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Regional Responses to Global Change

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This second issue of *Conservation Ecology* begins a Special Focus on global climate change. This Special Focus initiates a series of occasional experiments to explore the interactive potential of an electronic journal. The overall focus of these experiments is the present and emerging class of global issues that present novel challenges to the integrity of ecosystems and regional economies. The consequences of biodiversity loss, emergence of novel diseases, and interhemispheric disruption of animal migration are examples. Global climate change, the most obvious current issue, is emphasized in this Special Focus.

Four papers launch this experiment, two to be published in this issue of *Conservation Ecology* and two to be published in the future. Each paper opens a key avenue of understanding and uncertainty. They are intended to initiate a process that will draw upon the knowledge and experience of the *Conservation Ecology* community to deepen and broaden understanding. The process includes a way for readers to easily respond to each paper, two internet−based dialogues triggered by all four papers, and a published synthesis of the results of the entire "experiment" by April 1998. The goal is to engage the community of scientists, scholars, and practitioners to integrate the ecological, economic, and social causes and consequences of global change and of policies to deal with it. A central point is that such efforts will fail unless they recognize the opportunities, uncertainties, and surprises that emerge from interactions across scales, local to planetary and intercommunity to international.

The lead Synthesis paper, "Challenges in adaptive management of riparian and coastal ecosystems" by Carl Walters, provides a policy focus that has seldom been considered in literature or debate on climate change. Most attention is given to mitigation policies that can coordinate international efforts to slow the accumulation of greenhouse gases. Because greenhouse gases will inevitably accumulate for decades or more, and climate will probably change as a consequence, regions will be exposed to novel extremes in climate and novel ecosystem responses to those extremes. Under such novel conditions, it can be dangerous to apply existing knowledge and experience alone. An active, adaptive approach designs policies as probes of changing systems to create new knowledge and adjust existing knowledge.

Development of adaptive ecosystem management, considered by Walters, began about 30 years ago to deal with the novelty, uncertainty, and surprise caused by human−induced changes in the underlying structures and processes of ecosystems. Carl Walters pioneered the process, modeling approach, methods, and theories, and has been a key figure in continuing developments and tests throughout three decades. Literally no one else in the world has accumulated such a rich body of experience in regional−scale examples of resources and management where uncertainty is high and change is inevitable. He has been centrally involved in dozens of cases in North America, Europe, and Australia. His paper will, I judge, become a classic in the field. He notes the extraordinary science, methods, and approaches that have been developed and tested, arguing that we know how, in principle, to deal with those parts of the issues. The challenges now facing adaptive ways of dealing with novelty and uncertainty are not scientific or methodological, but institutional, organizational, behavioral, and political. He ends with a series of 15 critical questions. We invite readers to use the response "button" at the end of his paper to comment on those challenges by briefly summarizing other experience, analyses, or papers. Those questions will also provide the initial seeds for an internet dialogue planned for early in the New Year.

The second Synthesis paper is "An overview of the implications of global change for natural and managed terrestrial ecosystems" by Brian Walker and Will Steffen. It is a unique statement, not because it is based on decades of pioneering research and experience, such as Walters', but because it is the first published summary synthesizing six years of international collaborative research on the impacts of global change on terrestrial ecosystems in every region and continent of the world. That study, sponsored by the International Geosphere

Biosphere Programme of the International Council of Scientific Unions, has no parallel. A book on specifics of the research is in press. One principal conclusion of the study has dramatic policy consequences: the transformations driven by greenhouse gas emissions, biodiversity losses, land use changes, and economic development converge to turn terrestrial ecosystems from sinks for carbon from the atmosphere to sources of carbon to the atmosphere. Thus, CO_2 fertilization of plant growth will not be sufficient, as some hoped, for terrestrial ecosystems to provide a natural correction to greenhouse gas accumulations in the atmosphere. As traditional ecosystems become an additional source of CO_2, the need to mitigate human−induced emissions of greenhouse gas becomes more urgent.

The third paper, "Impacts on Canadian competitiveness of international climate change" by Chris Holling and Robin Somerville, is a Perspective invited because it exposes the extraordinary difficulty of designing politically feasible economic policies for such mitigation. It summarizes a detailed econometric study focused on mitigation policies for one nation, Canada, and its provincial regions. However, the main study upon which it is based is still confidential, and its results cannot yet be released. The Perspective article will be published when the main study has been publicly released.

