Dr. Botkin is the 1995 recipient of the Fernow Award for Outstanding Contributions in International Forestry, given by American Forests and the German Forestry Association. Also in 1995, he was elected to the Environmental Hall of Fame, housed at California Polytechnic Institute, Pomona. He is the 1991 winner of the Mitchell International Prize for Sustainable Development. He has been a Fellow at the Rockefeller Bellagio Institute in Italy and the Woodrow Wilson International Center for Scholars, Washington, DC. He is a Fellow of the American Association for the Advancement of Sciences and a member of the Cosmos Club of Washington, DC, and the Explorers Club, New York.

Recent, Relevant Publications

With H. Saxe et al. "Forecasting Effects of Global Warming on Biodiversity." (Submitted to *BioScience).*

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With G.E. Belovsky et al. 2004. "Ten Suggestions to Strengthen Ecology." *BioScience, 54* (4), 345–351.

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2000. "Preface," *Forces of Change: A New View of Nature*. National Geographic Society, Washington, DC, 15–19.

Eric J. Chaisson

Dr. Eric J. Chaisson is Director of the H. Dudley Wright Center for Innovative Science Education at Tufts University, where he is also Research Professor of physics and astronomy, and Research Professor of education. He is also an Associate of the Harvard College Observatory, where he teaches introductory astrophysics, and Affiliate-director of the Massachusetts Space Grant Consortium, based at MIT.

Trained initially in atomic physics, Chaisson obtained his doctorate in astrophysics from Harvard University in 1972. Before assuming his current position, he spent a decade as a member of Harvard's Faculty of Arts & Sciences. During his tenure as Associate Professor at the Harvard-Smithsonian Center for Astrophysics, Chaisson's research concentrated largely on the radio astronomical study of interstellar gas clouds. This work won him fellowships from the National Academy of Sciences and the Sloan Foundation, as well as Harvard's Bok Prize for original contributions to astrophysics and Harvard's Smith-Weld Prize for literary merit. He has also held research and teaching positions at MIT and Wellesley College and, before joining Tufts, was a scientist on the senior staff and Director of Educational Programs at the Space Telescope Science Institute at Johns Hopkins University. He has more than 100 publications to his credit, most of them in the professional journals.

Chaisson's major research interests are currently twofold: His scientific research focuses on an interdisciplinary, thermodynamic study of physical and biological phenomena, thereby searching for the origin, evolution, and unification of galaxies, stars, planets, and life forms in the universe. His educational research engages experienced teachers and computer animators to discover better methods, technological aids, and novel curricula to enthuse teachers and instruct students in all aspects of natural science. He currently teaches an undergraduate course at Harvard University on the subject of cosmic evolution, which combines both of these research and educational goals.

In order to share the essence of his research and teaching with a wide audience, Chaisson has written several books, including *Cosmic Dawn*, which won several literary awards such as the Phi Beta Kappa Prize, the American Institute of Physics Award, and a National Book Award Nomination for distinguished science writing. His other books include two works on relativity, a textbook on cosmic evolution, and a volume (co-authored with George Field) outlining the scientific rationale for the United States' national space policy. Another book, *The Hubble Wars*, also won the American Institute of Physics Science Writing Award, and his popular textbook, *Astronomy Today* (co-authored with Steve McMillan), is the most widely used college astronomy textbook in the nation. His most current books, *Cosmic Evolution: The Rise of Complexity in Nature* and *Epic of Evolution: Seven Ages of the Cosmos*, were published by Harvard University Press and Columbia University Press, respectively. Chaisson won the 2007 Walter P. Kistler Book Award for *Epic of Evolution*.

Chaisson holds membership in numerous American and international scientific organizations, several honor societies, and a host of academic, public, and federal advisory committees.

Recent, Relevant Publications

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2006. *Epic of Evolution: Seven Ages of the Cosmos*. Columbia University Press, New York. Illustrated by Lola Judith Chaisson.

Albert de Haan

Albert de Haan is Commercial Director of European Climate Exchange, based in Amsterdam.

De Haan has spent some 25 years in the fast-moving world of metals and financial futures trading, first as a dealer and later as a Business Development Manager. More recently involved in developing the energy banking concept within the Fortis Bank organisation, he was also a key member of the Global Markets Venturing team that led the European banking giant into the carbon banking arena. De Haan's decision to take on his current role reflects his belief that a sound pan-European dealing platform in emissions is integral to delivering requested reductions to clients.

The European Climate Exchange (ECX) is the leading exchange in Europe for carbon emissions trading. ECX contracts are listed on the ICE Futures electronic platform and cleared by LCH. Clearnet.

Sylvia Earle

Dr. Sylvia Earle is founder and Chairman of DOER Marine, based in Alameda, California USA. She is an oceanographer with a B.S. degree from Florida State Univ. (1955), M.S. and Ph.D. degrees from Duke Univ. (1956, 1966), and honorary degrees from the 11 universities and colleges. She was Curator of Phycology at the California Academy of Sciences (1979–1986), Research Assoc. at the Univ. of California, Berkeley (1969–1981), Radcliffe Inst. Scholar (1967–1969), and Research Fellow or Associate at Harvard Univ. (1967–1981). From 1980 to 1984 she served on the President's Advisory Committee on Oceans and Atmosphere. In 1990 she was appointed Chief Scientist of NOAA (National Oceanic & Atmospheric Administration) where she served until 1992. In 1992, she founded Deep Ocean Exploration and Research, (D O E R), to design, operate, support, and consult on manned and robotic sub sea systems.

Dr. Earle is the Explorer in Residence at the National Geographic Society. She also serves as the Executive Director of Conservation International's Marine Conservation Program; Chairman of the Advisory Committee for the Harte Institute Marine Advisory Board, Texas A&M Corpus Christi; Chairman of the Science Committee for the National Park Service Advisory Board; and Honorary President of the Explorers Club. She led the Sustainable Seas Expeditions, a five-year study of the National Marine Sanctuaries sponsored by National Geographic and funded by the Goldman Foundation. She is an adjunct scientist at the Monterey Bay Aquarium Research Institute (MBARI) and a Director of Kerr-McGee Inc. She serves on various boards, foundations, and committees relating to marine research, policy, and conservation. She is a Fellow of the AAAS, the Marine Technology Society, the California Academy of Sciences, and the World Academy of Arts and Sciences.

Dr. Earle has led more than 50 expeditions worldwide involving in excess of 6500 hours underwater in connection with her research. She led the first team of women aquanauts during the Tektite Project in 1970 and holds a depth record for solo diving (1000 meters). Author of more than 100 publications concerning marine science and technology including the books *Sea Change* (1995), *Wild Ocean* (1999), and *Atlas of the Ocean* (2001), she has participated in numerous television productions and given scientific, technical, and general interest lectures in more than 60 countries. Her books for children include *Hello Fish*, *Sea Critters*, *Coral Reefs*, and the award-winning *DIVE!*

Among numerous honors and awards are the 2004 AAUS Scientific Diving Lifetime Achievement Award; 2004 International Banksia Environmental Award; 2003 Wyland Icon Award Lifetime Achievement Award; 1998 John M. Olguin Marine Environment Award; 1997 Bal de la Mer Foundation's Sea Keeper Award; 1997 Julius B. Stratton Leadership Award; 1997 Sea Space Environmental Awareness Award; 1997 Marine Technology Society Compass Award; 1997 Kilby Award; 1996 Explorers Club Medal; 1996 Lindbergh Award; 1995 Boston Museum of Science Washburn Medal; 1995 Massachusetts Audubon Society's Allen Morgan Prize; 1992 Director's Award of the Natural Resources Council; 1991 DEMA Hall of Fame Award; 1991 Golden Plate Award of the American Academy of Achievement; 1990 Society of Women Geographers Gold Medal; 1989 New England Aquarium David B. Stone Medal; 1981 Order of the Golden Ark, presented by the Prince of the Netherlands; 1980 Explorers Club Lowell Thomas Award; 1970 *Los Angeles Times* Woman of the Year Award; and a 1970 US Department of Interior Conservation Service Award. In October 2000, she was inducted to the National Women's Hall of Fame.

Recent, Relevant Publications

With Linda K. Glover (Eds.) 2004. *Defying Ocean's End : An Agenda for Action*. Island Press.

2003. *Sustainable Seas: The Vision, the Reality.* Eugene T. Wool. (Series: Grace A. Tanner Lecture in Human Values).

With Tim Cahill. 2001. *Atlas of the Ocean: The Deep Frontier*. Washington, DC: National Geographic Society.

With Ellen J. Prager. 2000. *Oceans*. McGraw-Hill Companies.

With Wolcott Henry. 1999. *Wild Ocean: America's Park under the Sea.* Washington, DC: National Geographic Society.

1999. Foreword in *The Living Ocean: Understanding and Protecting Marine Biodiversity*. 2nd Edition, Island Press.

1999. *Hello, Fish: Visiting the Coral Reef*. Washington, DC: National Geographic Society.

1995. *Sea Change: A Message of the Oceans*. New York: Random House, Inc.

1990. "Ocean Everest – An Idea Whose Time Has Come." *Marine Technology Journal, 24*(2): 9–12.

With Al Giddings. 1980. *Exploring the Deep Frontier: The Adventure of Man in the Sea*. Washington, DC: National Geographic Society.

Ricardo Guerrero

Dr. Ricardo Guerrero is a Full Professor of microbiology at the University of Barcelona (1988–present). Formerly, he was Professor and Chairman of the Department of Microbiology at the Autonomous University of Barcelona (1974–1988) and Professor of graduate studies at the University of Massachusetts–Amherst (beginning in 2001). Guerrero is Scientific Secretary of the Institute for Catalan Studies (Catalan Academy), Fellow of the American Academy of Microbiology, Fellow of the Linnean Society of London, member of the International Committee of the American Society for Microbiology, President of the Foundation Alsina-Bofill, and President of the Spanish Society for Microbiology.

His current research fields are: (a) study of the structure and functioning of primeval ecosystems, focusing mainly on both laminated planctonic microbial populations in Lake Cisó and microbial mats at the Ebro delta (both of them in Spain); (b) production of biodegradable plastics by microorganisms; (c) risk assessment of the release in the environment of genetically manipulated microorganisms; and (d) microbial sulfur cycle and environmental biotechnology.

Dr. Guerrero is the author of 290 publications on genetics, biochemistry, bacterial ecology, and environmental microbiology. He has collaborated in the preparation of several popular science collections and science encyclopedias, and also published opinion articles in the press. He is currently Editor-in-chief of *International Microbiology*, the official journal of the Spanish Society for Microbiology, and a member of the editorial boards of several scientific journals. He is Director of two scientific collections and a member of the executive committees of several scientific societies, both in Spain and abroad. A promoter of scientific international exchange, he keeps an integrative perspective towards science, humanity, culture, and society.

Guerrero chaired the 2nd Spanish Conference on Biotechnology (Barcelona, 1988), the 6th International Symposium on Microbial Ecology (Barcelona, 1992), the 10th International Conference on the Origin of Life (Barcelona, 1993), the 1st Spanish Symposium on Bioscience (Madrid, 1995), the 15th Catalan Congress of Physicians and Biologists (Lerida, 1996), and the 10th International Symposium on Phototrophic Prokaryotes (Barcelona, 2000). He has organized several international symposia: New Frontiers in Microbial Ecology (Barcelona, 2001), Microbiology Societies of Spain, Portugal, and Latin America; Challenges for the 21st Century (Madrid, 2003); and The Microbe's Contribution to Biology (Barcelona, 2006).

Recent, Relevant Publications

With A. Haselton et al. 1999. *Titanospirillum velox*: A huge, speedy, sulfur-storing spirillum from Ebro Delta microbial mats. *Proc Natl Acad Sci USA, 96*: 11584–11588.

With A. Navarrete et al. 2000. Physiological status and community composition of microbial mats of the Ebro Delta, Spain, by signature lipid biomarkers. *Microb Ecol, 39*:92–99.

With L. Margulis and M.F. Dolan. 2000. The chimeric eukaryote: Origin of the nucleus from the karyomastigont in amitochondriate protists. *Proc Natl Acad Sci USA, 97*:6954–6959.

With M.M. Rothermick et al. 2000. Characterization seasonal occurrence, and diel fluctuation of poly(hydroxyalkanoate) in photosynthetic microbial mats. *Appl. Environ. Microbiol., 66*:4279–4291.

With A. Wier et al. 2002. Spirochete and protist symbionts of a termite (*Mastotermes electrodominicus*) in Miocene amber. *Proc Natl Acad Sci USA, 99*:1400–1403.

2002. Microbial ecology comes of age. *Int Microbiol, 5*: 157–159.

With L. Villanueva et al. 2004. Combined phospholipid biomarkers and 16S rDNA/DGGE analysis of bacterial diversity and physiological status in an intertidal microbial mat. *Appl Environ Microbiol, 70*:6920–6926.

With A. Navarrete et al. 2004. Analysis of signature lipid biomarkers of microbial mats of the Ebro Delta (Spain), Camargue and Étang de Berre (France): an assessment of biomass and activity. *Ophelia, 58*:175–188.

With J. Garcia-Cantizano et al. 2005. Partitioning of CO_2 incorporation among planktonic microbial guilds and estimation of *in situ* specific growth rates. *Microbial Ecology, 50*:230–241.

With M. Berlanga. 2006. Life's unity and flexibility: the ecological link. *Int Microbiol, 9*:XXX–XXX (in press)

Malcolm Hadley

Dr. Malcolm Hadley is a biologist by training. After doctoral studies on the population dynamics of subapterous tipulid flies in upland areas of northern England, from 1967–1972 he was Scientific Coordinator of the Terrestrial Productivity Section of the International Biological Programme.

Hadley then spent most of his professional career (from the early 1970s to 2001) with the Natural Sciences Sector of UNESCO and its Division of Ecological Sciences, as part of the Secretariat for the Man and the Biosphere (MAB) Programme. Primary concerns have included natural resource issues and human-environment interactions in tropical regions, and contributing to the development of the World Network of Biosphere Reserves, particularly in the humid tropics and in the Asian region. Promoting collaborative research involving national scientific institutions, international nongovernmental organizations and UNESCO has included Tropical Soil Biology and Fertility (TSBF, jointly with the International Union of Biological Sciences) and People and Plants (jointly with the World Wide Fund for Nature [WWF] and the Royal Botanic Gardens, Kew). He has also had a career-long interest in issues related to the design and putting into practice of interdisciplinary research and its application to land use planning and resource management.

Hadley has been involved in diverse initiatives for communicating scientific information for different audiences, including the 36-poster "Ecology in Action" exhibit, the 28-volume Man and the Biosphere book series, and several overviews of UNESCO work on island environments, territories, and societies. He has authored or co-authored over 70 scientific articles and reviews. From 1995 to 1999, he was Editor of the quarterly magazine *Nature & Resources.* Since formally retiring from UNESCO in 2001, he has continued to be associated with the environmental sciences programmes of the Organization, and more especially the work of the Coastal Regions and Small Islands Platform.

Recent, Relevant Publications

2006. "A Practical Ecology: The Man and the Biosphere (MAB) Programme." In: *Sixty Years of Science at UNESCO 1945–2005*, pp. 260–295. UNESCO, Paris.

2005. "Biosphere Reserves as a Tool in Regional Planning and Resource Management in Forested Landscapes." In D. Babin (Ed.) *Beyond Tropical Deforestation: From Tropical Deforestation to Forest Cover Dynamics and Forest Development*, pp. 355–377. UNESCO/CIRAD, Paris

2002. *Biosphere Reserves: Special Places for People and Nature*. UNESCO, Paris.

With P. Lasserre. 1997. "Biosphere Reserves: A Network for Biodiversity." *Ecodecision* (Winter 1997): 34–38.

With C.M. Hladik, A. Hladik, O.F. Linares, H. Pagezy, and A. Semple (Eds). 1993. *Tropical Forests, People and Food: Biocultural Interactions and Applications to Development*. Man and the Biosphere Series, Volume 13, UNESCO, Paris, and Parthenon Publishing, Carnforth.

With A. Gómez-Pompa and T.C. Whitmore (Eds). 1991. *Rain Forest Regeneration and Management*. Man and the Biosphere Series, Volume 6. UNESCO, Paris, and Parthenon Publishing, Carnforth.

With K.S. Bawa (Eds). 1990. *Reproductive Ecology of Tropical Forest Plants*. Man and the Biosphere Series, Volume 7. UNESCO, Paris, and Parthenon Publishing, Carnforth.

With F. di Castri. 1986. "Enhancing the Credibility of Ecology: Is Interdisciplinary Research for Land Use Planning Useful?" *GeoJournal*, *13* (4): 299–325.

With F. di Castri and F.W.G. Baker (Eds). 1984. *Ecology in Practice*. Volume 1 – *Ecosystem Management*. Volume 2 – *The Social Response*. Tycooly International Publishing Company, Dublin, and UNESCO, Paris.

With F. Bourlière. 1970. "The Ecology of Tropical Savannas." *Annual Review of Ecology and Systematics*, *l*: 125–152.

David Macdonald

Professor David Macdonald, of Witney, Oxon, has been Director of the Wildlife Conservation Research Unit at Oxford University since founding it in 1986, and is also Senior Research Fellow in wildlife conservation at Lady Margaret Hall, Oxford. He is Professor of wildlife conservation at the University of Oxford, has held the A.D. White Professorship at Cornell University in New York State, and is Visiting Professor at Imperial College, London.

Macdonald holds a D.Sc. from Oxford. He won the 2005 Dawkins Prize for Conservation, and in 2006 he was awarded the American Society of Mammalogists' Merriam Award for outstanding contributions to research. He has published over 300 refereed papers on aspects of mammalian behaviour, ecology, and conservation. Currently Macdonald is Chairman of the Darwin Advisory Committee, a member of the Council of English Nature and of the Wildfowl and Wetlands Trust, and VP of the Wildlife Trusts. He is also on the Board of Natural England. Recently he has been on the Council of the Zoological Society of London, of which he was a Vice President, as he was also of the RSPCA. He was founder of IUCN/SCC Canid Specialist Group, of which he was Chairman for 24 years, and is now an Emeritus Fellow of the IUCN/SSC.

Macdonald is also known for his books and television documentaries. He has twice been awarded the Natural History Author of the Year, and 500,000 copies of the first edition of his *Encyclopaedia of Mammals* were printed worldwide. His documentary films include the seven-part BBC-1 series *The Velvet Claw* (about carnivores) and his *Meerkats United* has been watched by an estimated 500 million viewers.

David Macdonald officially founded the WildCRU (www.wildcru.org) in 1986. The WildCRU has a mission to achieve practical solutions to conservation problems. It undertakes original research on aspects of biology relevant to wildlife conservation and environmental management. Its aim is to meet the need for rigorous scientific study to underpin policy formation and public debate of the many issues and problems that surround the conservation of wildlife and their habitats.

Recent, Relevant Publications

With K. Laurenson (Eds.). 2006. Infectious Diseases and Mammalian Conservation. *Biological Conservation* (Special Issue), *131* (2).

With P. Riordan and F Mathews. 2006. Biological hurdles to the control of TB in cattle: A test of two hypotheses concerning wildlife to explain the failure of control. *Biological Conservation* (Special Issue), *131* (2), 268–286.

With K. Service (Eds.) 2007. *Key Topics in Conservation Biology*. Oxford: Blackwell Publishing Ltd.

With N.M. Collins and R. Wrangham. 2007. Principles, practice and priorities: the quest for 'alignment.' In: *Key Topics in Conservation Biology* (Eds. D.W. Macdonald and K. Service), pp. 271–290. Oxford: Blackwell Publishing Ltd.

With C.M. King and R. Strachan. 2007. Introduced species and the line between biodiversity conservation and naturalistic eugenics. In *Key Topics in Conservation Biology* (Eds. D.W. Macdonald & K. Service), pp. 186–205. Oxford: Blackwell Publishing Ltd.

With F. Mathews et al. 2006. Bovine tuberculosis in cattle: reduced risk on wildlife-friendly farms. *Biology Letters* doi:10.1098/rsbl. 2006.0461 Published online.

With F. Mathews et al. 2006. Bovine tuberculosis (*Mycobacterium bovis*) in British farmland wildlife: the importance to agriculture. *Proceedings of the Royal Society B – Biological Sciences, 273* (1584): 357–365.

With D.A. Randall et al. 2006 An integrated disease management strategy for the control of rabies in Ethiopian wolves. *Biological Conservation, 131*: 151–162.

With W.J. Sutherland et al. 2006 The identification of 100 ecological questions of high policy relevance in the UK. *Journal of Applied Ecology*, *43* (4): 617–627.

With F.H. Vargas et al. 2006. Biological effects of El Nino on the Galapagos penguin. *Biological Conservation, 127*: 107–114.

Lynn Margulis

Lynn Margulis, Ph.D., Distinguished University Professor in the Department of Geosciences at the University of Massachusetts-Amherst, received the 1999 National Medal of Science from President William J. Clinton. She has been a member of the US National Academy of Sciences since 1983 and of the Russian Academy of Natural Sciences since 1997. The Library of Congress announced in 1998 that it will permanently archive her papers. Author, editor, or co-author of chapters in more than 40 books, she has published or been profiled in many journals, magazines, and books, among them: *Natural History* magazine, *Science*, the journal *Nature*, *New England Watershed*, *Scientific American*, *Proceedings of the National Academy of Sciences*, *Science Firsts*, and *The Scientific 100*. She contributes to the primary scientific literature of microbial evolution and cell biology. Her most recent co-authored scientific paper, published August 29, 2006 [*The last eukaryotic common ancestor (LECA): Acquisition of cytoskeletal motility from aerotolerant spirochetes in the Proterozoic Eon,* PNAS 103: 13081–13085], details the evolutionary origin of nucleated cells, those that comprise the bodies of amoebae, sea weeds, water molds, animals, fungi, plants, and many other life forms.

Dr. Margulis' theory of species evolution by "symbiogenesis" was put forth in the (2002) book *Acquiring Genomes*: *A theory of the origins of species*, co-authored with Dorion Sagan, her eldest son and *Sciencewriters* partner. Speciation, they claim, does not occur by random mutation alone. Rather symbiotic detente, interactions followed by integration of once independent organisms (members of different taxa) create new species. Intimacy of strangers that leads to permanent or cyclical physical contact between them has been the major generator of new life; this process of "symbiogenesis" accelerates positive evolutionary change. Margulis works in the laboratory, in the field, and with many other scientists and students to illustrate how specific symbioses, in a given order over more than a billion years, generated the species we see with our unaided eyes. The fossil record, in fact, does not show Darwin's predicted gradual change between closely related groups, but rather the "punctuated equilibrium" pattern of Eldredge and Gould: a discontinuity from one to a different species.

Margulis earned her graduate education in biology (joint master's degree in the departments of genetics and zoology) at the University of Wisconsin in Madison. Her research on chloroplast DNA at the University of California, Berkeley, led to her Ph.D. in genetics.

Over the past two decades Margulis has co-written many books with Dorion Sagan, among them *Microcosmos*: *Four billion years of microbial evolution* (1986); *Garden of Microbial Delights, A practical guide to the subvisible world* (1993); *What Is Sex?* (1997); *What Is Life?* (1995); *Mystery Dance: On the Evolution of Human Sexuality* (1991); and *Origins of Sex: Three Billion Years of Genetic Recombination* (1986). Her work with K.V. Schwartz provides a consistent formal classification of all life and has led to the third edition (soon to be a fourth) of *Five Kingdoms: An Illustrated Guide to the Phyla of Life on Earth* (1998). Their classification scheme was generated from scientific results of myriad colleagues and its logical-genealogical basis is summarized in her single-authored book *Symbiosis in Cell Evolution: Microbial Communities in the Archean and Proterozoic Eons* (second edition, 1993). The bacterial origins of both chloroplasts and mitochondria are now established. Currently, with colleagues and students, she explores the possible origin of cilia from spirochete bacteria. She is passionately interested in the rescue of all scientific films that directly demonstrate the behavior, genetics, and development of *living* organisms. Since the mid-1970s, Margulis has aided James E. Lovelock, FRS, in documentation of his Gaia theory, which posits that the Earth's surface interactions among live beings, rocks and soil, air and water have created a vast self-regulating system. From the vantage point of outer space, *Planet Earth* (or better yet *Planet Water*) acts alive.

