

Wildlife  
Responses  
*to*  
Climate Change

NORTH AMERICAN CASE STUDIES

*Edited by*  
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## *Foreword*

It was not long ago that the big question about climate change was whether or not it actually was taking place. Now, there is broad scientific consensus that it is, in fact, happening, and that human activities are largely to blame.

The most recent body of scientific evidence sounds a warning that global climate change could occur more quickly than previously thought, and take an even greater toll on people and wildlife. We are beginning to see convincing evidence that climate trends are already affecting the Earth's natural systems: butterflies are moving north, birds are breeding earlier, and coral reefs are bleaching across the globe.

While the challenge of global climate change is daunting, the first step toward creating the solution is understanding the problem. The National Wildlife Federation is committed to providing and supporting the sound science necessary to build that understanding and to shape the solutions that will mitigate an environmental problem that is global in scale.

This book is the culmination of a three-year project to research and study the impacts of global climate change on U.S. ecosystems and individual wildlife species. In 1997, we provided fellowships to eight outstanding graduate students to conduct research on global climate change. NWF engaged Steven Schneider, Ph.D., and Terry Root, Ph.D., two of the world's leading scientists studying the effects of climate change on wildlife, to shepherd the students through their studies. This work, combined with the generous support of a Dorothy Chancellor Estate grant, enables NWF to add to

the body of knowledge critical to scientists, resource managers, and policymakers in shaping a solution to the climate change crisis.

The book has another important function too. By detailing the potentially devastating effects of climate change on wildlife and their habitat, we hope to stir the concern and the action of countless people who care deeply about the fate of our natural world. Such people have previously rallied America behind historic efforts to clean up our air and water and to save imperiled species. Addressing the crisis of global climate change will require an even greater commitment to action and, in keeping with its long and distinguished history, the National Wildlife Federation will help to provide the knowledge, the understanding, and the tools to make it possible. Nothing less than the future of both people and wildlife depends on it.

—MARK VAN PUTTEN  
President and CEO  
National Wildlife Federation

*Introduction: The Rationale for  
the National Wildlife Federation Cohort  
of Young Scientists Studying Wildlife  
Responses to Climate Change*

STEPHEN H. SCHNEIDER AND TERRY L. ROOT

The project that has culminated in this book has two main purposes. The first is to establish a credible scientific link between the health of natural systems (wildlife in particular) and human-induced climate change. The second is to help create a community of young scholars who can demonstrate that interdisciplinary science and outreach activities connecting wildlife and climate change disciplines can be accomplished with a high level of scientific quality. Often, academia discourages scientists from engaging in research outside traditional disciplinary boundaries or research with strong policy components. Implicitly, and occasionally explicitly, scientists are also discouraged from providing information to the public, particularly when the subject is plagued by many inherent uncertainties, as is the case of wildlife and climate change. The disincentives are often overwhelming. We expect this group of young scientists will join the nucleus of a growing community of scholars that help provide a positive example of the rewards of pursuing interdisciplinary research and outreach.

In 1997 the National Wildlife Federation (NWF) asked us to

comment on their idea that the time was ripe to create a cohort of young scholars interested in branching out from traditional ecological inquiries (concerning the structure or functioning of particular parts of ecosystems) to address fundamental scientific issues concerning the threats to wildlife conservation imposed by the prospect of human-induced climate change. Furthermore, the NWF identified a need to train young scholars to produce scientifically credible writings that are understandable to a broad audience and to help sponsor the publication of their respective works as a collection. Moreover, we strongly agree that science should not be isolated from important questions in biological conservation, in general, and about wildlife conservation, in particular. We responded enthusiastically to their inquiry, but warned that traditional research paradigms in ecology (or climatology) tend to encourage narrowly defined laboratory, field, or theoretical problems, especially for graduate student dissertations or postdoctoral projects, which was the level of scholars the NWF had targeted.

We fundamentally agree that public acceptance of policies to promote conservation activities requires understanding of the reasons for actions by the public and its elected officials, which in turn requires literacy in the issues and knowledge of the trade-offs involved. Thus, we share with NWF a belief in the value of encouraging and training young scientists in the art of clear, jargon-free communication of scientific research and the assessment of its implications, and that such communication is an important skill.

Not all practicing scientists, however, agree that public outreach—let alone advocacy—is an appropriate activity for scientists (e.g., see the reported debate in *Science* [Kaiser 2000]). Young scientists are often discouraged from such pursuits during formative stages in their careers. Nevertheless, we believed that a cohesive group of young scientists could show by example that it is possible to do high quality scientific research on multiscale and multidisciplinary questions that attend ecological impact analyses of climate change. In particular, a single, peer-reviewed volume that publishes the activities of such a cohort could serve as an example and help reduce skepticism. Such a volume could demonstrate to hesitant, more senior colleagues that working on important conservation issues across disciplinary boundaries and across scales of analysis can produce first-rate science while sending a message to other young scientists that such work is both rewarding and respectable.