Results from the study that have been reported in the press indicate that the study's planning scenarios are designed to achieve future national targets by using tradable permits for CO_2 emissions and carbon taxes. Over a long term of three decades, press reports indicate the study forecasts little negative effects on Canada's overall GDP by achieving emission reductions in this way. But the political dynamite that makes implementation so difficult is that there is a projected 2% drop in GDP from "business as usual" for the first decade and a half of operation of the policy and that dramatic differences are created between winners and losers. How can politics deal with those short and long term conflicts in a Federal system with the decentralized nature of Canada's? Project those and similar tensions to a world scene of haves and have−nots over an issue that has many uncertainties, and the route to effective mitigation is bumpy indeed. It is no surprise that vested interests can mount such powerful disinformation campaigns exploiting the uncertainties, in order to confuse discussion and subvert decisions.

The fourth and final Perspective paper, "An evaluation of integrated climate protection policies for the U.S." by Bernow and Duckworth, was invited to provide a different, technological evaluation of innovative paths to mitigating emissions. As it complements the Holling and Somerville paper, we will publish it when the other becomes available. The analysis reported by Bernow and Duckworth demonstrates that it is technologically feasible to dramatically reduce emissions and, at the same time, stimulate the economy. The Holling and Somerville paper is a so−called top−down approach; that of Bernow and Duckworth is a bottom−up approach. The latter identifies and explores technologies available to each of the separate sectors of the economy, and describes economic policies and government regulations needed to establish a technologically feasible path of innovation.

There are dozens of top−down and bottom−up analyses of the economic impacts of reducing CO_2 emissions. When the target is to stabilize CO_2 emissions at 1990 levels, these studies forecast impacts on the U.S. economy in 2020 ranging from about −2% to over +2% change in GDP. I find the two Perspectives presented here to be particularly clear, compelling examples, even though their conclusions are, in part, very different. As in all forecasts and models, everything depends on assumptions. The backdrop of confusion and uncertainty arising from different assumptions has been brilliantly summarized and the reasons for differences made transparent by Robert Repetto and Duncan Austin in "The costs of climate protection: a guide for the perplexed" (World Resources Institute 1997). The summary, at http://www.wri.org/wri/climate/ccp−home.html, provides a lovely example of simple web use and clear analysis and presentation techniques to make the complex understandable.

As readers consider and respond to these separate papers, and as we initiate internet dialogues, three issues needing discussion stand out for me.

1. Most studies of mitigation policies analyze economic impacts at some fixed future date, essentially a kind of steady−state forecast, but few analyze the path to that state. The Holling and Somerville paper

does, revealing that, at times, a potentially longer term "good news" condition can only be reached through an extraordinarily difficult transition. There may be no politically feasible path from here to there. How can we begin to better understand the possible transition trajectories for economies, societies, and ecosystems?

2. The degree of difficulty predicted in the transition depends on assumptions of how easily people respond to change and shift to more effective technologies. Optimistic forecasts imagine a clearly logical decision maker making the most logical cost/benefit choices, with the least incentive, in the most rapid way. More pessimistic forecasts imagine confused, uncertain decision makers, caught by past investments and momentum, who will only change when sharp increases in prices provide little alternative. This is not a question of science or economics, but of behavior of individuals and organizations. How can we better understand the sources of novelty and of the processes by which individuals and organizations either smother or release novelty?
3. All of these models and forecasts, of climate change itself and of impacts on ecosystems and economies, are full of uncertainties and will always be so. Surprise is inevitable, whatever is done or not, and will unfold on a regional stage where adaptive response becomes central. Hence, the long history of experience in adaptive ecosystem management has major potential. It explicitly embraces uncertainty and surprise. By designing policies as hypotheses of cause and designing management as experiments to separate those hypotheses, it is an approach that accelerates learning and demands flexibility. Yet, how can it function when uncertainties become the foundation for powerful interests to design and brilliantly implement disinformation campaigns? What is the role of science? What is the role of collaboration among those from science, policy, business, and politics?

These questions along with those raised explicity by Walters and implicitly by the other authors served as a starting point for an internet dialogue involving young scholars and practitioners earlier this month. This second in a series of "Young Scholar Dialogues" proved extremely engaging − participants continued to post discussion items to the on−line conference server even after the scheduled end of the dialogue. The results of this exchange are synthesized in the paper "Uncertainty, Climate Change, and Adaptive Management".

We invite readers to use the response facility in each paper to respond to the issues raised by this set of papers. Your responses will become input to the second internet−based dialogue, or workshop, on regional responses to global change and involving senior scholars, managers, and policy makers. The results of the whole experiment will be summarized and published in *Conservation Ecology* by April 1998.

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