Her novel *Luminous Fish* will be published in 2007 by *the* publishing company devoted to the "politics and practice of sustainable living," Chelsea Green of White River Junction, VT.

Recent, Relevant Publications

2004. "Introduction: Gaia by Any Other Name." In S.H. Schneider et al. (Eds.) *Scientists Debate Gaia: The Next Century*. MIT Press, Cambridge, MA. pg. 7–12.

With D. Sagan. 2002. "Five Kingdoms of Nature." In N. Eldredge (Ed.). *Life On Earth: An Encyclopedia of Biodiversity, Ecology and Evolution*. Vol. 1, ABC-CLIO, Inc., Santa Barbara, CA. pg. 357–361.

With C. Matthews and A. Haselton (Eds.) 2000. *Environmental Evolution: Effects of the Origin and Evolution of Life on Planet Earth.* 2nd edition. MIT Press, Cambridge, MA. xvi + 338 pp.

1999. Foreword. In R. Morrison's *The Spirit in the Gene: Humanity's Proud Illusion and the Laws of Nature.* Cornell University Press, Ithaca, NY. pg. vii–x.

1998. Foreword to English translation of *The Biosphere*, V.I. Vernadsky (1926). A Peter N. Nevraumont Book. Copernicus/Springer-Verlag, New York, NY. pg. 14–19.

1998. *Symbiotic Planet: A New Look at Evolution.* Basic Books, New York, NY. vi + 147 pp. Hardcover, paperback, translations in Spanish, Dutch, German, Japanese, Chinese and Portuguese.

With D. Sagan. 1997. *Slanted Truths: Essays on Gaia, Evolution and Symbiosis.* Copernicus/Springer Verlag, New York, NY. xxiii + 368 pp. Translation in Chinese.

With D. Sagan. 1993. "God, Gaia and Biophilia." In S.R. Kellert and E.O. Wilson (Eds.) *The Biophilia Hypothesis.* Island Press, Washington, DC. pg. 345–364.

With J. E. Lovelock. 1989. "Gaia and Geognosy." In L. Margulis et al. (Eds.). *Global Ecology: Towards a Science of the Biosphere.* Academic Press, Boston, MA. pg. 1–30.

With J.E. Lovelock. 1978. "The Biota as Ancient and Modern Modulator of the Earth's Atmosphere." In H.U. Dütsch (Ed.) *Influence of the Biosphere on the Atmosphere.* [*Contributions to Current Research in Geophysics*, vol. 5]. Birkhäuser Verlag, Basel, Germany. pg. 239–243. (Reprinted from Pageoph, 1978.)

June Marie Mow

June Marie Mow works at all levels to improve environmental protection and planning, environmental education and awareness, and grass roots community involvement in environmental management. She has an undergraduate degree in microbiology from the University of Los Andes, Bogota, Colombia, and completed graduate work in marine microbiology through the University of Kiel in Germany. She also holds a post-graduate degree in regional sciences from the University of Karlsruhe in Germany.

Mow was elected the first General Director of the Corporation for the Sustainable Development of the Archipelago of San Andres, Old Providence, and Santa Catalina – CORALINA, the environmental authority for Colombia's only oceanic department, which is located in the western Caribbean. CORALINA's jurisdiction includes the insular area of the Archipelago as well as the territorial waters and Exclusive Economic Zone of the islands (approximately 300,000 km^2). As a result of her work in establishing the Seaflower Biosphere Reserve, she was a member of the UNESCO Man and the Biosphere board from 2001 to 2005. CORALINA's work during her tenure furthered marine conservation, not only to the benefit of the San Andres Archipelago and Colombia, but also with regional and global significance. CORALINA has become internationally recognized for successfully designed Marine Protected Areas, particularly in community involvement. Its vision is resource users working hand in hand to influence activities and actions in the Seaflower Marine Protected Areas.

Mow also served UNESCO as an external advisor: to lead an assessment team for the 2002 project "Coastal Resources Management and Ecotourism," an intersectoral approach to localizing sustainable development, Ulugan Bay, Palawan, Philippines; to support the establishment of new biosphere reserves for Coastal Areas and Small Islands in the Caribbean and Cape Horn (Chile) in 2005; and to assess the visioning process on Old Providence and Santa Catalina in 2005. The Man and the Biosphere Programme of Spain invited her in 2005 to advise the autonomous communities and municipal governments during the planning phase of Biosphere Reserves. She successfully carried out an assessment of InWEnt's (Capacity Building International, Germany) development cooperation programme to strengthen Integrated Coastal Zone Management in Southeast Asia, Latin America, and Africa on behalf of the German Development Ministry (BMZ) and the Bremen State Office for Development Cooperation through capacity building in 2005–2006.

Other recent work experiences include serving the Colombian National Government to develop Colombia's National Ocean Strategy, including the integration of ocean issues such as multiple uses and good management, tourism development for both the Caribbean and the Pacific zones, scientific knowledge for better use, management and conservation of the ocean, as well as a new system of good governance in the development plans at the national, regional, and local levels. A National Ocean Policy and the Law of the Ocean are to be enacted by 2019. In 2005 she served the National Marine Research Institution (INVEMAR) in the planning phase of the GEF Project "Integrated national adaptation pilot: high mountain ecosystems, Colombia's Caribbean insular areas, and human health (INAP)." She is a founding member of Providence Foundation, whose mission is to promote the conservation of the ecosystems of the Seaflower Biosphere Reserve.

Recent, Relevant Publications

2006. The native islanders of San Andres, Old Providence and Santa Catalina: Dreaming between two worlds. Proceedings of the Islands of the World IX Conference. Sustainable Islands – Sustainable Strategies. Kahului, Maui, Hawai'i.

Et al. 2006. Visión Colombia II Centenario. Aprovechamiento del Territorio Marítimo y sus Recursos. Departamento Nacional de Planeación. In review.

With M. Foth. 2006. Küsten nachhaltig entwickeln. Das internationale Netzwerk COASTMAN – Eine Erfolgsbilanz. InWEnt, Berlin.

2005. Gestión del Turismo. Islas de Old Providence y Santa Catalina. Presente y Futuro. Anuario Turismo y Sociedad, Universidad Externado de Colombia, Facultad de Administración de Empresas Turísticas y Hoteleras, *6* (04).

2005. La Reserva de Biosfera SEAFLOWER: Una opción viable para las Islas de San Andrés, Old Providence y Santa Catalina. Revista ANACONDA. Especial de San Andrés, Providencia y Santa Catalina.

With C. Recchia. 2003. "Establishing large, multiple-use marine and coastal protected areas in the San Andrés Archipelago, Colombia." Proceedings of the Fifty-Sixth Annual Gulf and Caribbean Fisheries Institute Meeting, Tortola, BVI. *Gulf and Caribbean Research*.

With M. Howard et al. 2003. The Archipelago of San Andres: towards new paradigms and new partnerships in the planning and management of its most important commons, the marine and coastal zone. In review.

With M. Howard et al. 2003. Community-based development of multiple-use marine protected areas: Promoting stewardship and sharing responsibility for conservation in the San Andres Archipelago, Colombia. *Gulf and Caribbean Research*, *14* (2). Gulf and Caribbean Fisheries Institute, Fort Pierce.

With M. Howard and V. Pizarro. 2003. Ethnic and Biological Diversity within the SEAFLOWER Biosphere Reserve. *International Journal of Island Affairs*.

With M. Howard et al. 2002. Using environmental education as a management tool to promote sustainable development: A Case Study of the Seaflower Biosphere Reserve. *Prospects* (a UNESCO Publication).

Magnus Ngoile

Dr. Magnus Ngoile is Team Leader of the Marine and Coastal Environment Management Project in Tanzania, Africa. He has extensive experience in fisheries science, marine ecology, and population biology, and he specializes in national and regional processes related to the establishment of integrated coastal management. In 1989 he launched a national effort in his native Tanzania to establish marine parks and reserves to conserve ocean biodiversity and encourage stakeholder participation in the sustainable use of marine resources. The initiative culminated in the enactment of national legislation for marine protected areas in 1994. In 1995, Mafia Island Marine Park in Zanzibar was gazetted as Tanzania's first marine reserve. Ngoile coordinated the collection of baseline marine and coastal data in the Zanzibar Islands that led to selection of the Mafia Island site. He also championed incorporation of indigenous management mechanisms into policies that promote and authorize community participation and governance of the reserve.

At the regional level, Dr. Ngoile has been integral to the development of marine sciences in East Africa. He was for ten years Director of the Institute of Marine Sciences of the University of Dar es Salaam in Tanzania, where he enhanced curriculum and advocated for policy based on sound science. He also organized regional courses, workshops, and conferences on marine conservation to promote a region-wide approach to integrated coastal management.

Internationally, Ngoile has actively fostered networks and partnerships that facilitate improved coastal management initiatives through his position as coordinator of IUCN's global Marine and Coastal Program, where he worked for three years until his appointment as Director General of Tanzania's National Environmental Management Council. He also helped launch the Western Indian Ocean Marine Science Association and is now a board member of the organization. His Ph.D. in fisheries science was earned at University of Aberdeen, Scotland.

Recent, Relevant Publications

With J. Ruitenbeek and I. Hewawasam (Eds.) 2005. *Blueprint 2050: Sustaining the Marine Environment in Mainland Tanzania and Zanzibar.* IBRD/The World Bank, Washington, DC.

With D. Moffat, et al. 1998. "The Reality of the Stomach: Coastal Management at the Local Level in Eastern Africa." *Ambio, 19*: 307–315.

With L. Melamari and S. Makoloweka. 1998. Assessment of Mafia Island Marine Park (MIMP).

With O. Mwaipopo and J. Julian. 1996. "The Development of Mafia Island Marine Park: A Case Study." In O. Linden and C.G. Lundin (Eds.) *Proceedings of the National Workshop on Integrated Coastal Zone Management in Tanzania*. The World Bank, pg. 124–132.

With O. Linden. 1996. "Lessons Learned from Eastern Africa: The Development of Policy on ICZM at National and Regional Levels." In *Proceedings of the International Workshop on ICM*. Xiamen, China.

1996. "Coastal Zone Management in Tanzania." In O. Linden and C.G. Lundin (Eds.) *Proceedings of the National Workshop on Integrated Coastal Zone Management in Tanzania*. The World Bank, pg. 14–123.

With J.C. Horrill and W.R.T. Darwall. 1996. *Development of a Marine Protected Area: Mafia Island, Tanzania.*

With C.M. Coughanowr and O. Linden. 1995. "Coastal Management in Eastern Africa including the Island States: A Review of Issues and Initiatives." *Ambio, 24* (7): 448–457.

With A.K. Semesi. 1995. "Status of the Coastal and Marine Environment in the United Republic of Tanzania. In *Proceedings of the Arusha Workshop and Policy Conference on Integrated Coastal Zone Management in Eastern Africa including the Island States*. SAREC Marine Program, Manila, pg. 291ff.

1990. "The Development of a Marine National Park on Mafia Island, Tanzania: The Current State of the Marine Environment of the South Mafia Channel." Report for Shell Development. Tanzania Ltd. and the Institute of Marine Sciences, p. 45.

Shekhar Singh

Shekhar Singh is currently a Governor of the Canadian International Development Research Centre (IDRC) and co-chairs the Transparency Task Force, part of the Initiative for Policy Dialogue (IPD), based in Columbia University, New York. The Transparency Task Force brings together scholars and activists from many regions who are working to improve global understanding of what transparency [openness of institutions] can accomplish and how it can be increased.

Singh taught social and moral philosophy, and epistemology, at St. Stephen's College, University of Delhi (1972–73), and at the North-Eastern Hill University, Shillong (1974–1980). He subsequently lectured to civil servants on ethics and administration, and on the management of the environment at the Indian Institute of Public Administration, New Delhi (1980–2002). He has also been Director of the Centre for Equity Studies, New Delhi (2002–2004) and Convenor of the National Campaign for People's Right to Information (2004–2006). His major areas of work and interest include biodiversity conservation, environmental management, and good governance.

In 1990 he was appointed the first head of the integrated division on environment, forests, and wildlife in the Planning Commission of India, with the responsibility of supervising the planning process in the federal and state governments, and of advising the government on environmental matters. He was concurrently Secretary of the Island Development Authority of the Government of India, which oversees development activities in the island territories of India.

Subsequently, he was appointed Chair of the Environmental Appraisal Committee for Power Projects in India, with the statutory obligation to appraise power projects from the environmental angle. He has been a member of the Indian Board for Wildlife and Central Board for Forestry, Chair of various government task forces, and a member of the steering committee for the formulation of the VIII, IX, X, and XI five-year plans of the Government of India. He has also been a Supreme Court-appointed Commissioner for forests and related matters in the Andaman and Nicobar Islands.

Internationally, Singh has been a consultant to various organisations, including the UNDP, FAO, ADB, DANIDA, and the World Commission on Dams. In 2000 he headed, as the lead consultant, the international team conducting the Biodiversity Programme Study of the Global Environmental Facility (GEF). He has also been associated with various non-government organisations and popular movements, especially in the areas of transparency, environmental conservation, and social justice, and was, for many years, honorary advisor to WWF India.

Recent, Relevant Publications

With Arpan Sharma. 2004. "Ecodevelopment in India" in Tom O. McShane and Michael P. Wells (Eds.) *Getting Biodiversity Projects to Work: Towards More Effective Conservation and Development.* Columbia University Press, New York.

With Pranab Banerji (Eds.). 2002. *Large Dams in India: Environmental, Social and Economic Impacts*. Indian Institute of Public Administration. New Delhi.

With A.H. Zakri and Jose T. Villarin. 2000. *Country Capacity Development Needs and Priorities: Regional Report for Asia Pacific.* GEF/UNDP. Washington, DC & New York.

With A.R.K. Sastry, Raman Mehta, and Vishaish Uppal (Eds.). 2000. *Setting Biodiversity Conservation Priorities for India.* (two volumes). WWF India.

With Vasumathi Sankaran, Harsh Mander, and Sejal Worah. 2000. *Strengthening Conservation Cultures: Local Communities and Biodiversity Conservation.* UNESCO, Paris.

1999. "Assessing Management Effectiveness of Wildlife Protected Areas in India." *Parks*, 9 (2). IUCN: The World Conservation Union. Gland, Switzerland.

1999. "Sovereignty, Equity and the Global Environment" in George James (Ed.) *Ethical Perspectives on Environmental Issues in India.* APH Publishing Corporation, New Delhi.

1998. "Environmental Issues in the Energy Sector" in *Energy for Growth and Sustainability.* Indian National Science Academy. Allied Publishers Limited, New Delhi.

1997. *Biodiversity Planning through Ecodevelopment: Planning and Implementation Lessons from India.* UNESCO/MAB, Paris.

1996. Case Study on India in Ernst Lutz and Julian Caldecott (Eds.) *Decentralisation and Biodiversity Conservation*. The World Bank, Washington, DC.

Presentations

Two PowerPoint presentations by Bob Citron, Co-founder and Executive Director of the Foundation For the Future, were given at the seminar as background information for the deliberations of the scholars.

The first presentation was "The Human Journey on Planet Earth," which includes a series of National Geographic Society slides illustrating the departures of groups of *Homo Sapiens*, initally from their place of origin in Africa 160,000 years ago, to journey to other locations, ultimately settling throughout the Earth. The Genographic Project, a major international program of geneticist Spencer Wells, the National Geographic Society, IBM, and the Waitt Family Foundation, is a five-year program using genes to chart this human migration. Each chronological period depicted in the slides shows the full extent of human life on Planet Earth at that time. The Foundation For the Future provided a planning grant for the project in 2005.

The second presentation was "The Human Impact on Planet Earth," which uses space photography from the 1970s and current images from satellites to show changes in the Earth as a result of our species' activities over the last 35 to 40 years.

Foundation For the Future

Bellevue, Washington USA

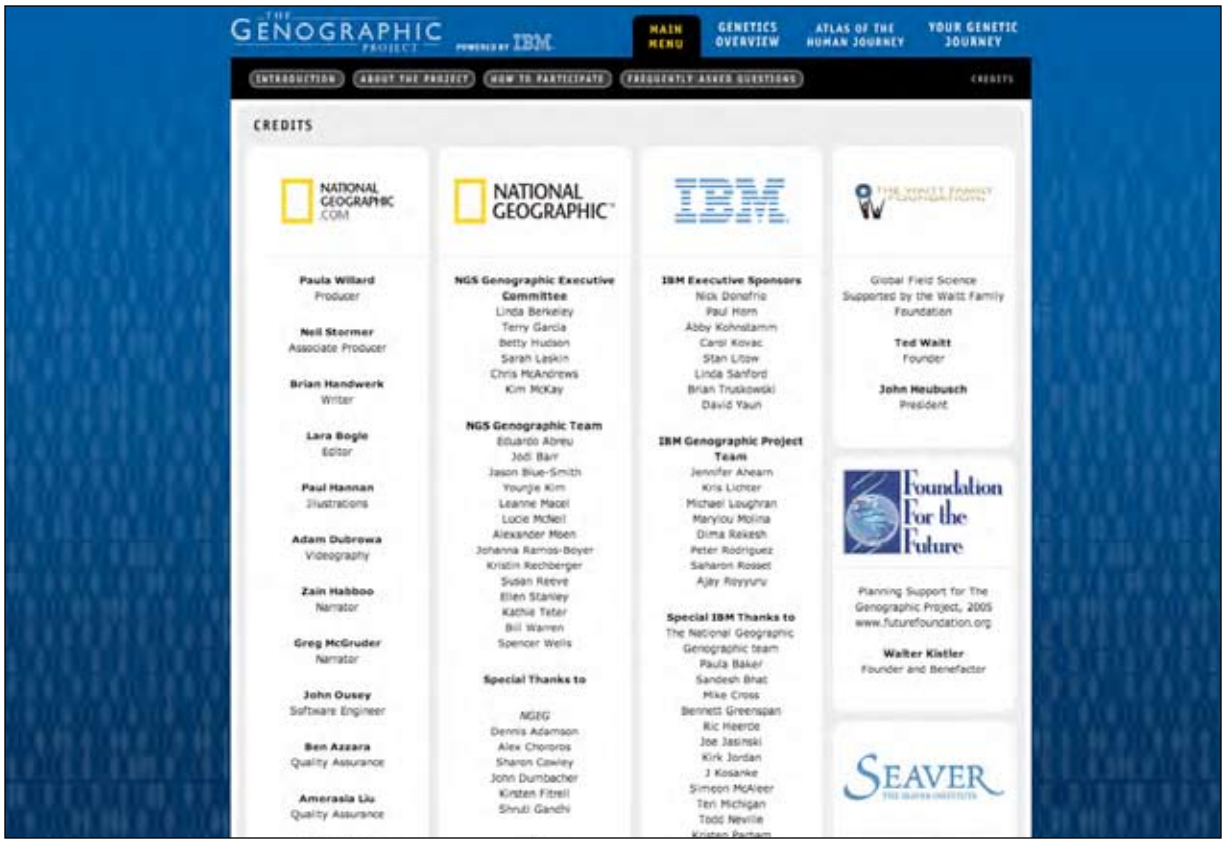
The Human Journey on Planet Earth

160,000 Years Ago to the Present

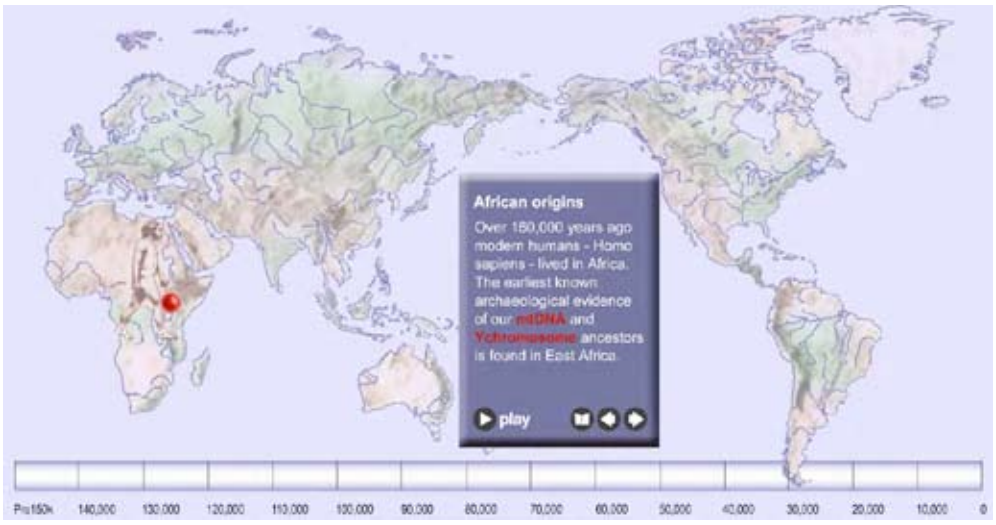
The National Geographic Society/IBM Genographic Project 2005 – 2010

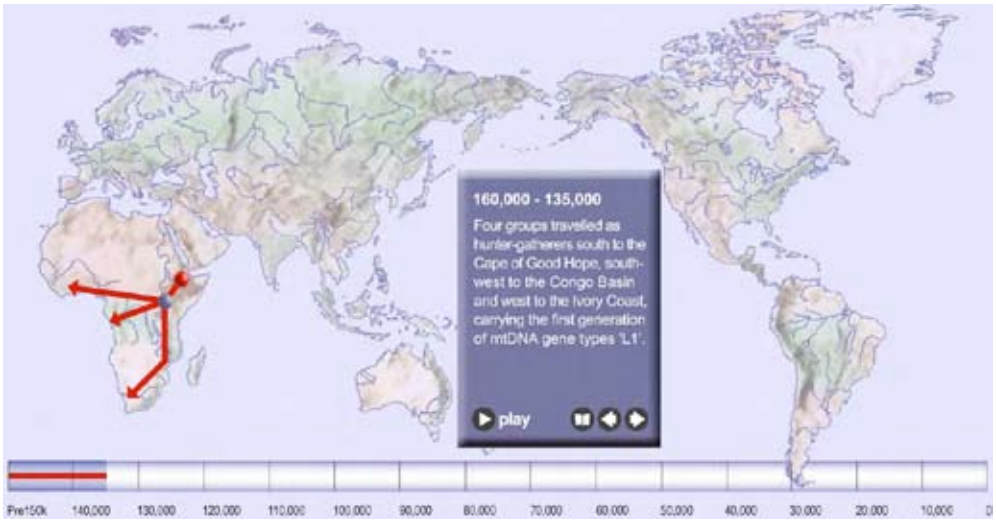
Preliminary Results from Recent Global DNA Analysis