To help achieve these goals, the NWF solicited proposals from junior scientists for funding. From a competitive applicant pool, we and a few other scientists selected the initial cohort of “NWF Fellows.” This volume summarizes the research efforts of the fellows, along with a chapter from another young scientist who joined the cohort at a later date, although she did not receive funding. In addition, the NWF anticipates that the fellows will work with NWF staff to produce more accessible accounts of their works that will be available to government officials and the public. These accounts will provide in lay terms scientifically grounded knowledge that has policy implications for wildlife conservation.

To establish an esprit de corps among the cohort and to discuss common concerns about career aspects of interdisciplinary research, conservation focus, and outreach activities, we held a symposium at the Ecological Society of America’s annual meeting in Spokane, Washington, in August 1999. We were highly gratified at the large turnout of ESA members to hear the preliminary contributions of this cohort. Moreover, we led extensive dialogues with the young scientists on issues of weighing fundamental scientific curiosity with problem-driven activities and balancing scholarly work with public outreach. We also discussed the responses of the first round of peer reviews on each participant’s chapter and discussed strategies for revisions.

The success of creating a cohort of young scientists to work on the interdisciplinary issues of studying the effects of climate change on wildlife (or wildlife-dependent vegetation systems) is quite promising. This volume represents the completed chapters of the NWF cohort after two rounds of external, scientific peer review as well as exchanges among the fellows themselves on each other’s work. We believe the volume represents high quality science, as well as a positive model for younger scientists also wanting to work on tough problems of conservation in the face of global change disturbances. In addition, this cohort and this volume provide an example to more senior scientists that such exemplary activity can be done by our best young scientists. In fact, our observation from working with this group is that many young scientists insist that they not be distanced from pursuit of important scientific problems inherent in the conservation of wildlife, nor that they be discouraged from the public dissemination of such work. Yet, such work must and is being done within the traditional scientific culture of peer

review—and with appropriate care to present a balanced account of the science and implication of their works.

The fellows were not chosen deliberately to have their work span both terrestrial and marine locations, nor to have representative examples of climatic impacts on insects, mammals, and vegetation important to wildlife conservation; nevertheless, their research spans such broad topics. For example, the chapters by Sagarin and Sanford study marine responses to recent and projected climatic changes and demonstrate that a discernible impact of recent regional climatic changes is already being felt by marine animals. In addition, chapters by Koteen and Saavedra address climatic effects on plants that are critical to animals—bears in Yellowstone Park in one case and alpine meadow communities subjected to a deliberate warming experiment in another. Hellmann and Crozier's chapters on butterflies demonstrate that ecological theory suggests these animals should respond to climatic changes; one of these chapters demonstrates that recent data indicate that range shifts are already occurring for recent climatic variations. Zavaleta and Royval argue that conservation efforts must be cognizant of the multiple stresses imposed by human disturbances and show that exotic invasive species of plants in the United States, combined with climatic changes, will likely pose a synergistic combination of disturbances that will confront native species—especially endangered ones—in the twenty-first century. Finally, Shevliakova addresses the potential impacts of climate change on the geographic distribution of vegetation in the United States—by using a probabilistic model of the likelihood various vegetation types would occur as climate changes. Such alterations in the geographic patterns and likelihood of various vegetation types could reverberate significantly through animal communities.

Reflecting this point, our opening chapter sketches out the nature of the climate change debate, the need for cross-scale and cross-disciplinary research, and addresses some ecological implications of climate change. We also report briefly on our recent work in which a meta-analysis of more than 2000 studies shows highly significant associations between recent observed regional climate changes and response by environmental systems like lake ice, flowering dates, and wildlife behavior. The most consistent explanation for this set of associations is that there is indeed already a discernible impact of global climate change on ecosystems.

We are pleased with the breadth and depth of this set of chapters, and we believe this volume helps to launch this cohort of young scholars into careers that will be both scientifically credible and influential on the conservation efforts so critically required to protect ecosystems in the twenty-first century.

We are very gratified to have been asked by the NWF to guide this effort and to edit this volume. We also provide, as mentioned, an opening chapter that summarizes some of our own work in the area of climate change and its potential impacts on ecosystems, both to lay out the context for the specific contributions of the cohort that follow and to lend our weight to the growing movement of environmental scientists who believe that excellent science and work on important conservation projects and their communication to a wider public are all fundamental components of a scientist's job. Moreover, we believe that coupling submodels of climate to those of ecology (and even social systems) could well give rise to emergent properties that would not be discovered by disciplinary analyses alone, and that the search for emergent behavior of coupled physical, biological, and social systems will define a major thrust of basic environmental science research in the twenty-first century. That such systems science is also needed for conservation efforts is an added benefit in our view. We look forward to working with the young scientists in this cohort many times in the future, as we are certain they will become leaders in both science and conservation as they progress. We also eagerly anticipate getting to know other young scholars who, thanks to the efforts of these NWF Fellows, will feel a bit freer to follow in the fellows' footsteps in the years ahead.

Finally, we thank Patty Glick of the NWF and Camille Parmesan of the University of Texas for their extra efforts to work with these young scientists in their development as scholars, communicators, and concerned conservationists.

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