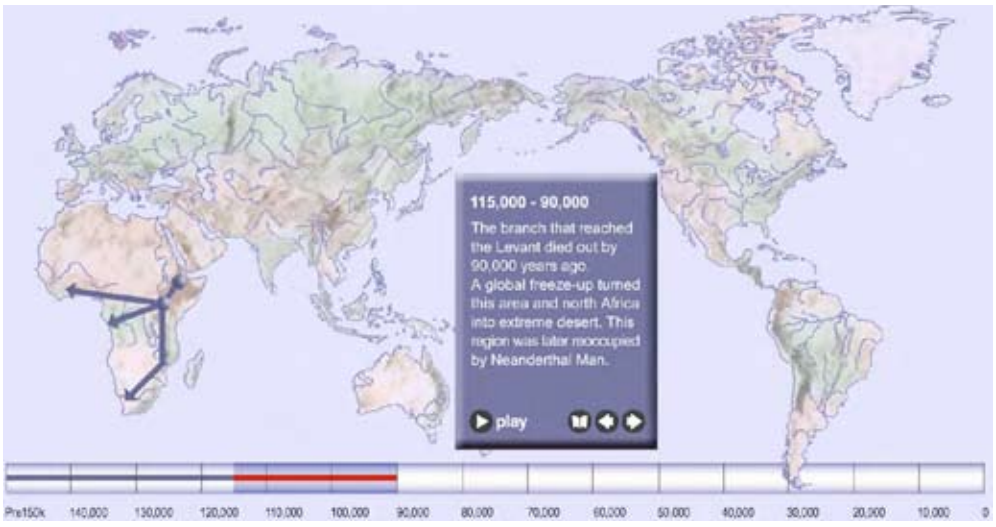
Bob Citron
Foundation For the Future
"Humanity and the Biosphere: The Next Thousand Years"
UNESCO – Paris, France, September 20–22, 2006

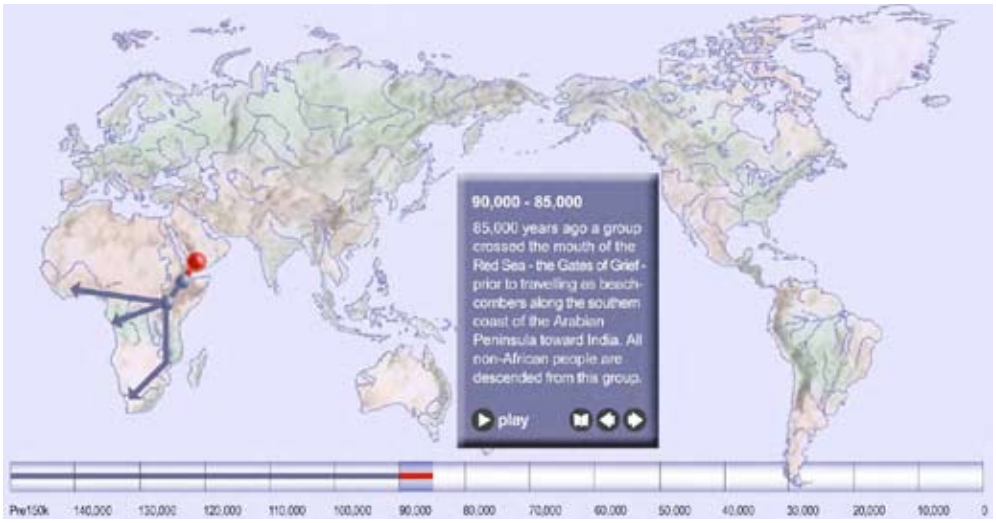


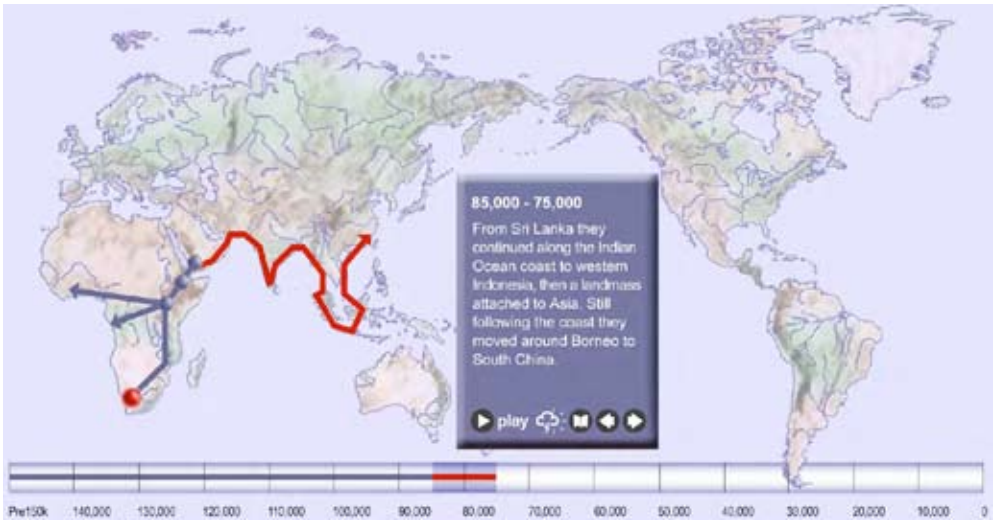
"The Human Journey on Planet Earth"
Bob Citron

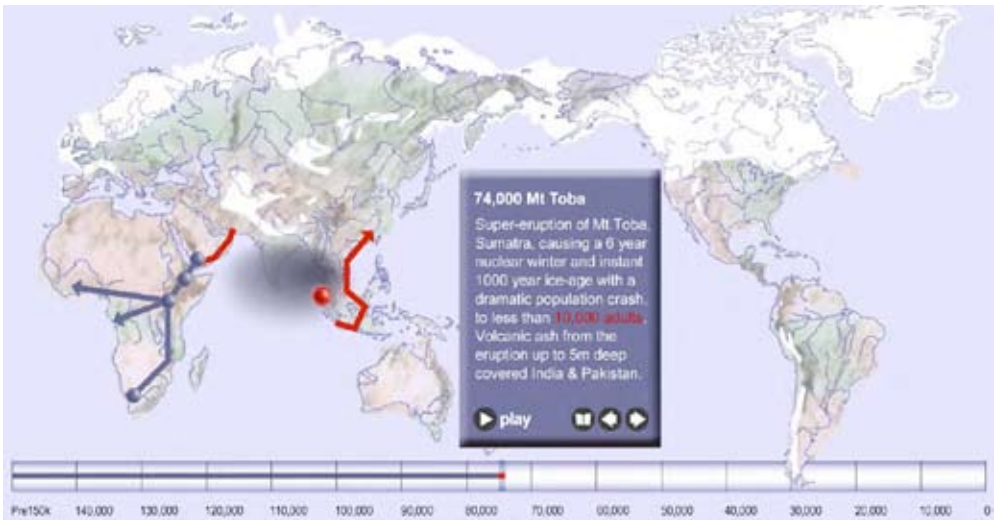


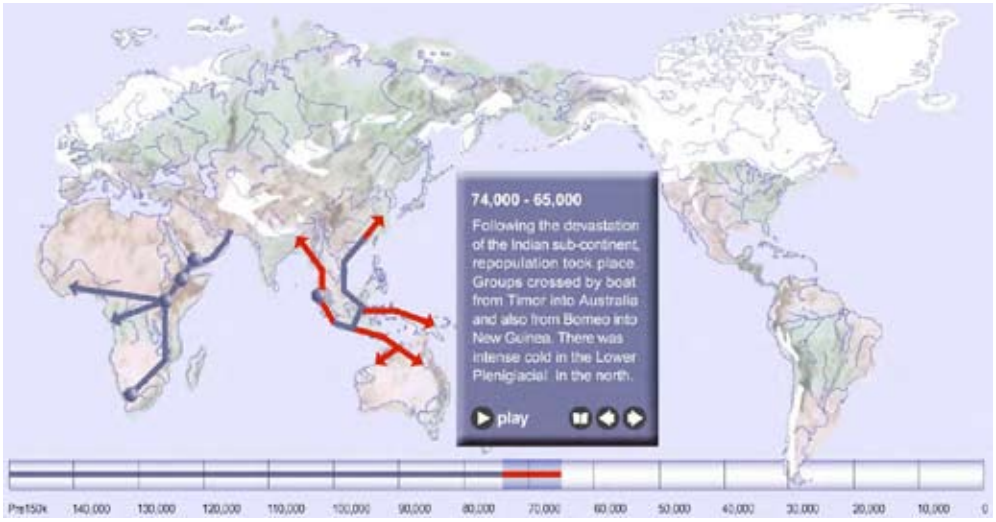


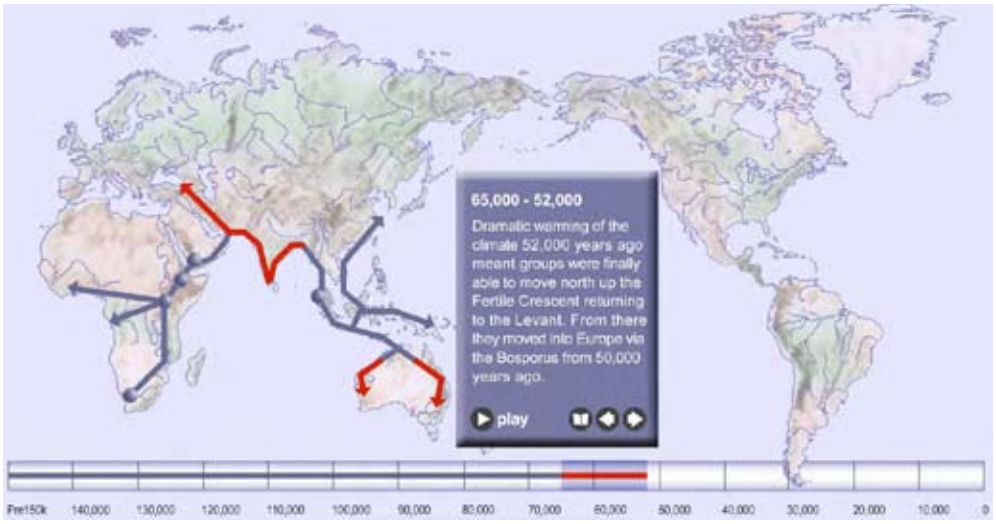

115,000 - 90,000
The branch that reached the Levant died out by 90,000 years ago. A global freeze-up turned this area and north Africa into extreme desert. This region was later reoccupied by Neanderthal Man.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0

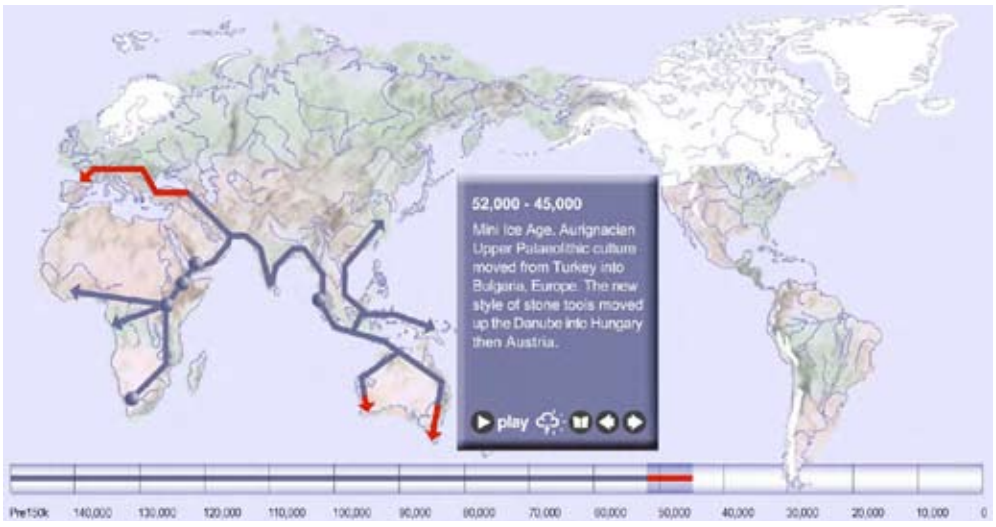

90,000 - 85,000
85,000 years ago a group crossed the mouth of the Red Sea - the Gates of Grief - prior to travelling as beach-combers along the southern coast of the Arabian Peninsula toward India. All non-African people are descended from this group.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0

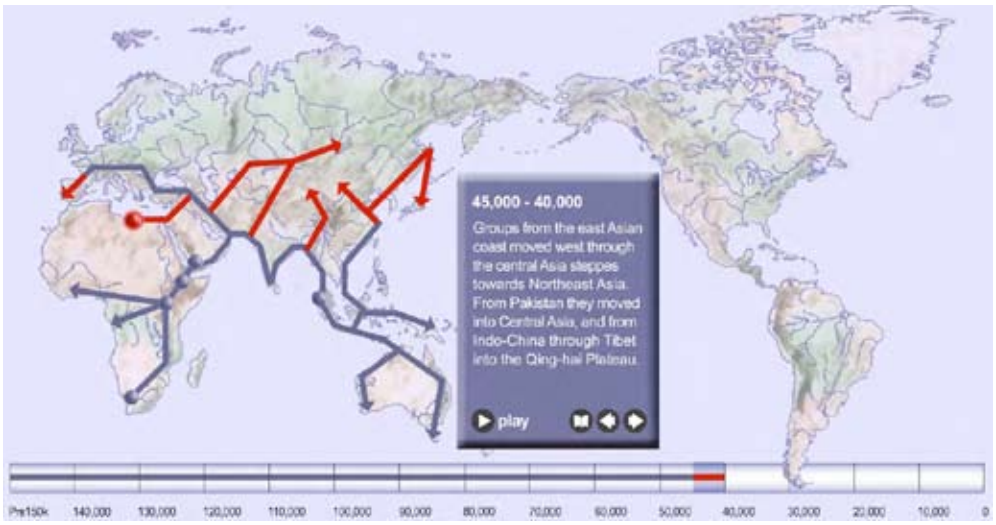

85,000 - 75,000
From Sri Lanka they continued along the Indian Ocean coast to western Indonesia, then a landmass attached to Asia. Still following the coast they moved around Borneo to South China.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0

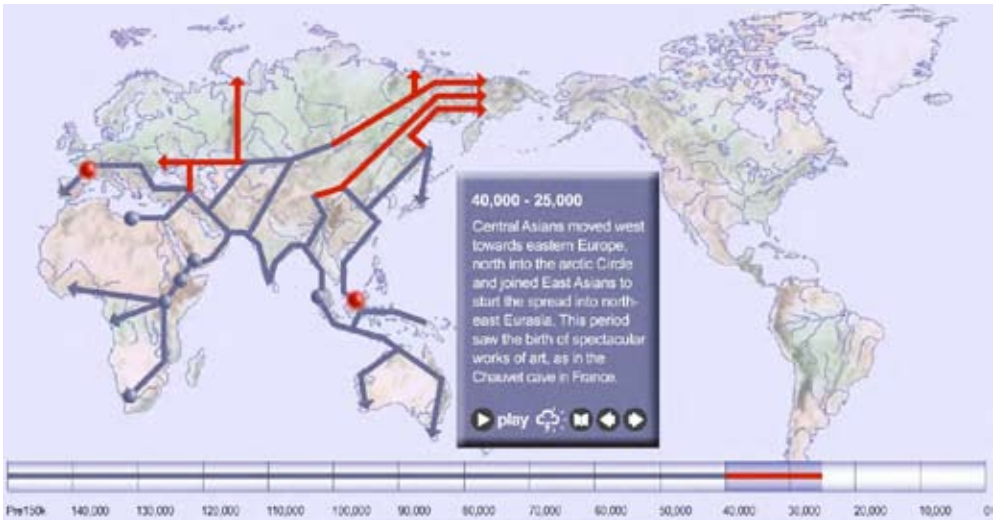

74,000 Mt Toba
Super-eruption of Mt Toba, Sumatra, causing a 6 year nuclear winter and instant 1000 year ice-age with a dramatic population crash, to less than 10,000 adults. Volcanic ash from the eruption up to 5m deep covered India & Pakistan.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0


74,000 - 65,000
Following the devastation of the Indian sub-continent, repopulation took place. Groups crossed by boat from Timor into Australia and also from Borneo into New Guinea. There was intense cold in the Lower Pleniglacial in the north.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0

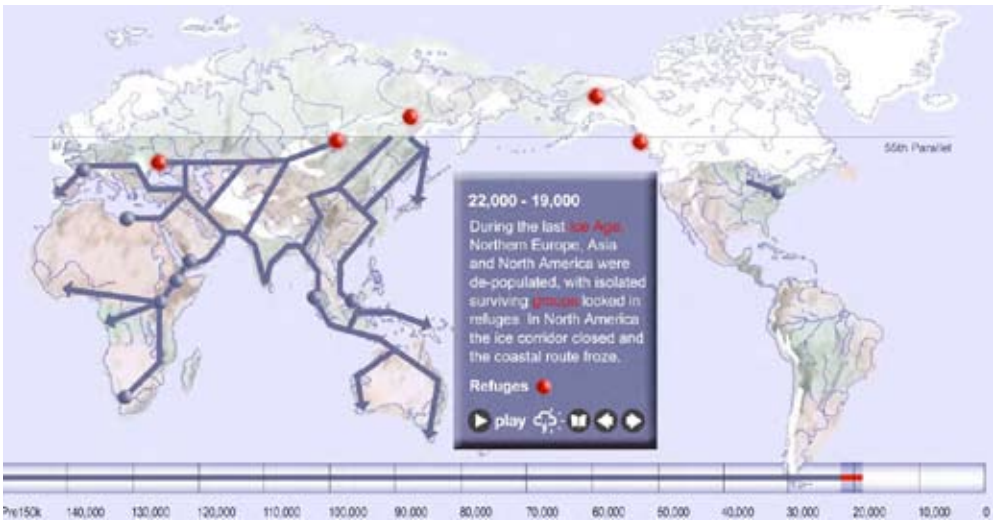

65,000 - 52,000
Dramatic warming of the climate 52,000 years ago meant groups were finally able to move north up the Fertile Crescent returning to the Levant. From there they moved into Europe via the Bosporus from 50,000 years ago.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0

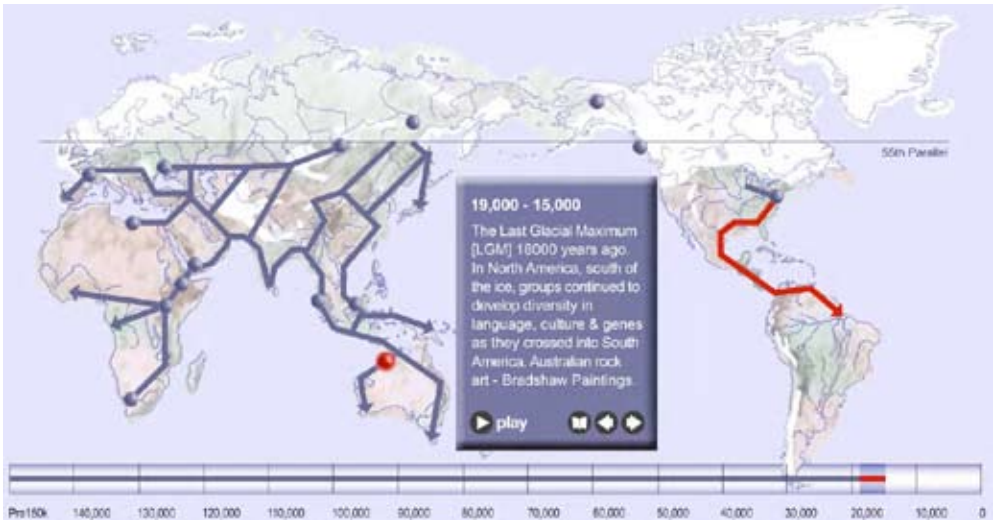

52,000 - 45,000
Mini Ice Age. Aurignacian Upper Palaeolithic culture moved from Turkey into Bulgaria, Europe. The new style of stone tools moved up the Danube into Hungary then Austria.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0

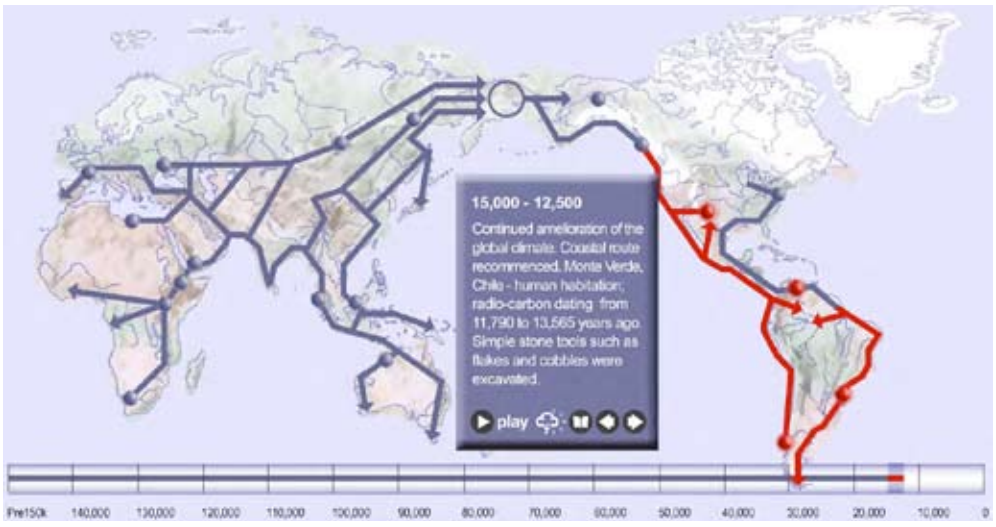

45,000 - 40,000
Groups from the east Asian coast moved west through the central Asia steppes towards Northeast Asia. From Pakistan they moved into Central Asia, and from Indo-China through Tibet into the Qing-hai Plateau.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0

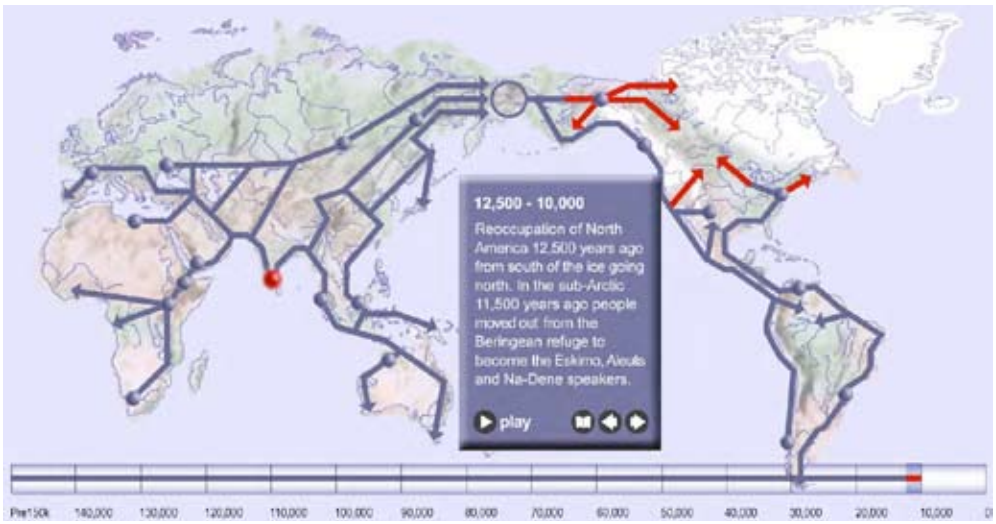

40,000 - 25,000
Central Asians moved west towards eastern Europe, north into the arctic Circle and joined East Asians to start the spread into north-east Eurasia. This period saw the birth of spectacular works of art, as in the Chauvet cave in France.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0

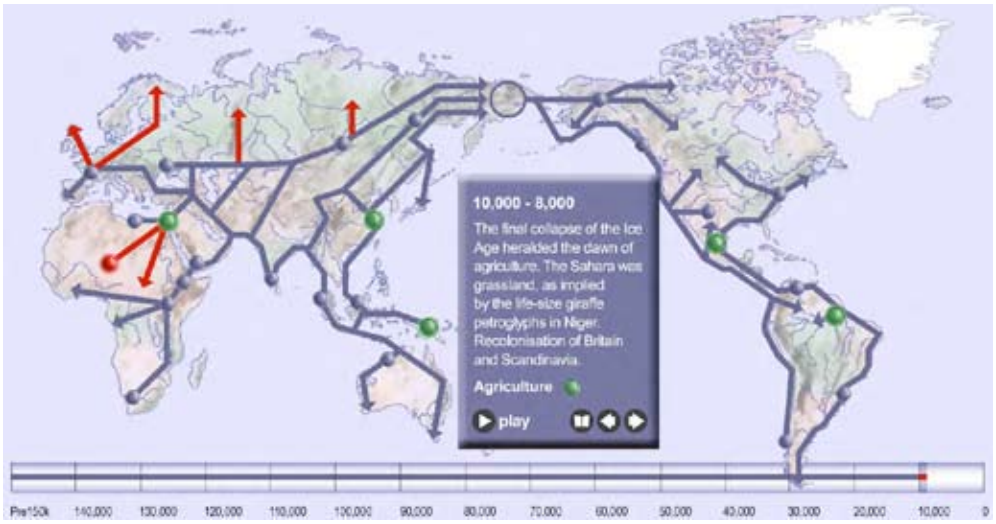

25,000 - 22,000
Ancestors of the native americans who crossed the Bering land bridge connecting Siberia to Alaska, passed through the ice corridor reaching Meadowcroft before the Last Glacial Maximum
play


55th Parallel
22,000 - 19,000
During the last Ice Age, Northern Europe, Asia and North America were de-populated, with isolated surviving groups locked in refuges. In North America the ice corridor closed and the coastal route froze.
Refuges
play


55th Parallel
19,000 - 15,000
The Last Glacial Maximum [LGM] 18000 years ago. In North America, south of the ice, groups continued to develop diversity in language, culture & genes as they crossed into South America. Australian rock art - Bradshaw Paintings.
play


15,000 - 12,500
Continued amelioration of the global climate. Coastal route recommenced. Monte Verde, Chile - human habitation; radio-carbon dating from 11,790 to 13,565 years ago. Simple stone tools such as flakes and cobbles were excavated.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0


12,500 - 10,000
Reoccupation of North America 12,500 years ago from south of the ice going north. In the sub-Arctic 11,500 years ago people moved out from the Beringean refuge to become the Eskimo, Aleuts and Na-Dene speakers.
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0


10,000 - 8,000
The final collapse of the Ice Age heralded the dawn of agriculture. The Sahara was grassland, as implied by the life-size giraffe petroglyphs in Niger. Recolonisation of Britain and Scandinavia.
Agriculture
play
Pre150k 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000 0

Appendix 3.1 | Presentations

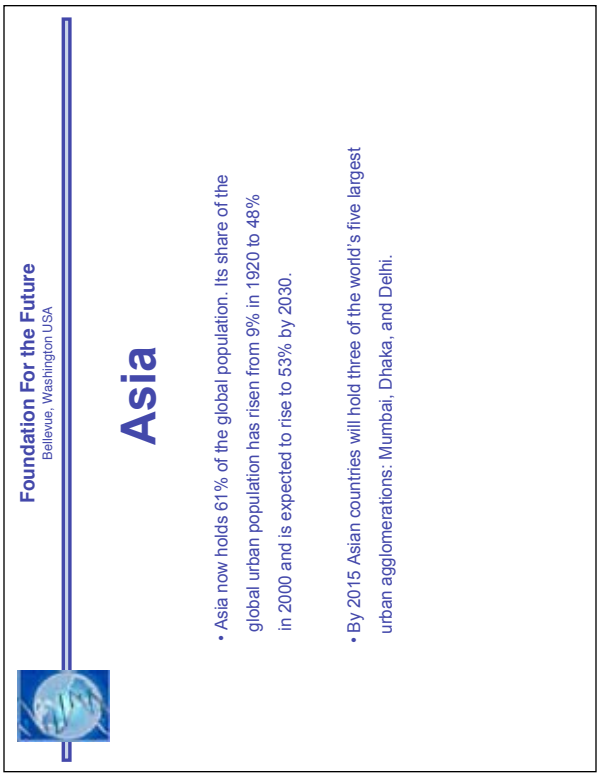
"The Human Journey on Planet Earth"
Bob Citron

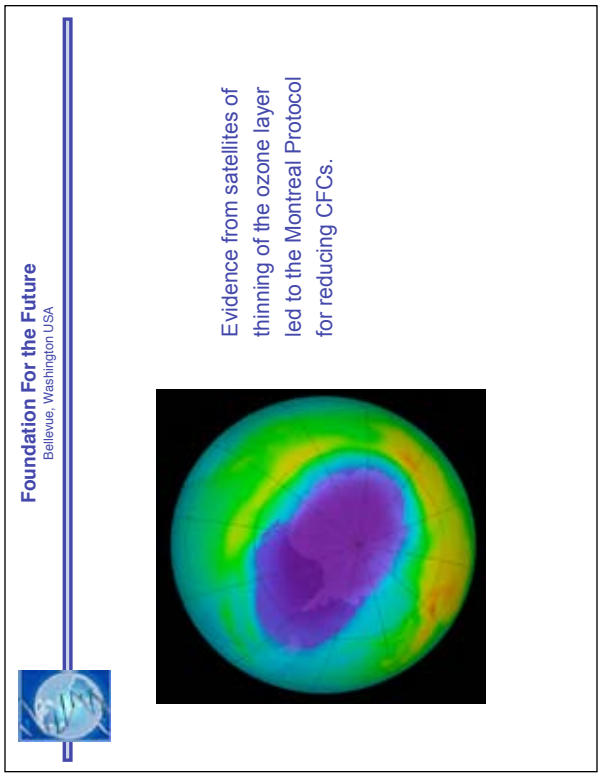
Foundation For the Future
Bellevue, Washington USA

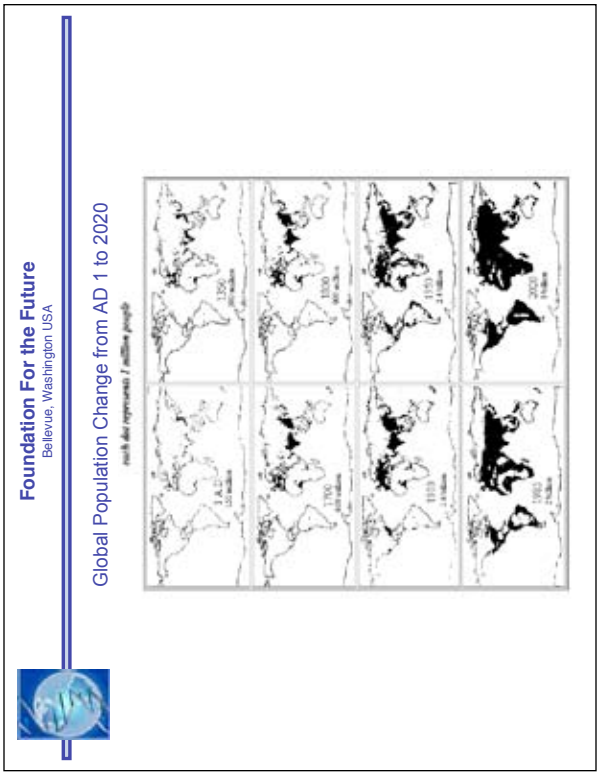
The Human Impact on Planet Earth

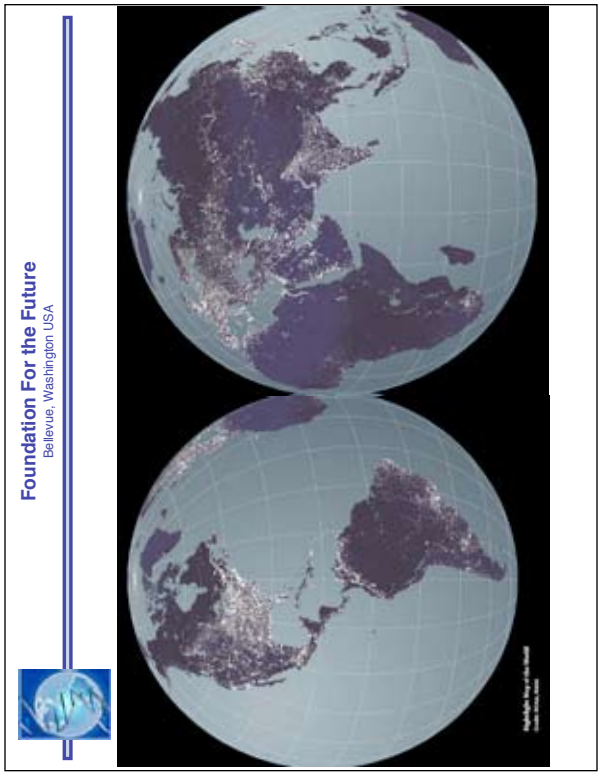
Imagery from Space –
Showing changes on Planet
Earth during the past 30 years

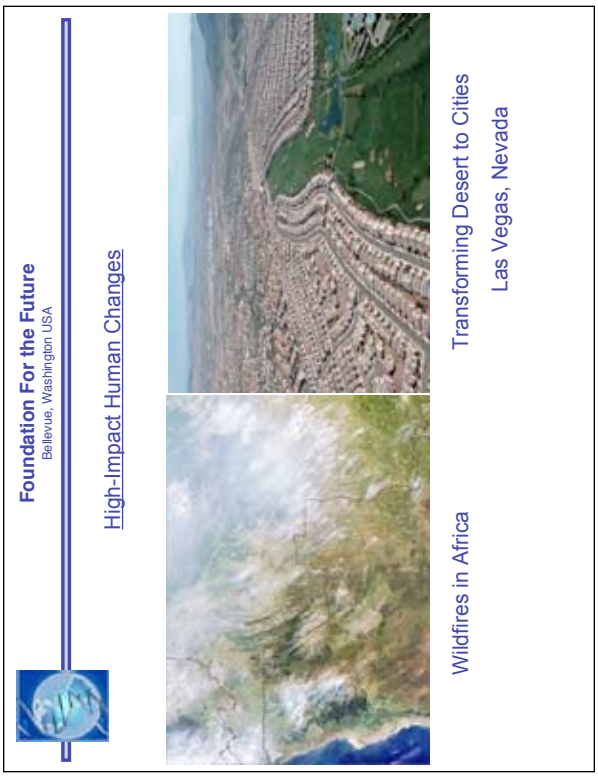
Bob Citron
Foundation For the Future
"Humanity and the Biosphere: The Next Thousand Years"
UNESCO – Paris, France, September 20–22, 2006

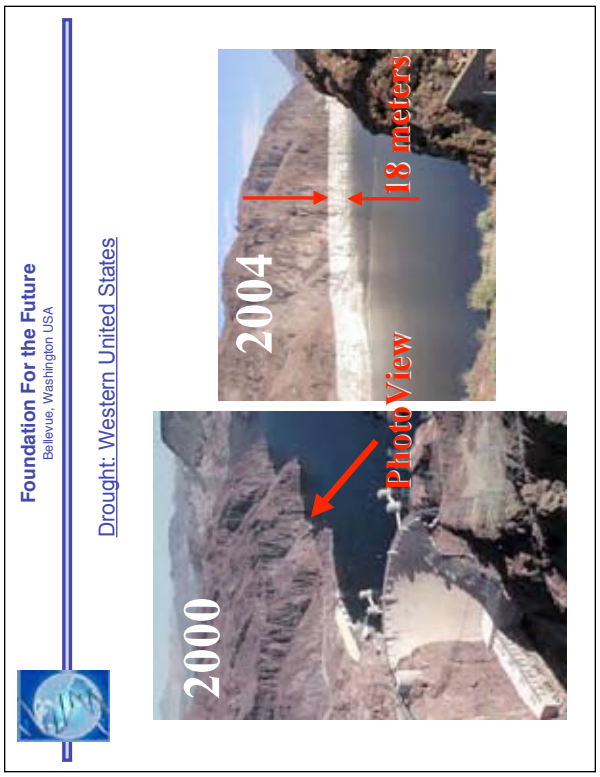

Foundation For the Future
Bellevue, Washington USA
Asia
• Asia now holds 61% of the global population. Its share of the global urban population has risen from 9% in 1920 to 48% in 2000 and is expected to rise to 53% by 2030.
• By 2015 Asian countries will hold three of the world's five largest urban agglomerations: Mumbai, Dhaka, and Delhi.

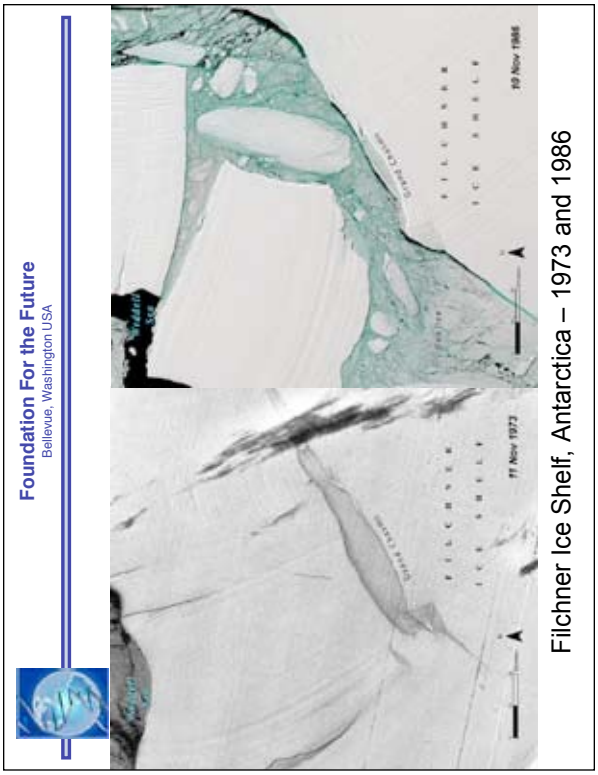

Foundation For the Future
Bellevue, Washington USA
Evidence from satellites of thinning of the ozone layer led to the Montreal Protocol for reducing CFCs.

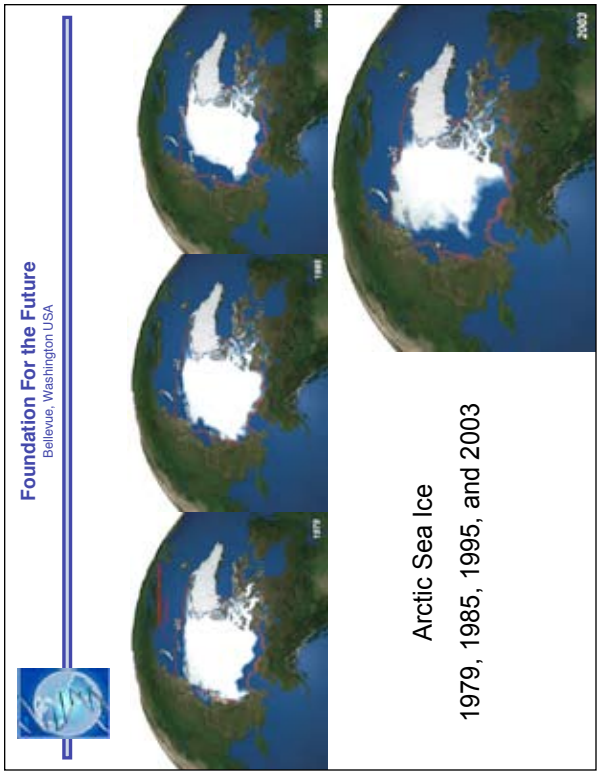

Foundation For the Future
Bellevue, Washington USA
Global Population Change from AD 1 to 2020


Foundation For the Future
Bellevue, Washington USA

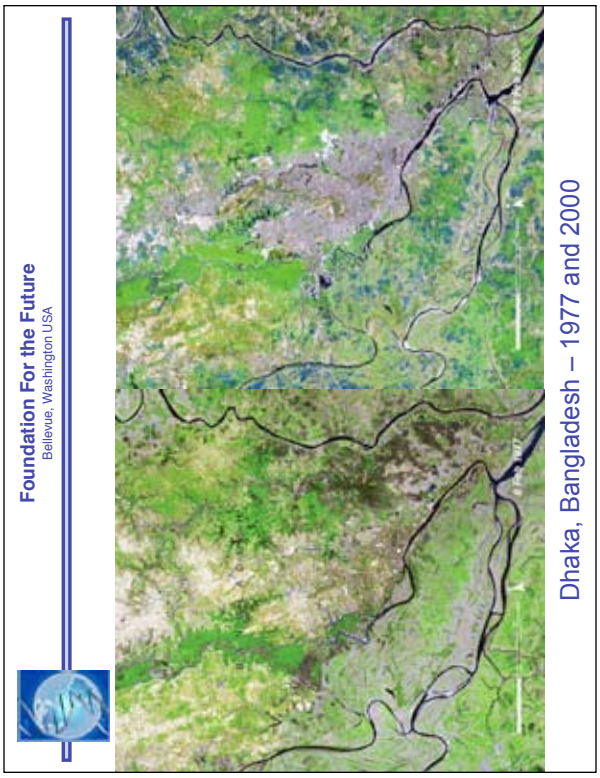

Foundation For the Future
Bellevue, Washington USA
High-Impact Human Changes
Transforming Desert to Cities
Las Vegas, Nevada
Wildfires in Africa

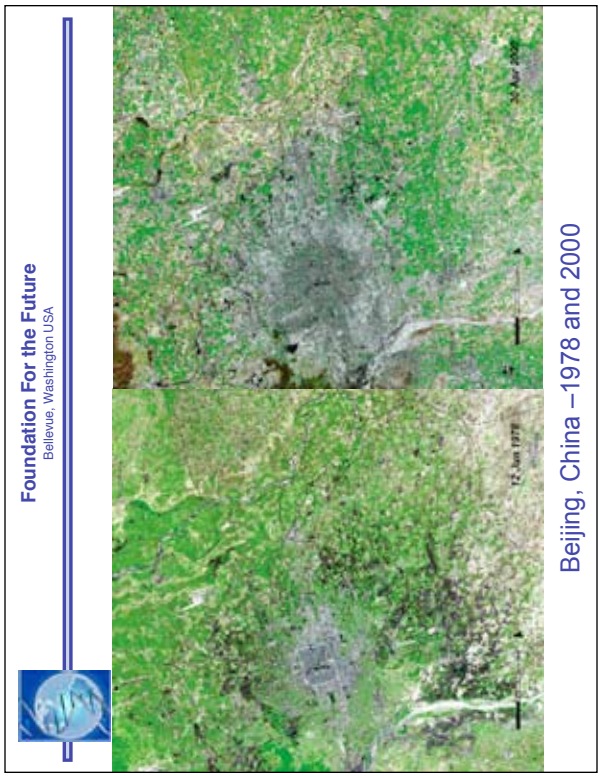

Foundation For the Future
Bellevue, Washington USA
Drought: Western United States
2000
Photo View
2004
18 meters

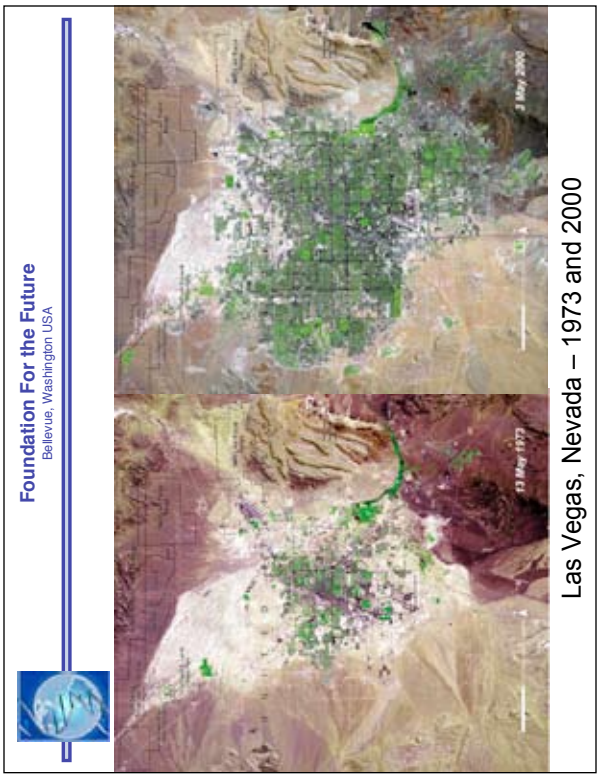

Foundation For the Future
Bellevue, Washington USA
Filchner Ice Shelf, Antarctica – 1973 and 1986

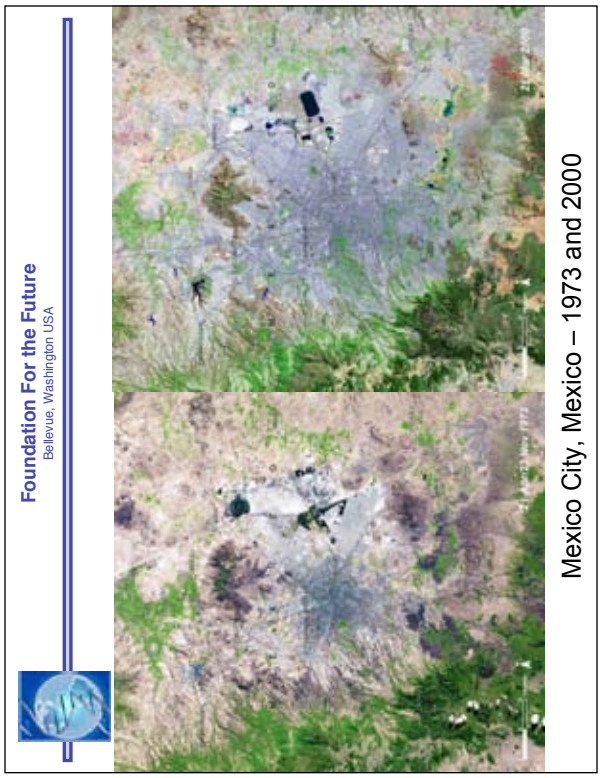

Foundation For the Future
Bellevue, Washington USA
Arctic Sea Ice
1979, 1985, 1995, and 2003

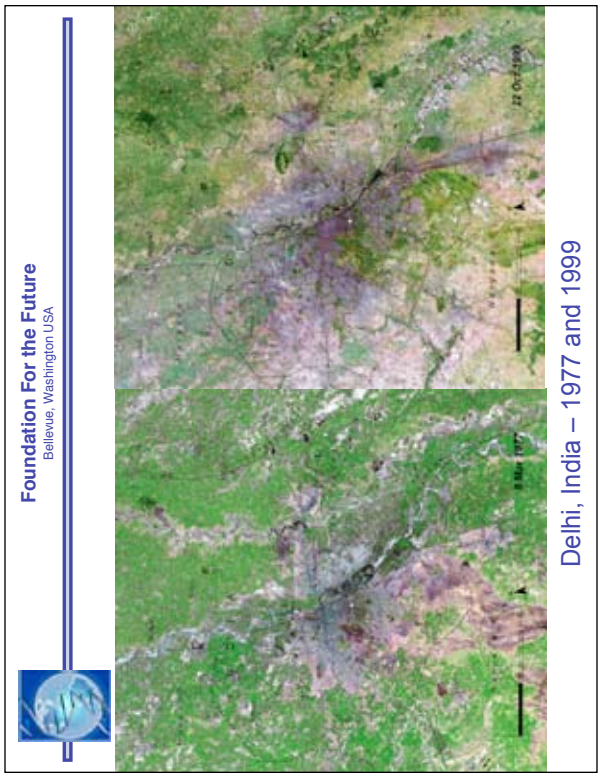
"The Human Impact on Planet Earth"
Bob Citron

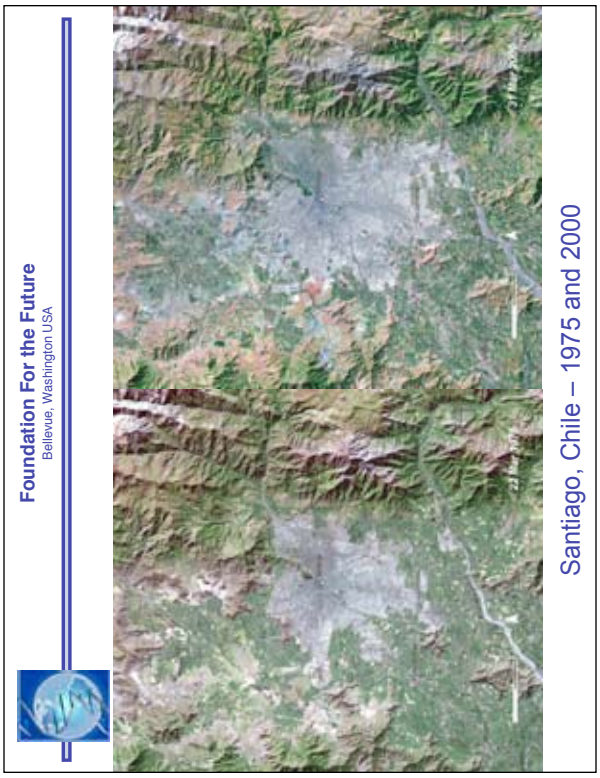


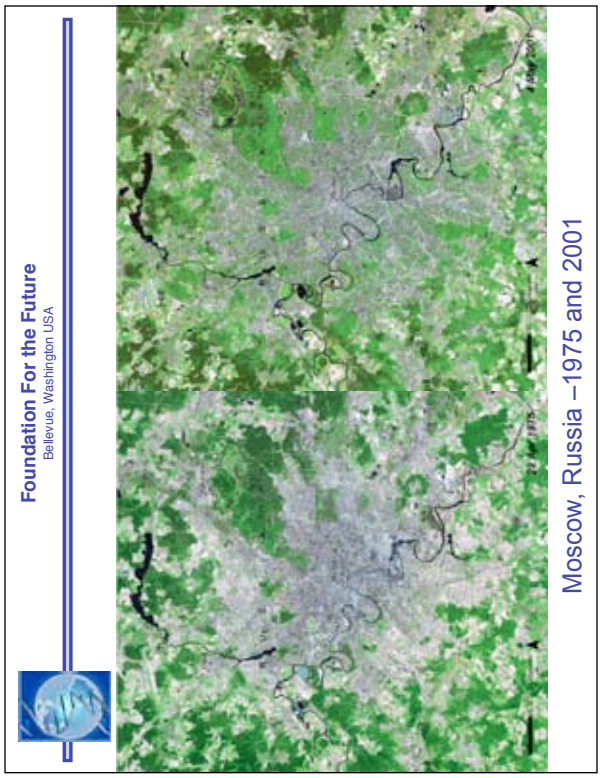


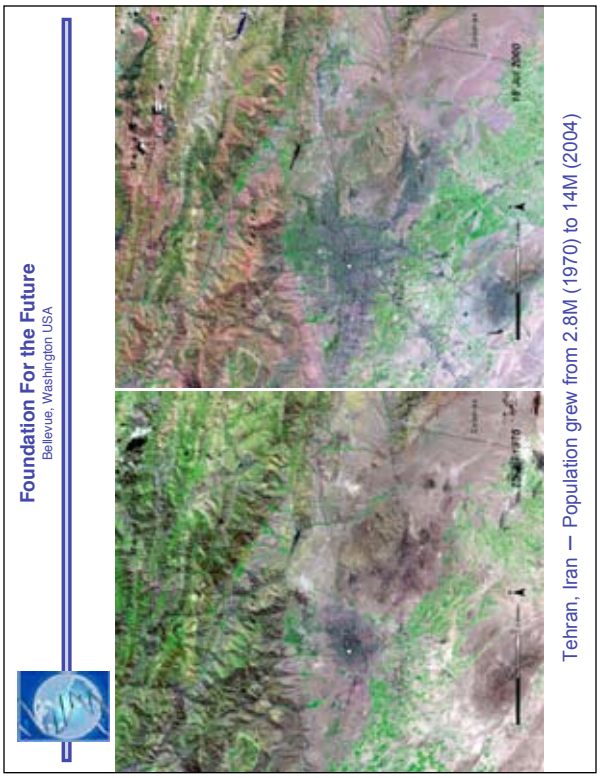




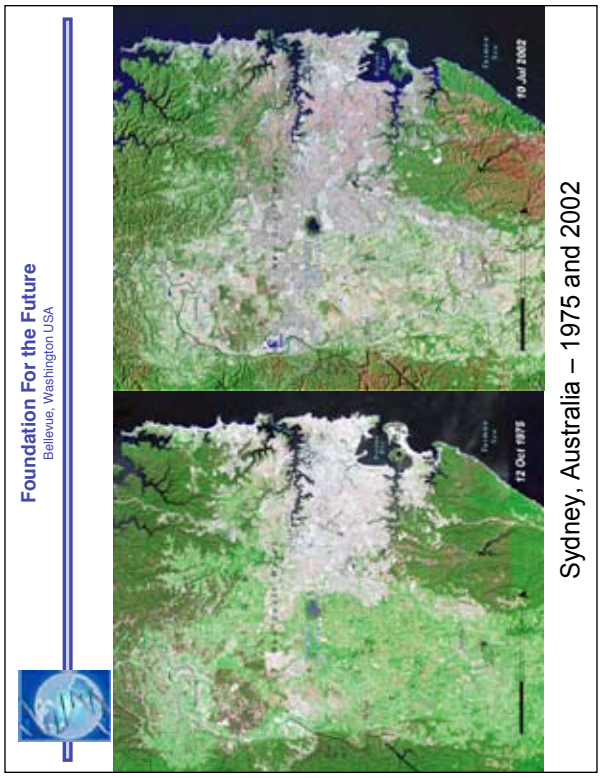

Foundation For the Future
Bellevue, Washington USA
Delhi, India – 1977 and 1999

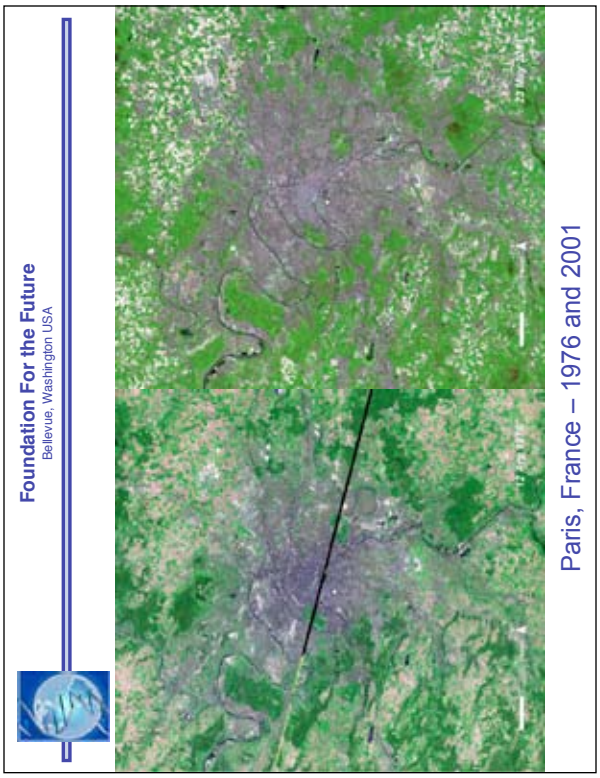

Foundation For the Future
Bellevue, Washington USA
Santiago, Chile – 1975 and 2000

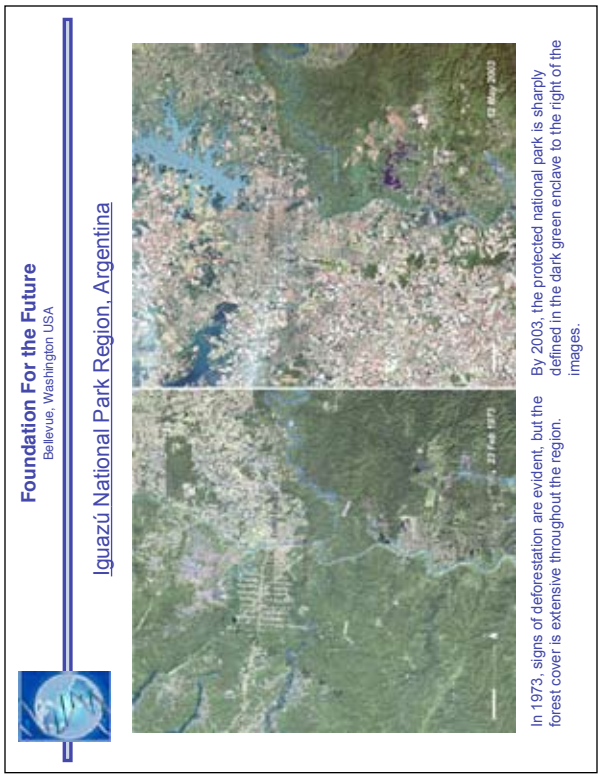

Foundation For the Future
Bellevue, Washington USA
Moscow, Russia –1975 and 2001


Foundation For the Future
Bellevue, Washington USA
Tehran, Iran – Population grew from 2.8M (1970) to 14M (2004)


Foundation For the Future
Bellevue, Washington USA
Bangkok, Thailand – 1978 and 2002


Foundation For the Future
Bellevue, Washington USA
Sydney, Australia – 1975 and 2002


Foundation For the Future
Bellevue, Washington USA
Paris, France – 1976 and 2001


Foundation For the Future
Bellevue, Washington USA
Iguazú National Park Region, Argentina
In 1973, signs of deforestation are evident, but the forest cover is extensive throughout the region.
By 2003, the protected national park is sharply defined in the dark green enclave to the right of the images.

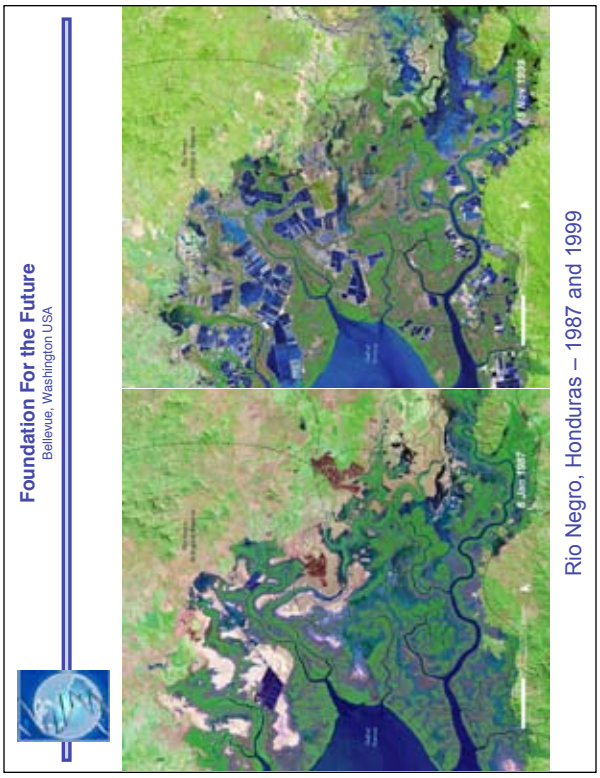
Foundation For the Future
Bellevue, Washington USA
Mining in Papua New Guinea – 1990 and 2004

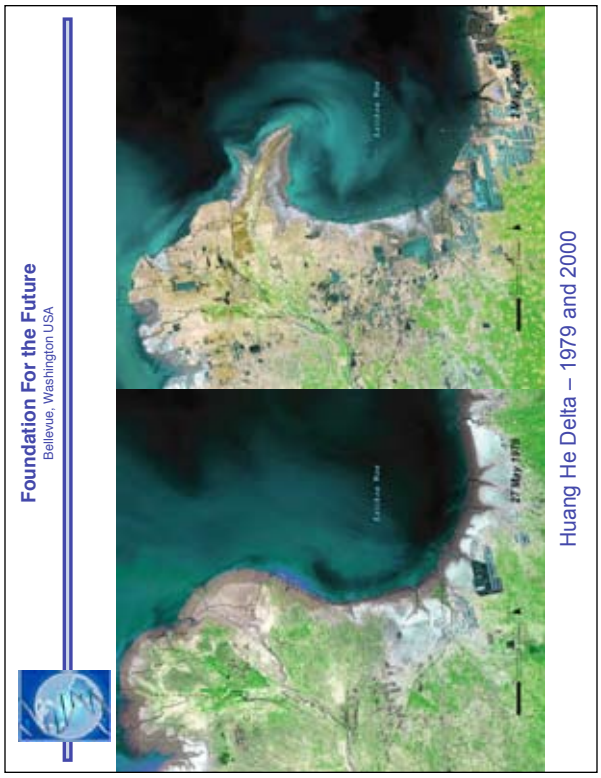
Foundation For the Future
Bellevue, Washington USA
Rondonia, Brazil – 1975 and 2001

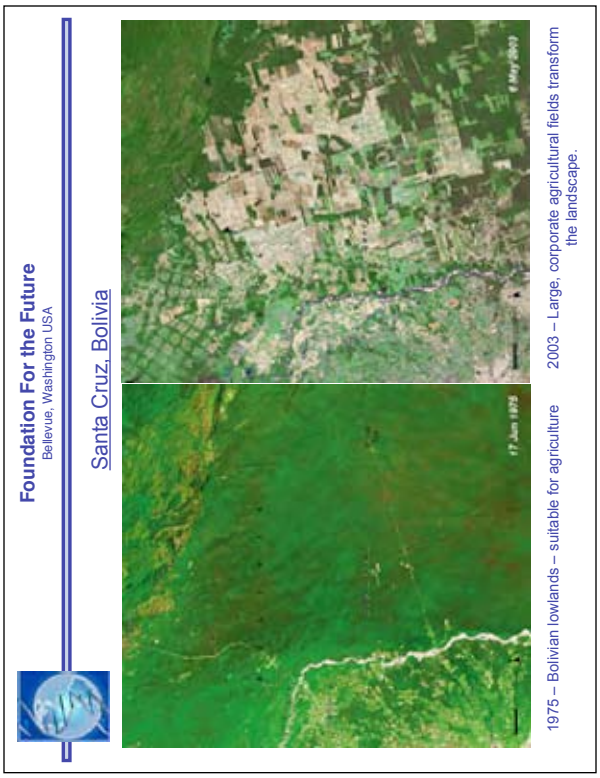
Foundation For the Future
Bellevue, Washington USA
24 Jun 1974
19 Jul 2004
This pair of satellite images shows the impact of massive and rapid agricultural development in Almeria Province along Spain's southern coast. In the 1974 image, the landscape reflects rather typical rural agricultural land use. In the 2004 image, much of the same region – an area covering roughly 20,000 hectares (49,421 acres) – has been converted to intensive greenhouse agriculture for the mass production of market produce. (Greenhouse-dominated land appears as whitish-gray patches.) In order to address increasingly complex water needs throughout Spain, the government adopted the Spanish National Hydrological Plan (SNHP) in 2001. Initially, this water-redistribution plan involved the construction of 118 dams and 22 water-transfer projects that would move water from parts of the country where it was relatively abundant to more arid regions. In 2004, the Spanish government announced that it would begin exploring more environmentally friendly water-saving technologies, such as wastewater recycling and seawater desalinization.

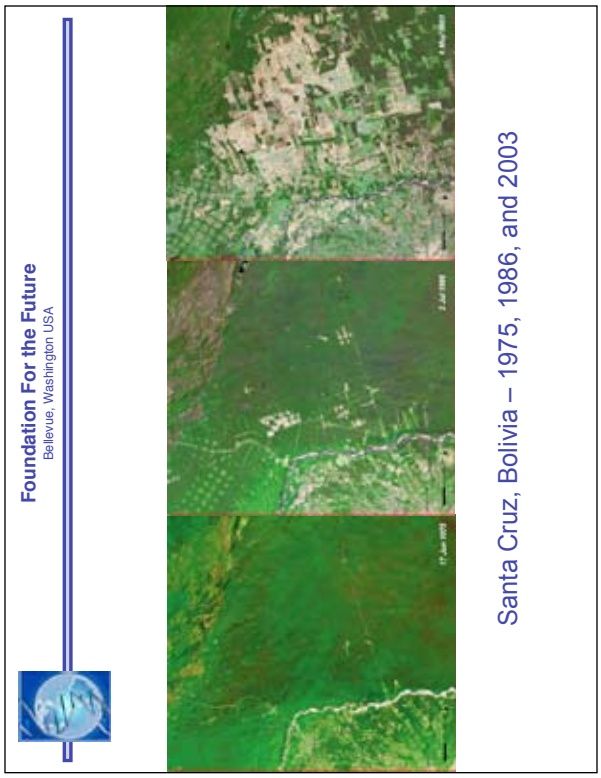
Foundation For the Future
Bellevue, Washington USA
Escondida, Chile – 1989 and 2003

"The Human Impact on Planet Earth"
Bob Citron









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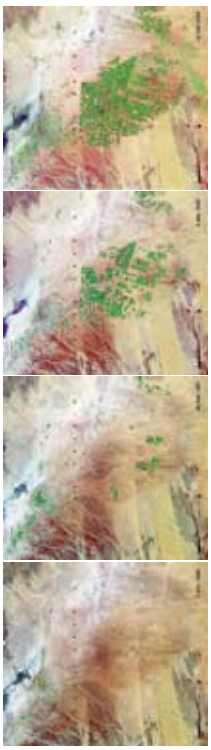
Al Isawiyah, Saudi Arabia



1986 A desert landscape

1991 Irrigation begins

2000 And transforms the desert

2004 Irrigation intensity increases

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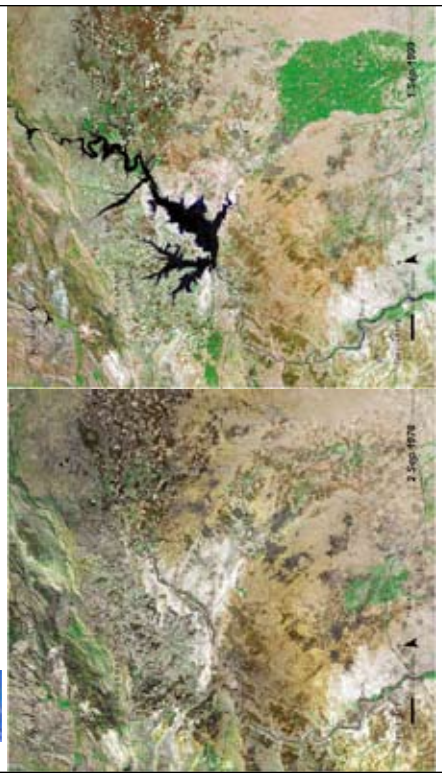
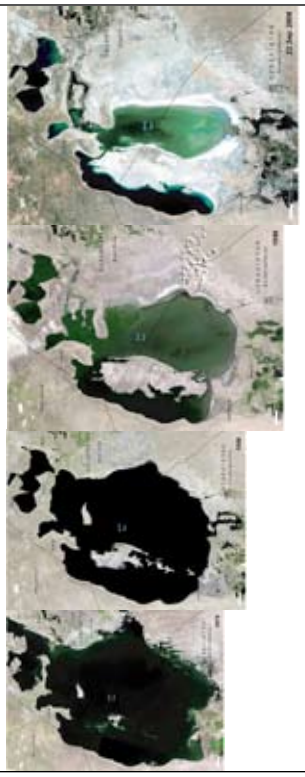


Ataturk Dam, Turkey – 1976 and 1999

Foundation For the Future
Bellevue, Washington USA



The Aral Sea, Kazakhstan, over 30 years: 1973, 1986, 1999, and 2004

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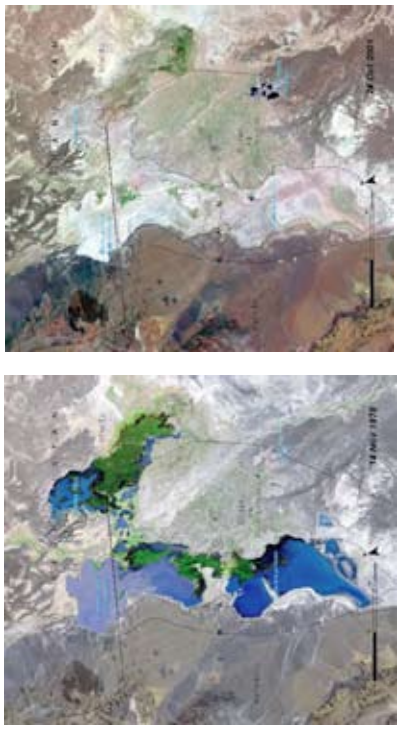
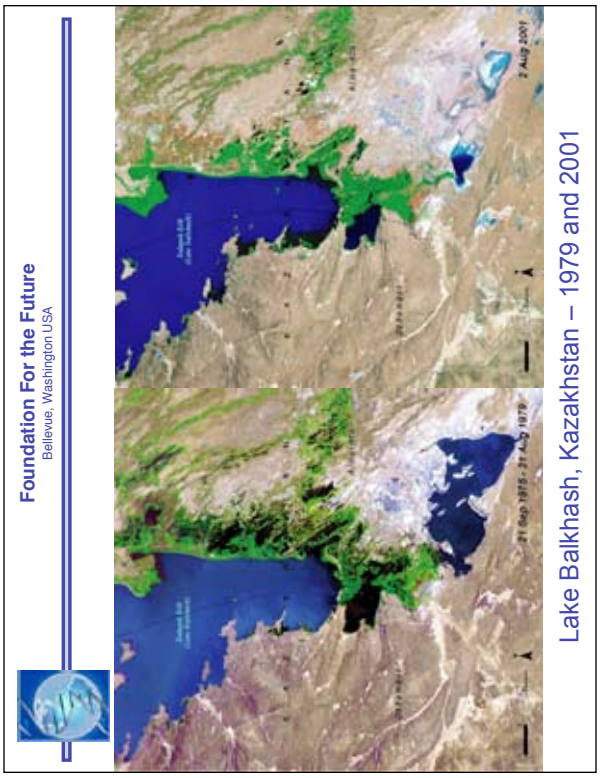
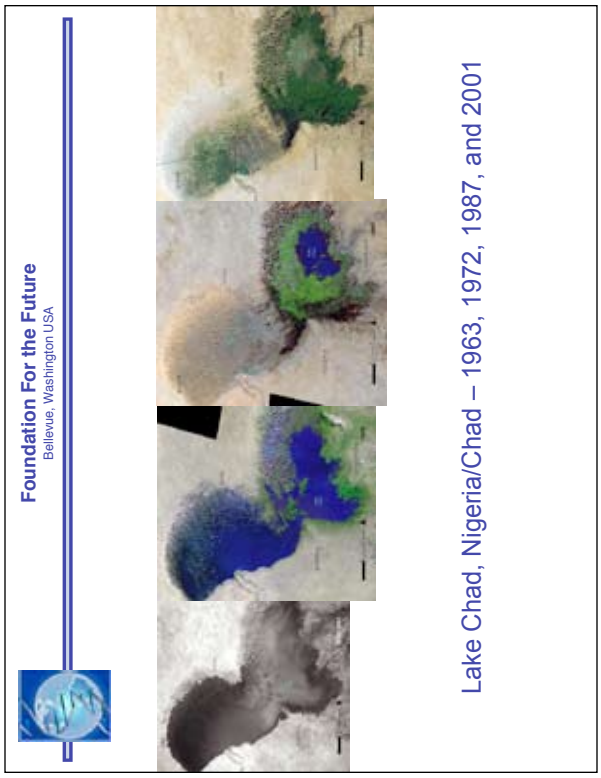
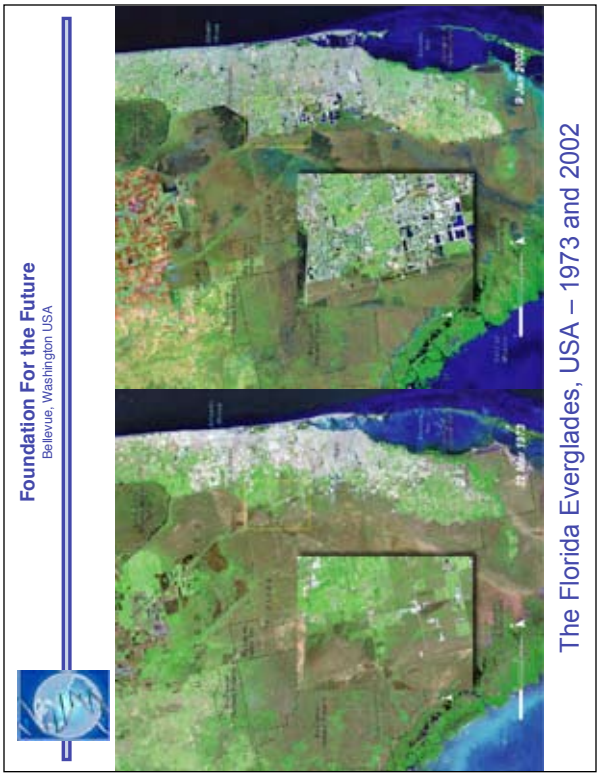
Lake Hamoun, Iran/Afghanistan

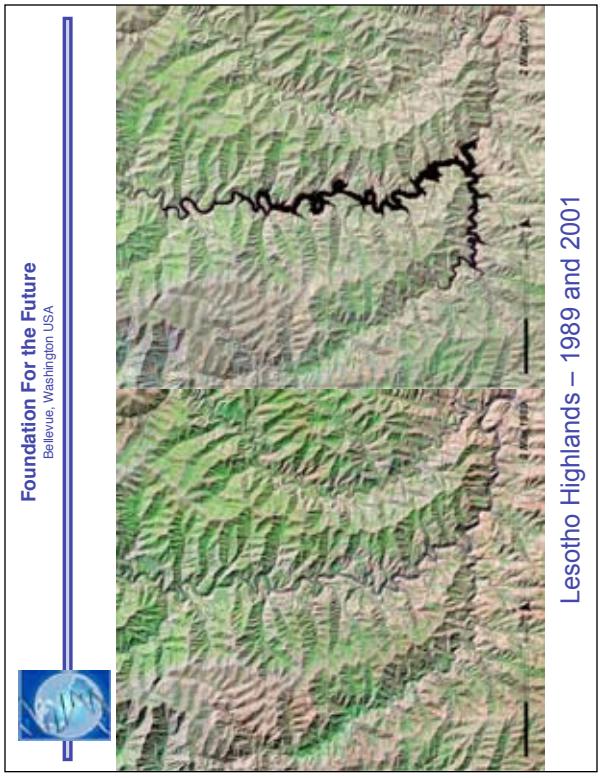


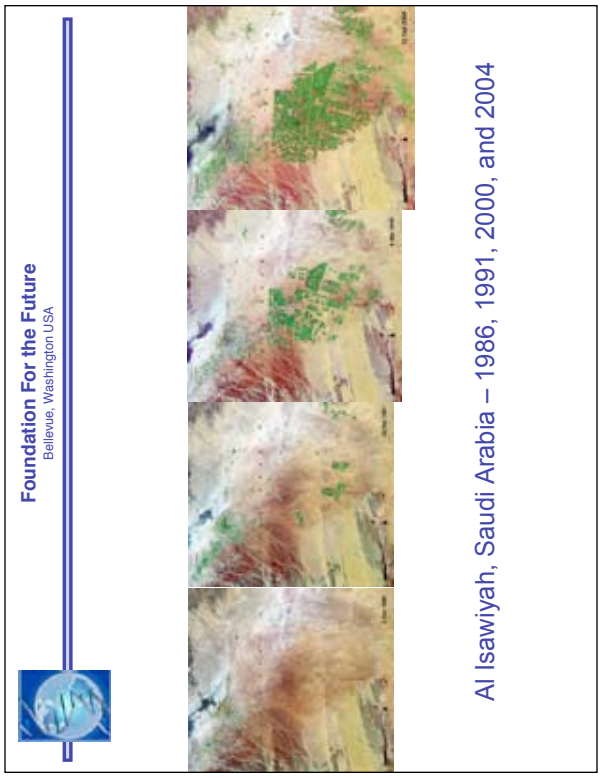
Changes in water levels between 1976 and 2001 in Lake Hamoun

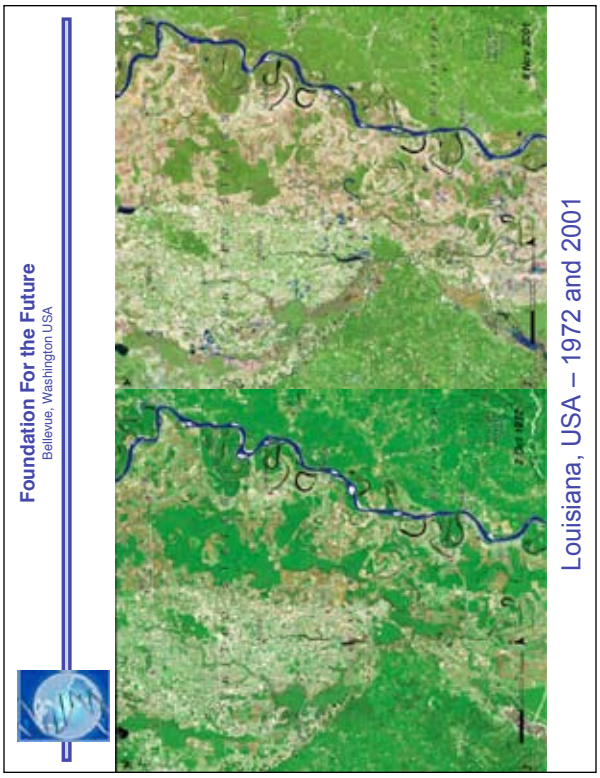

Foundation For the Future
Bellevue, Washington USA
Lake Balkhash, Kazakhstan – 1979 and 2001

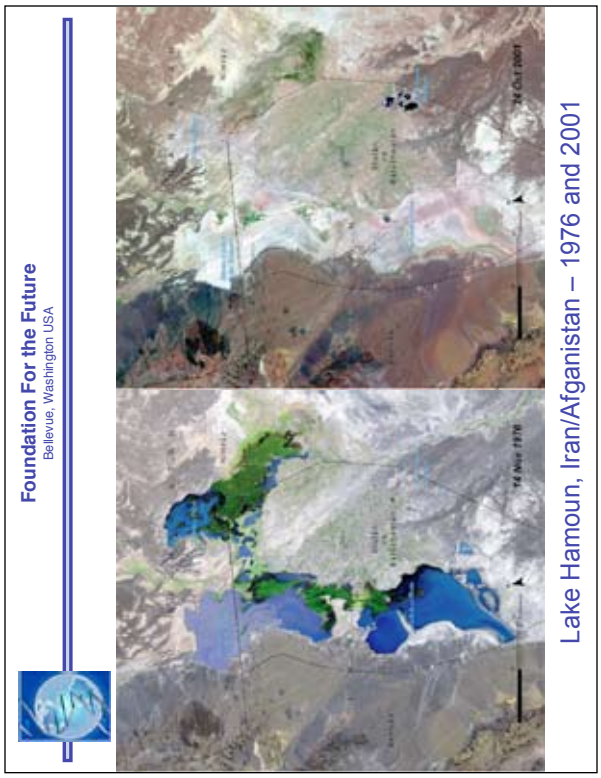

Foundation For the Future
Bellevue, Washington USA
Lake Chad, Nigeria/Chad – 1963, 1972, 1987, and 2001

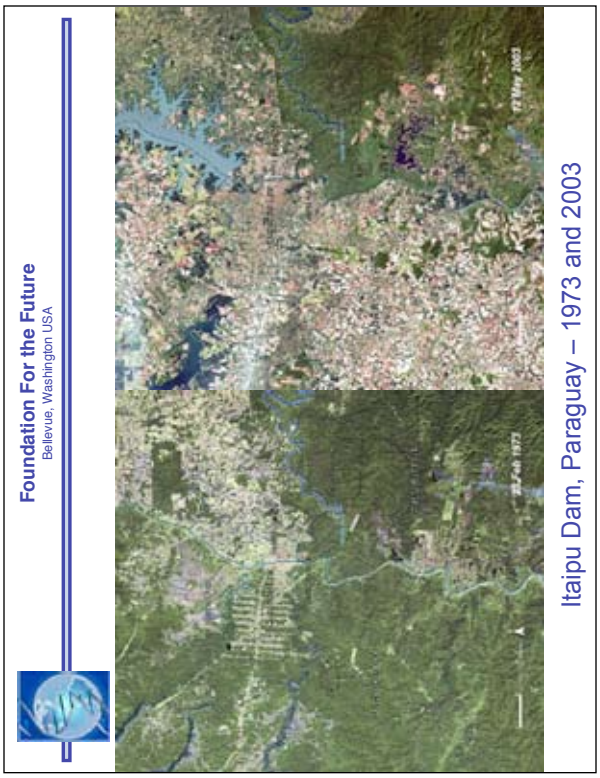

Foundation For the Future
Bellevue, Washington USA
The Florida Everglades, USA – 1973 and 2002

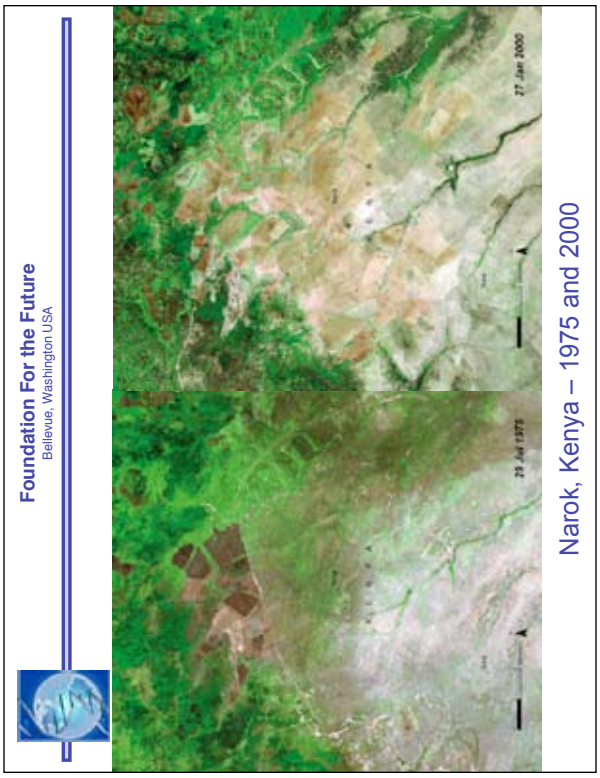

Foundation For the Future
Bellevue, Washington USA
Lesotho Highlands – 1989 and 2001

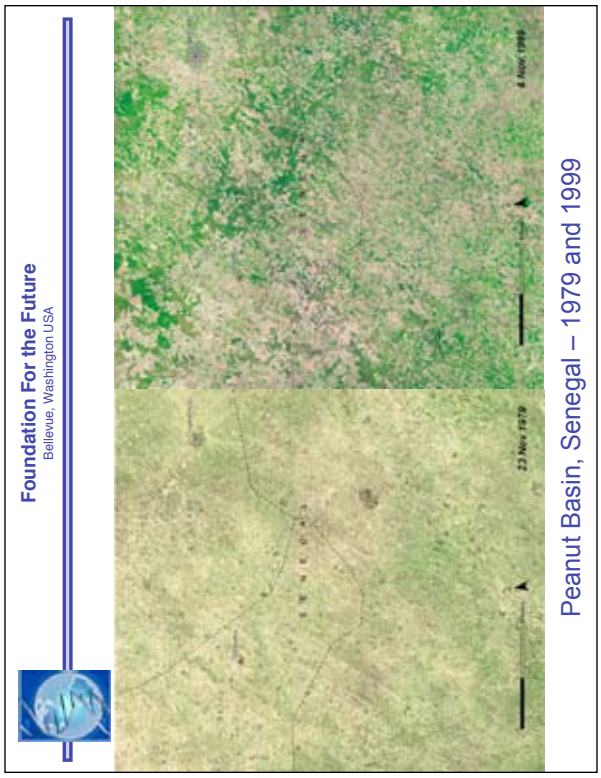

Foundation For the Future
Bellevue, Washington USA
Al Isawiyah, Saudi Arabia – 1986, 1991, 2000, and 2004

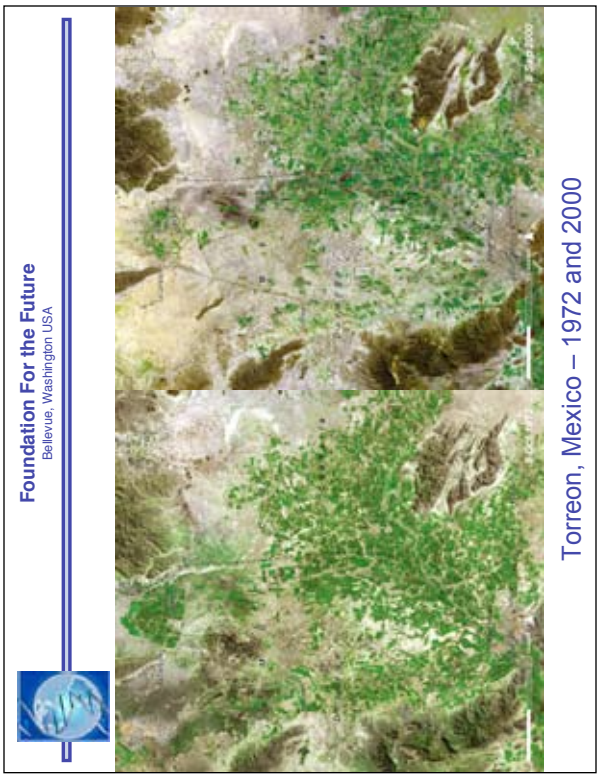

Foundation For the Future
Bellevue, Washington USA
Louisiana, USA – 1972 and 2001


Foundation For the Future
Bellevue, Washington USA
Lake Hamoun, Iran/Afganistan – 1976 and 2001

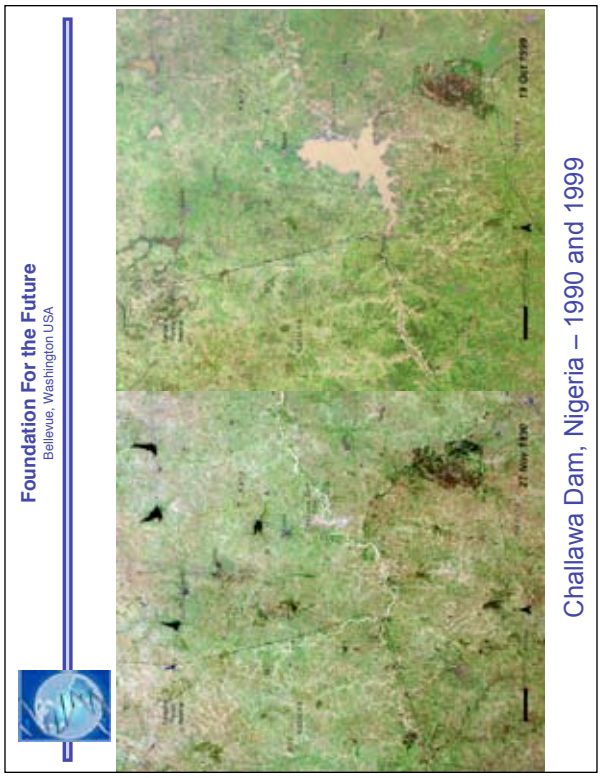

Foundation For the Future
Bellevue, Washington USA
Itaipu Dam, Paraguay – 1973 and 2003

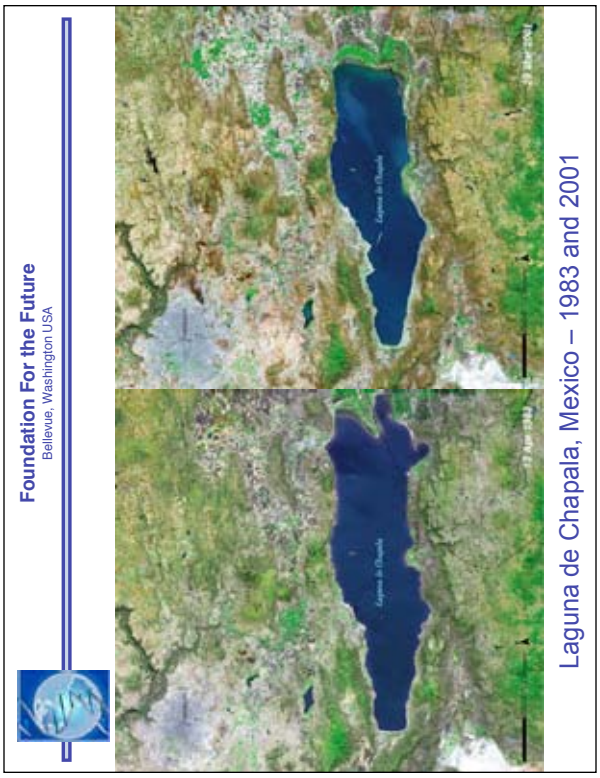

Foundation For the Future
Bellevue, Washington USA
Narok, Kenya – 1975 and 2000

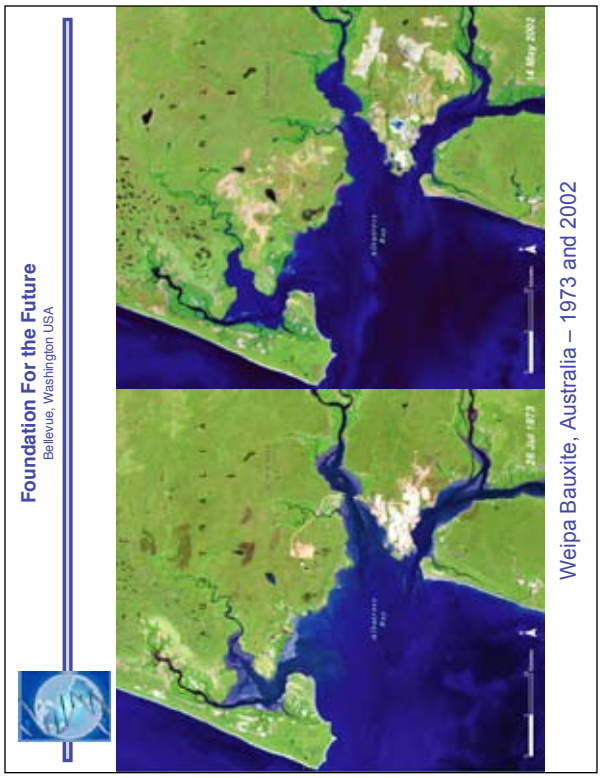

Foundation For the Future
Bellevue, Washington USA
Peanut Basin, Senegal – 1979 and 1999

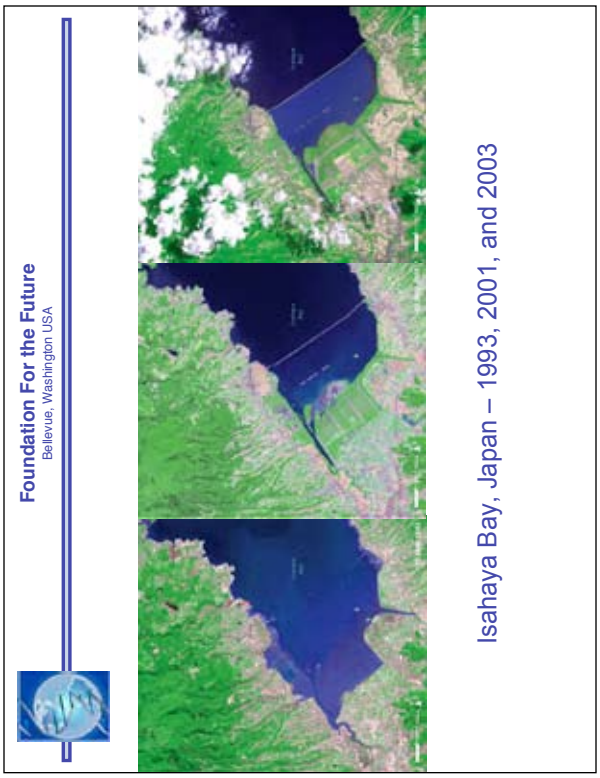

Foundation For the Future
Bellevue, Washington USA
Torreon, Mexico – 1972 and 2000


Foundation For the Future
Bellevue, Washington USA
Toshka Project, Egypt – 1984 and 2000

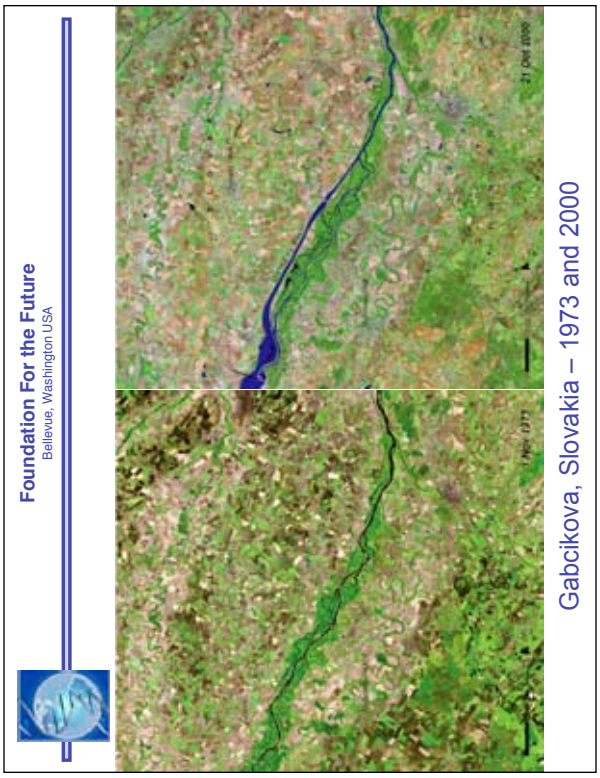

Foundation For the Future
Bellevue, Washington USA
Challawa Dam, Nigeria – 1990 and 1999

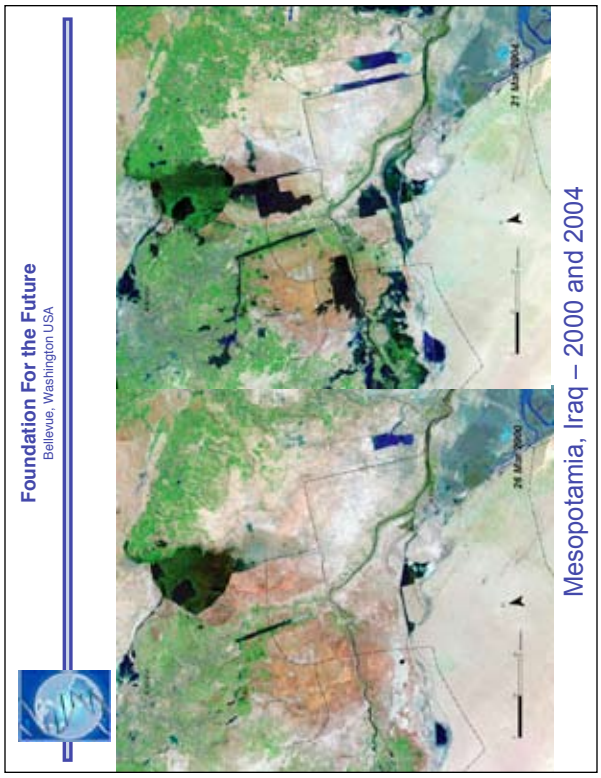

Foundation For the Future
Bellevue, Washington USA
Laguna de Chapala, Mexico – 1983 and 2001

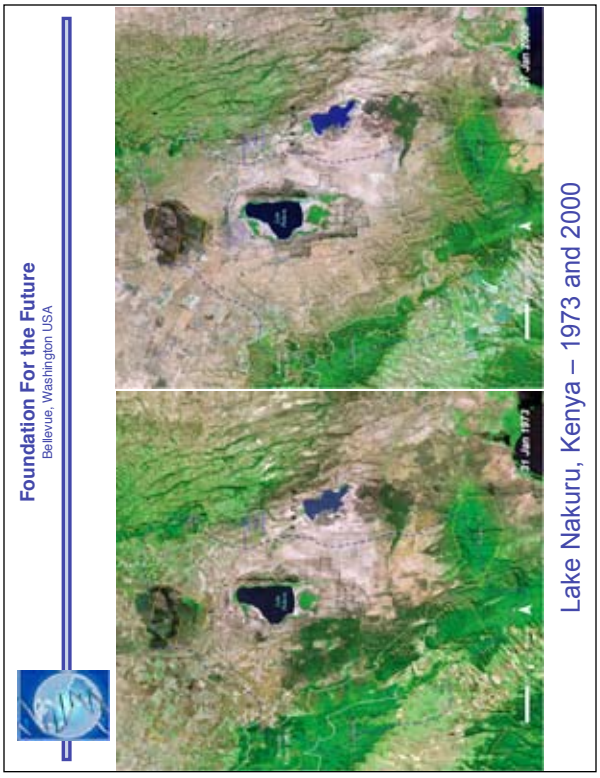

Foundation For the Future
Bellevue, Washington USA
Weipa Bauxite, Australia – 1973 and 2002

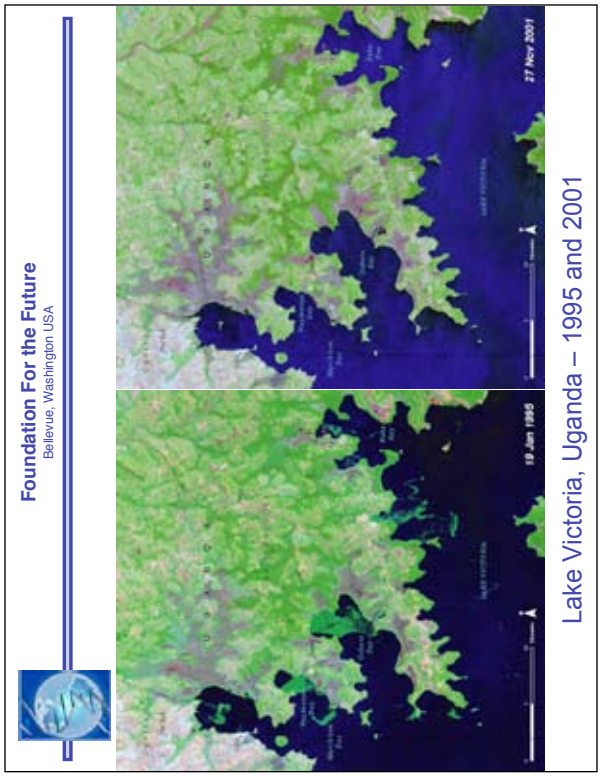

Foundation For the Future
Bellevue, Washington USA
Isahaya Bay, Japan – 1993, 2001, and 2003

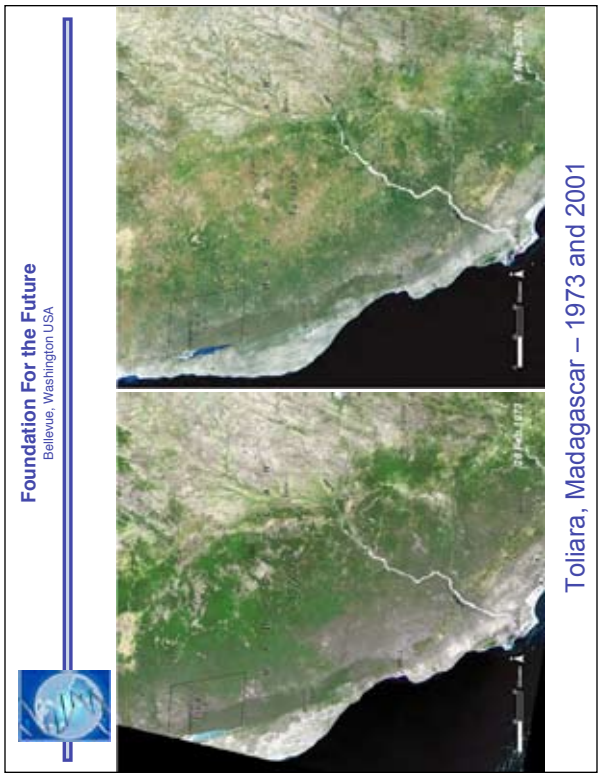
"The Human Impact on Planet Earth"
Bob Citron

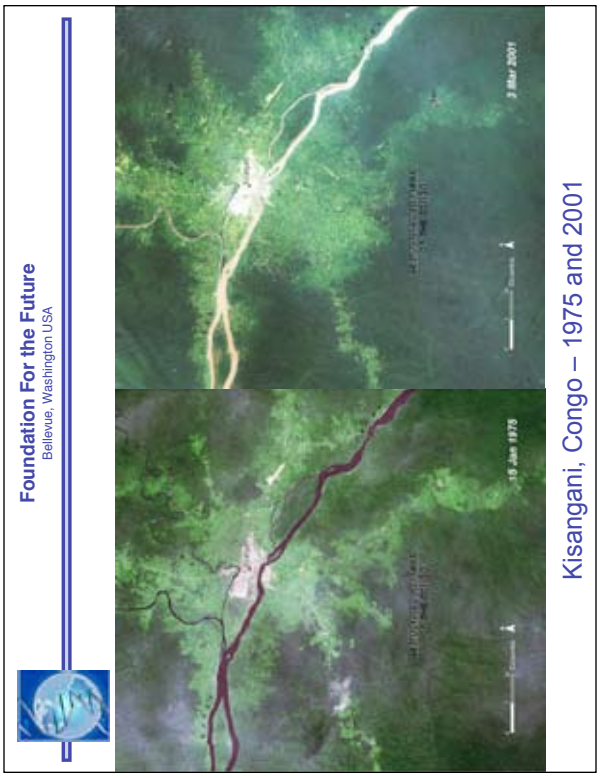


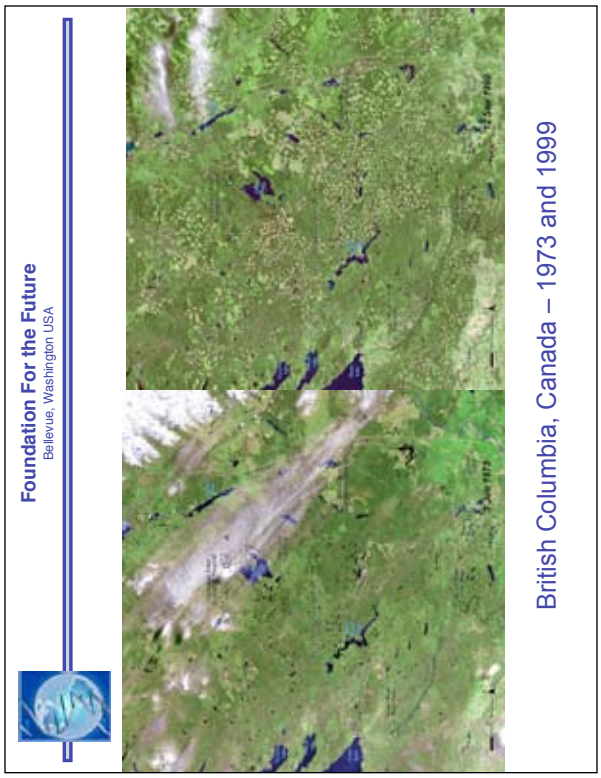


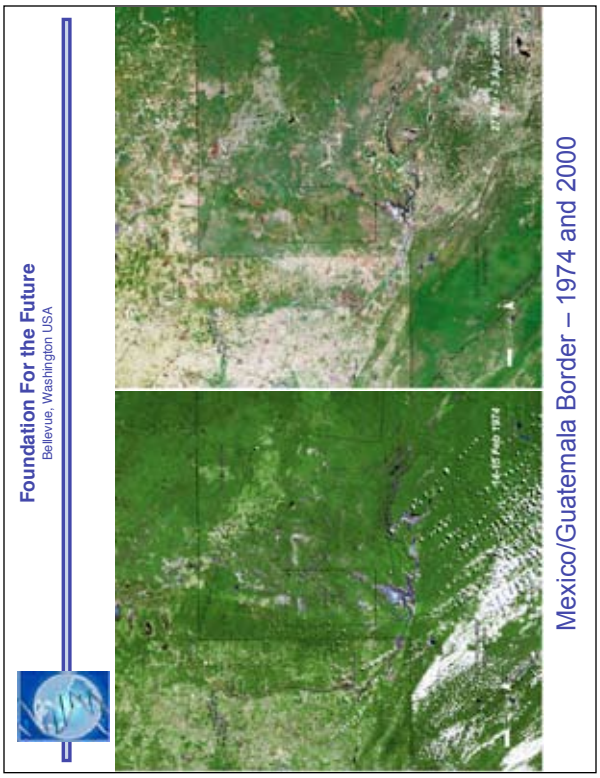




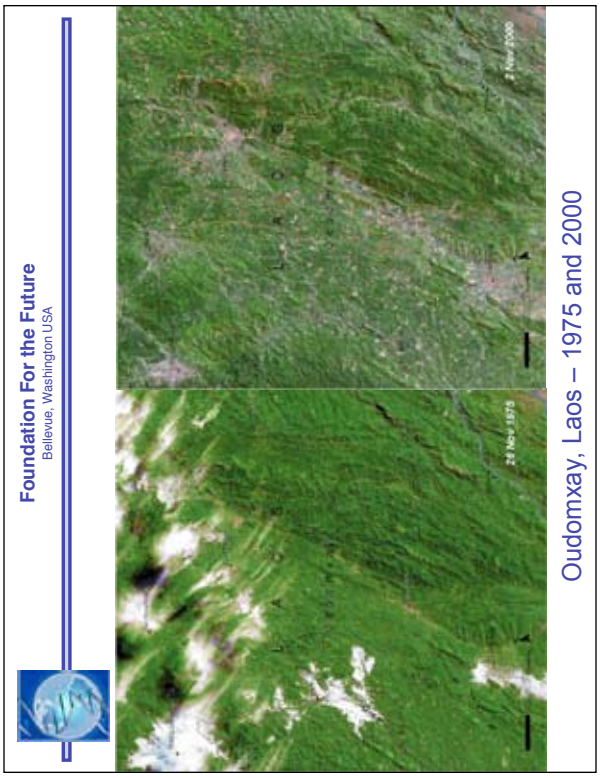

Foundation For the Future
Bellevue, Washington USA
Toliara, Madagascar – 1973 and 2001

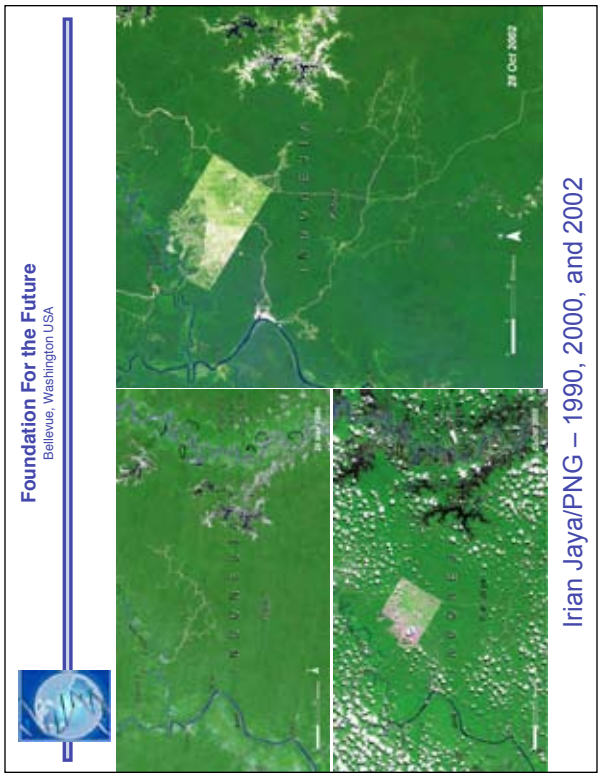

Foundation For the Future
Bellevue, Washington USA
Kisangani, Congo – 1975 and 2001

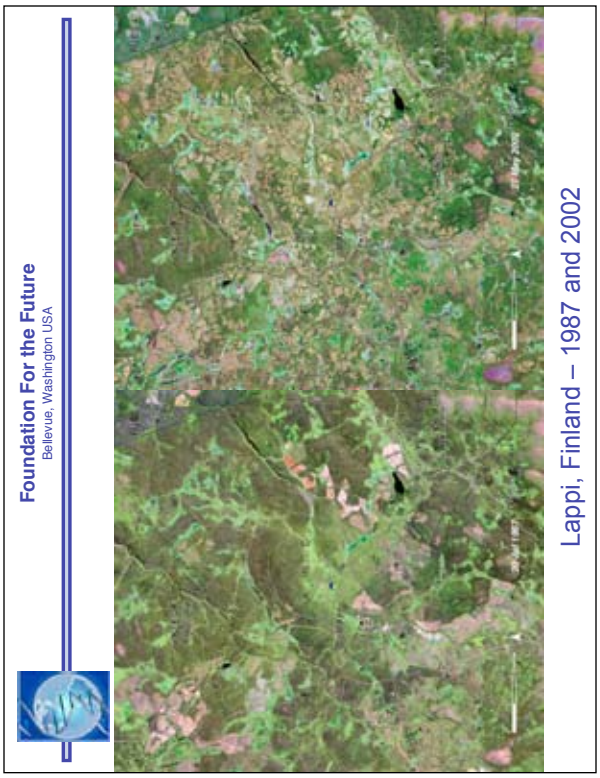

Foundation For the Future
Bellevue, Washington USA
British Columbia, Canada – 1973 and 1999

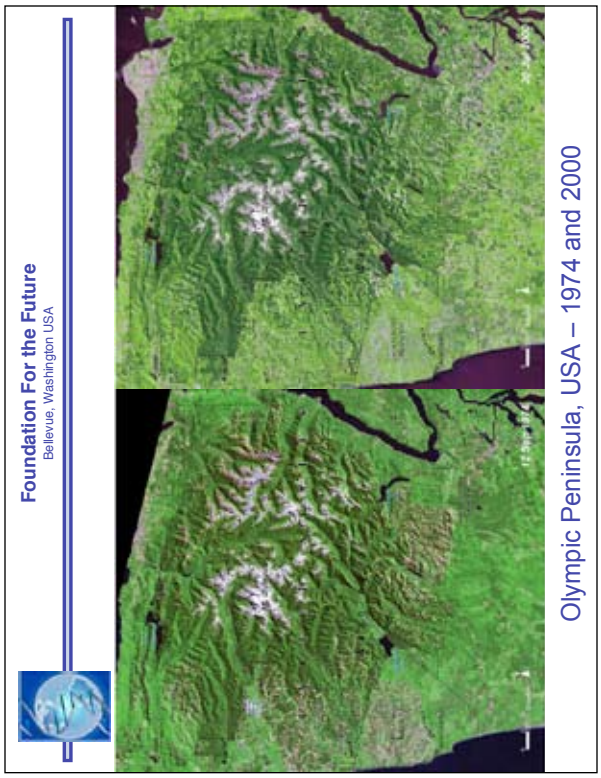

Foundation For the Future
Bellevue, Washington USA
Mexico/Guatemala Border – 1974 and 2000

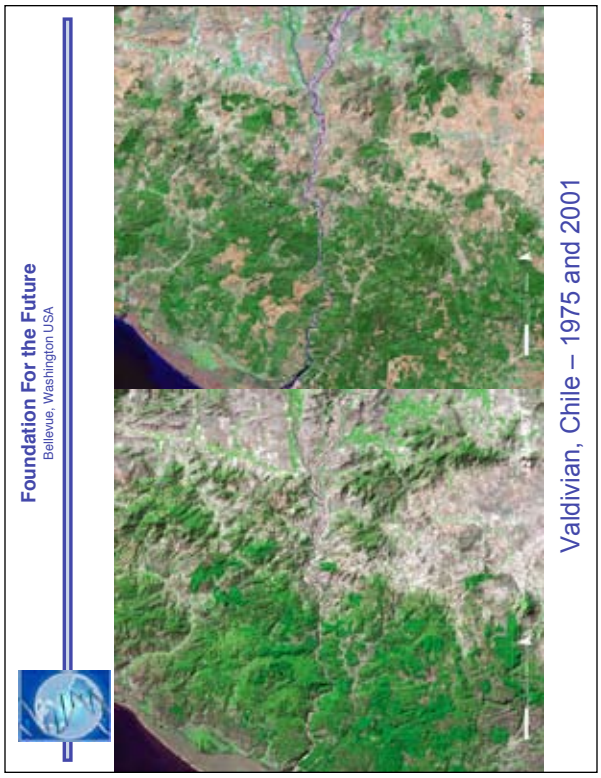
"The Human Impact on Planet Earth"
Bob Citron

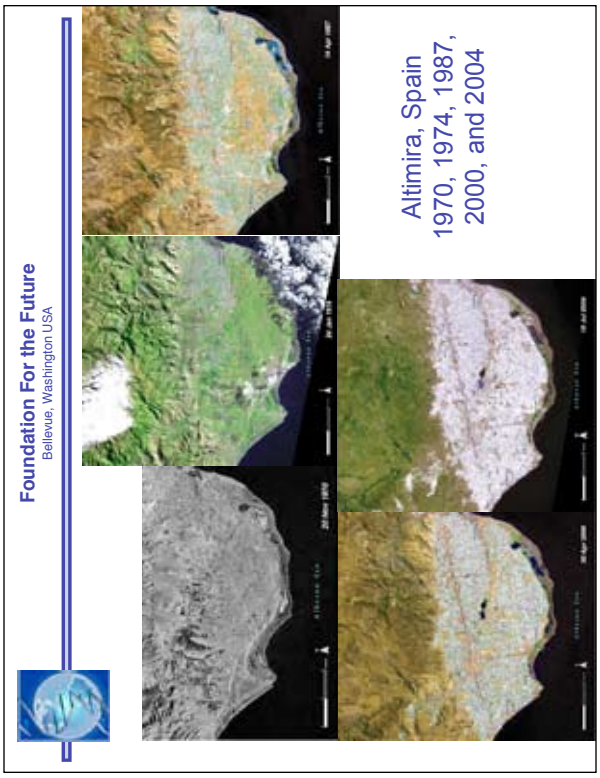


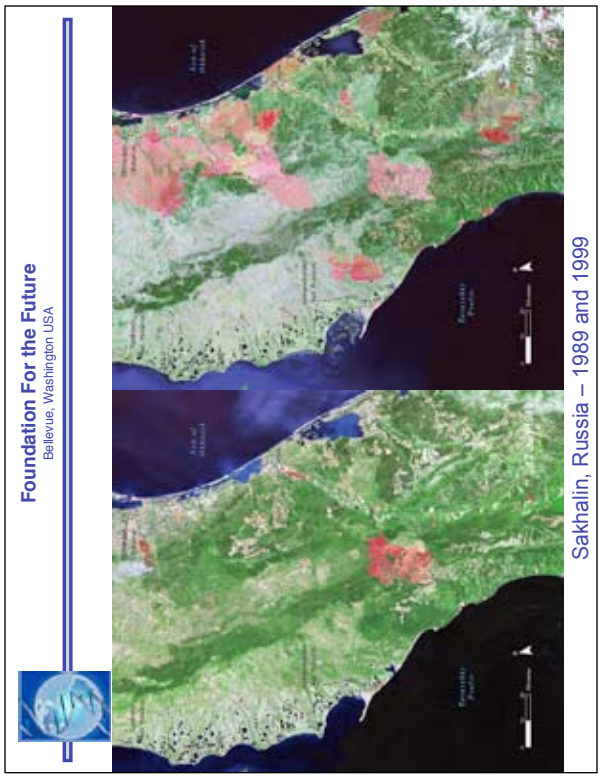


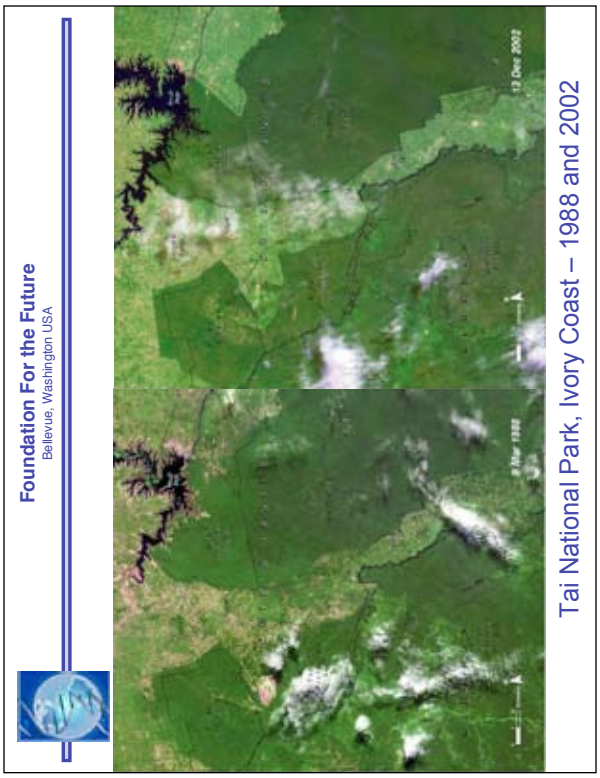


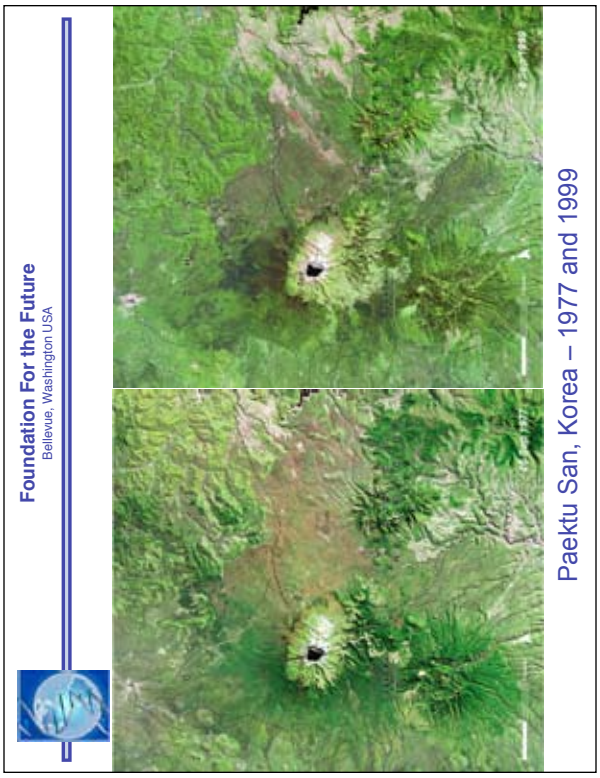


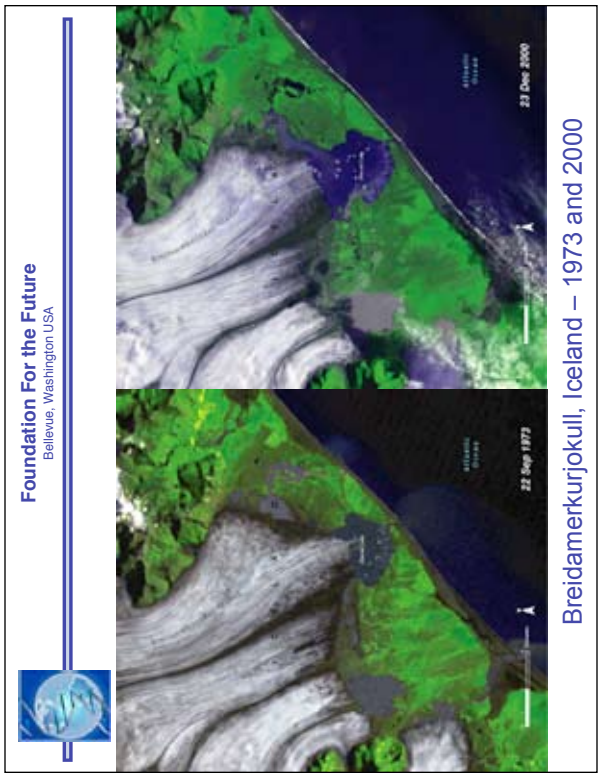

Foundation For the Future
Bellevue, Washington USA
Valdivian, Chile – 1975 and 2001

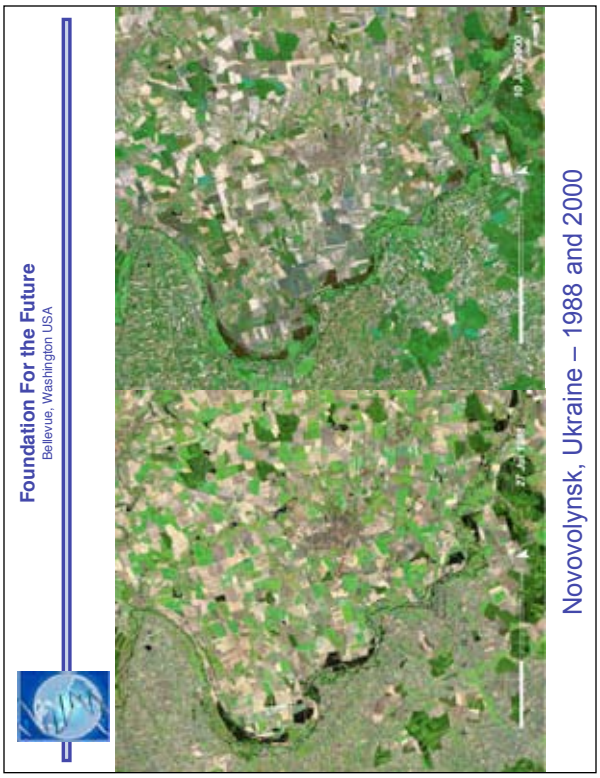

Foundation For the Future
Bellevue, Washington USA
Altimira, Spain
1970, 1974, 1987,
2000, and 2004

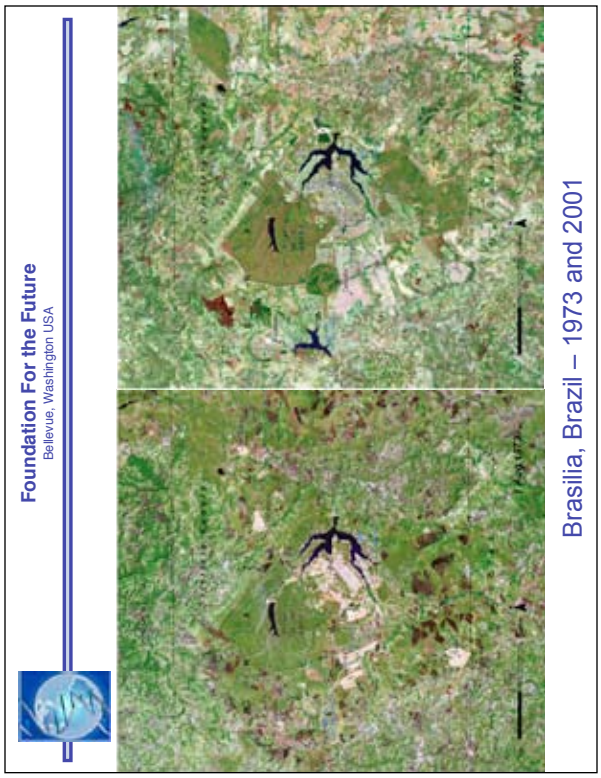

Foundation For the Future
Bellevue, Washington USA
Sakhalin, Russia – 1989 and 1999

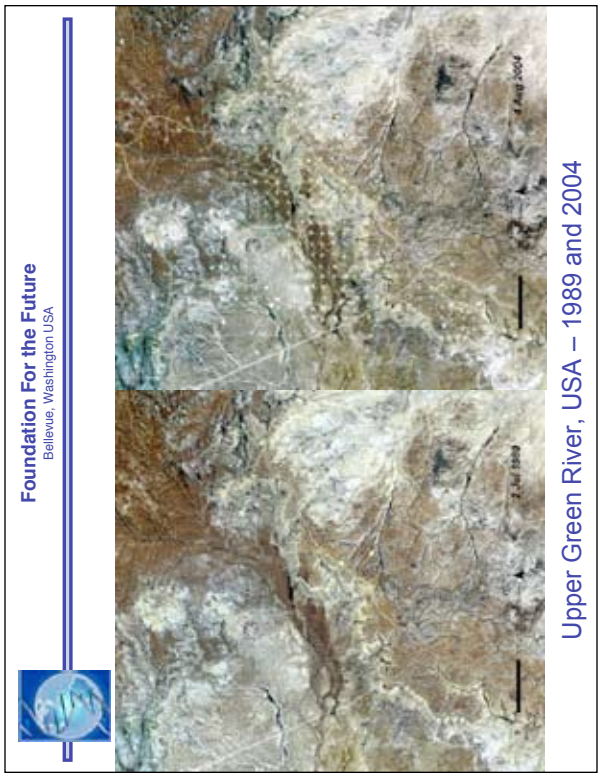

Foundation For the Future
Bellevue, Washington USA
Tai National Park, Ivory Coast – 1988 and 2002

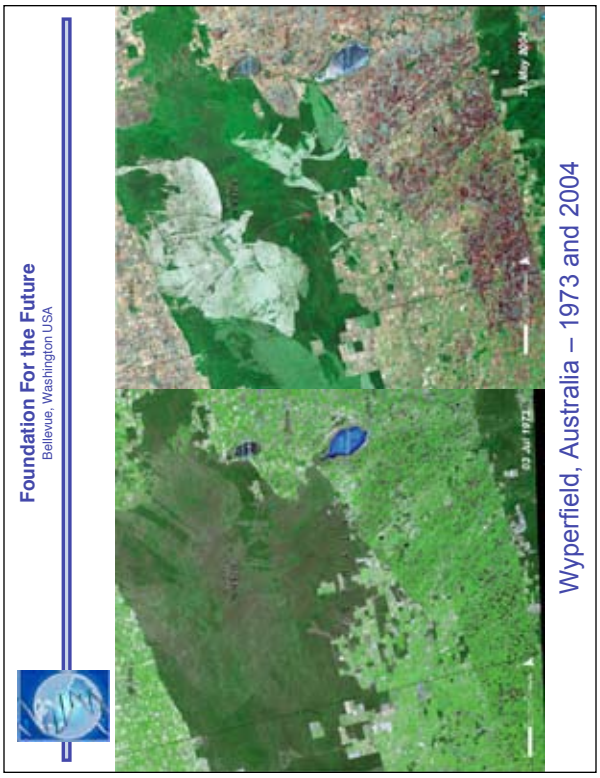

Foundation For the Future
Bellevue, Washington USA
Paektu San, Korea – 1977 and 1999

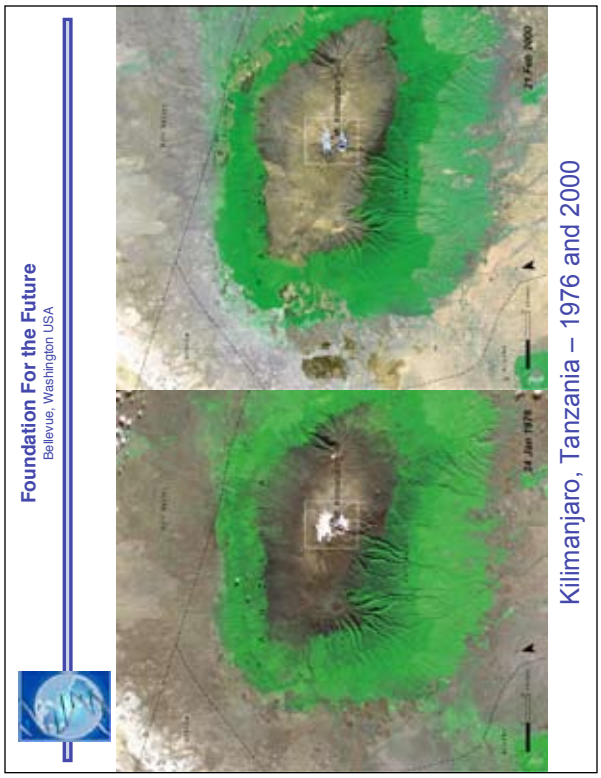

Foundation For the Future
Bellevue, Washington USA
Breidamerkurjokull, Iceland – 1973 and 2000

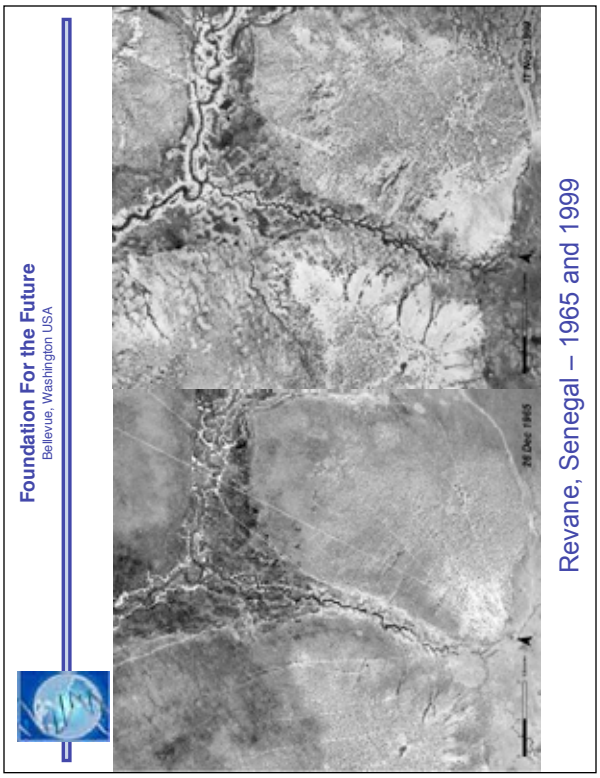

Foundation For the Future
Bellevue, Washington USA
Novovolynsk, Ukraine – 1988 and 2000


Foundation For the Future
Bellevue, Washington USA
Brasilia, Brazil – 1973 and 2001


Foundation For the Future
Bellevue, Washington USA
Upper Green River, USA – 1989 and 2004


Foundation For the Future
Bellevue, Washington USA
Wyperfield, Australia – 1973 and 2004


Foundation For the Future
Bellevue, Washington USA
Kilimanjaro, Tanzania – 1976 and 2000


Foundation For the Future
Bellevue, Washington USA
Revane, Senegal – 1965 and 1999

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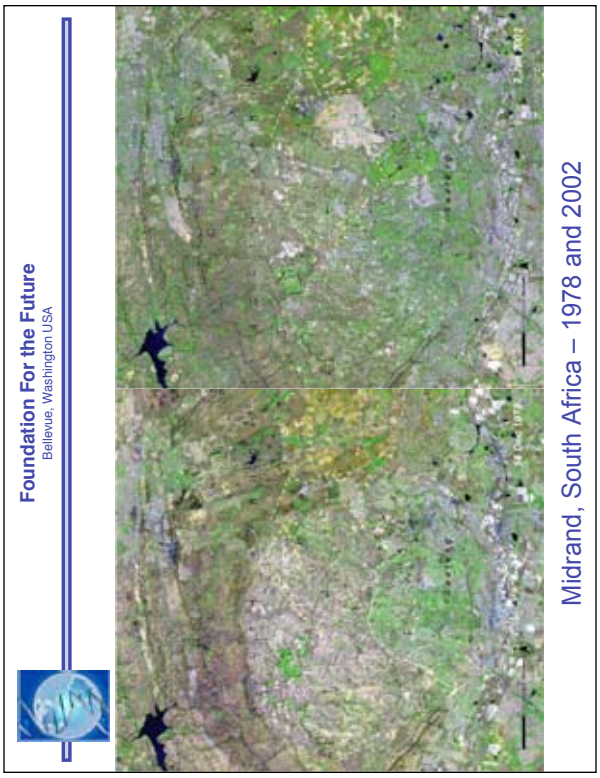

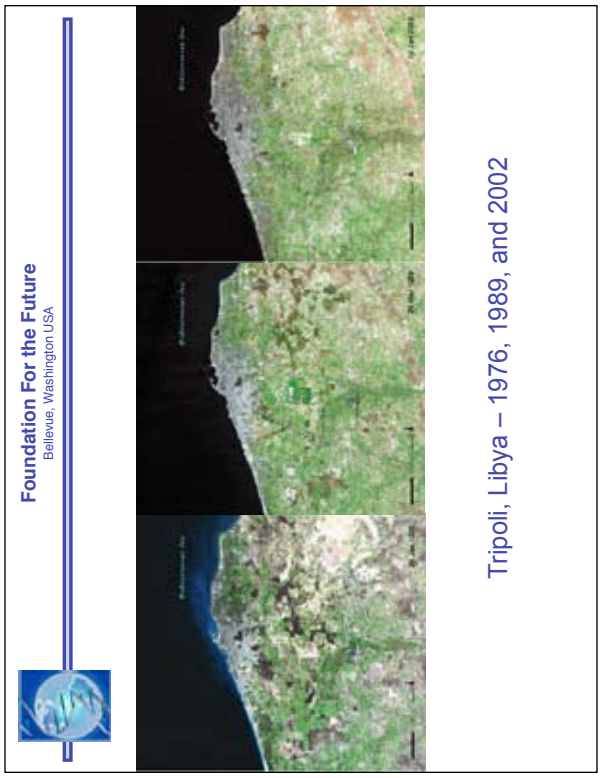

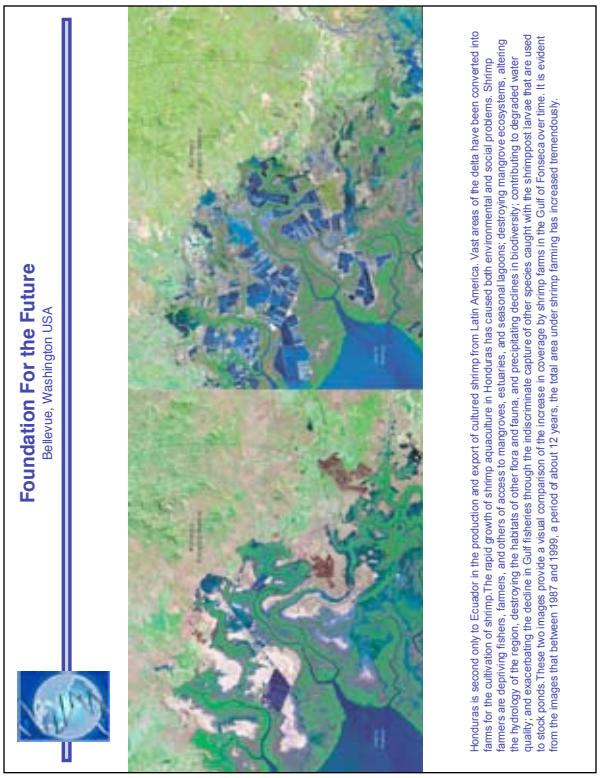

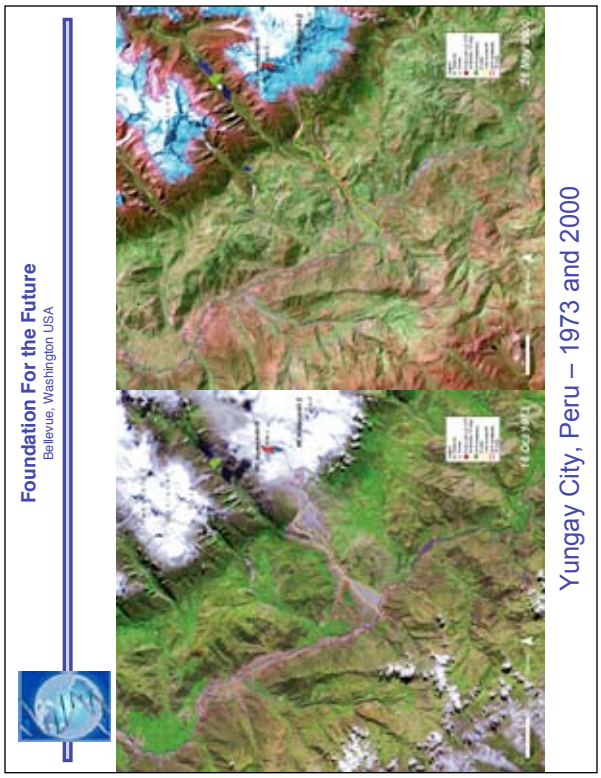

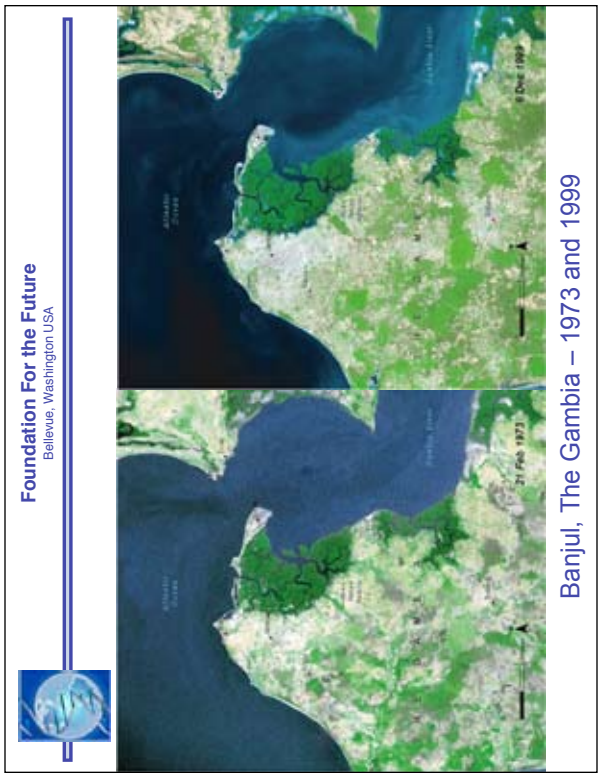
Foundation For the Future
Bellevue, Washington USA
Banjul, The Gambia – 1973 and 1999


Foundation For the Future
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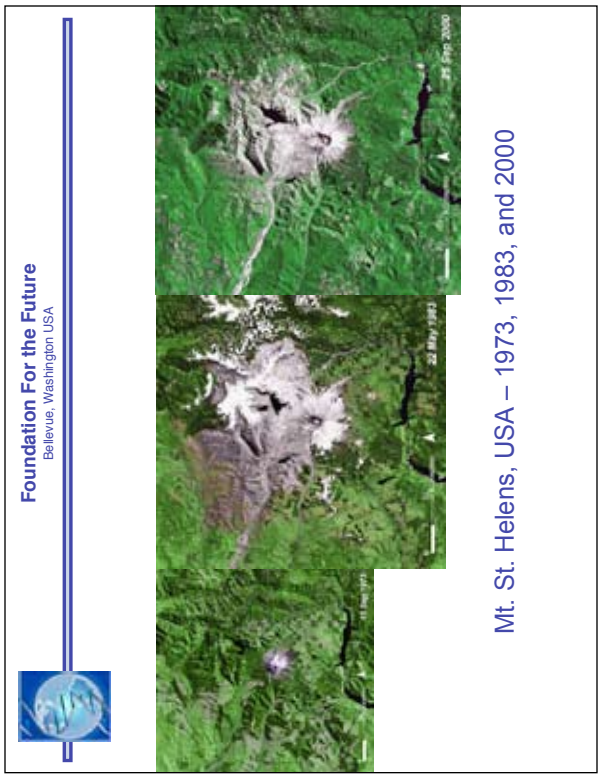
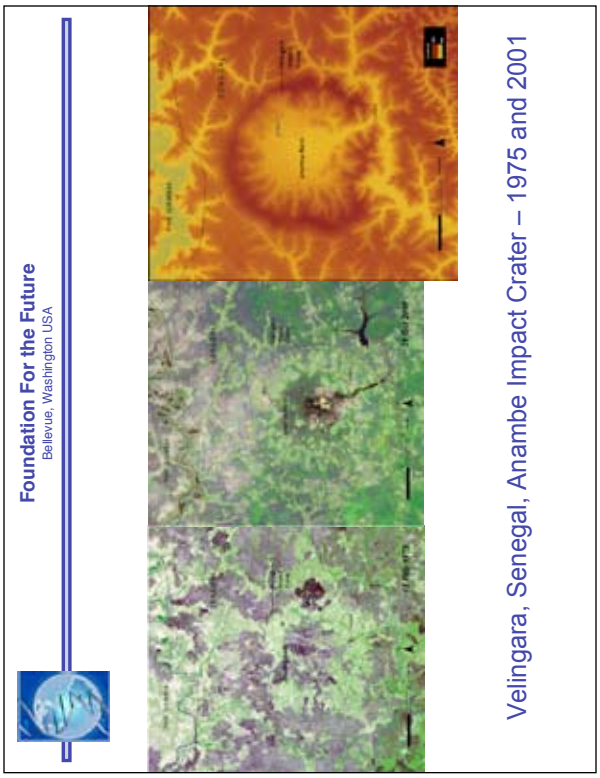
Kilimanjaro Ice Cap – 1976 and 2000


Foundation For the Future
Bellevue, Washington USA
Mt. St. Helens, USA – 1973, 1983, and 2000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Velingara, Senegal, Anambe Impact Crater – 1975 and 2001

"The Human Impact on Planet Earth"
Bob Citron