Future Challenges Project: Meeting the Grand Challenge

The Grand Challenge

Forty-five years ago, Rachael Carson looked across the American landscape and recognized that the capacity of natural systems to sustain plants and animals was being diminished by indiscriminate and irresponsible use of pesticides. It was a time when most agronomists, foresters and public health officials regarded pesticides as miracle compounds capable of increasing production of food and fiber and reducing disease, with few, if any, risks. Over the next decade, Carson helped the world understand and address an environmental crisis it had been slow to see. Faced with skepticism and derision, but armed with scientific data, professional credibility and personal integrity, Carson helped humankind appreciate the benefits that healthy natural systems provide and understand how indiscriminate and irresponsible uses of pesticides could damage those systems and threatened human health. Over the next two decades, scientists, citizens, industry and government joined together in curtailing indiscriminate and irresponsible uses of pesticides and in becoming more effective environmental stewards.

As the U.S. Geological Survey (USGS or Survey) and the U.S. Fish and Wildlife Service (USFWS or Service) approach the mid-point of the first decade of the 21st Century, they face similar challenges to the capacity and sustainability of biological resources and the systems that sustain them. Only by accepting these long-term challenges and expanding their capacities to understand, predict and respond to environmental change will the Survey and Service fulfill their missions and ensure the sustainability of landscapes and conserve biological diversity.

"Two Bureaus; One Mission"

The *Future Challenges Project* of the U.S. Geological Survey and the U.S. Fish and Wildlife Service is intended to improve the capabilities of both bureaus to understand, predict and respond to major ecological changes forecasted by our nation's most reputable scientists and scientific organizations. It is also intended to expand partnerships and collaboration between the two bureaus and with other conservation and science organizations. The Directors of both bureaus are convinced that collaborative applications of the principles of adaptive management hold great promise for addressing the scale and scope of ecological change expected during this century, some of which we are seeing today. In the words of Dr. Groat, Director of the U.S. Geological Survey, we are "Two bureaus; one mission."

The Geological Survey can help address landscape level ecological change by several means. First and foremost, USGS has the scientific staff and infrastructure to expand our understanding of the causes of ecological change; improve our capabilities to model and predict the nature, rate and magnitude of change; and monitor the effectiveness of mitigation strategies. The USGS also brings a philosophy of adaptive management to its partnership with the Fish and Wildlife Service, which enables the bureaus to address complex environmental challenges more effectively.

The U.S. Fish and Wildlife Service can also help address landscape level ecological change by

several means. The FWS manages habitats, fish, wildlife and plants directly, by on-the-ground stewardship and by regulation, in concert with public and private partners. The FWS has both scientific staff and management infrastructure that can contribute significantly to broadening and deepening our understanding of causes of major ecological change, as well as modeling, predicting and responding to those changes. These capabilities complement those of the Geological Survey and provide vital components of an adaptive management partnership.

Four Key Challenges

The U.S. Geological Survey and U.S. Fish and Wildlife Service joined in forming a *Future Challenges Team.* Team members reviewed the scientific literature and publications of well-respected scientific organizations, such as the National Science Foundation and the National Research Council, to better understand the perceptions of the larger scientific community concerning events and phenomena that are likely to cause landscape changes capable of reducing the sustainability of natural systems. They then overlaid on this backdrop their solid understanding of their bureaus' missions and authorities. Next they asked themselves two key questions:

- How will the changes in ecological sustainability that have been forecasted affect the basic authorities and mission of both bureaus?

- What could both bureaus do to position themselves to be more effective in addressing the changes that have been forecast?

These questions elicited important perspectives and questions about the forecasted ecological changes and the factors that produced them. The two questions also helped the bureaus focus realistically on their capabilities to mitigate predicted ecological changes. In addition, the questions helped both bureaus understand and appreciate that human activity and technology are driving changes in ecological processes and functions at unprecedented rates and scales. As a result, both bureaus recognized that in some situations they can be effective in addressing the root causes of environmental change, but in other situations, they can be more effective by focusing on the changes *per se.* For example, neither the U.S. Geological Survey nor the U.S. Fish and Wildlife Service have authorities to address the production of greenhouse gases, one of the root causes of climate change. Nonetheless, both bureaus have authorities that enable participation in activities that foster understanding of and affect systems that sequester atmospheric carbon.

The Geological Survey and Fish and Wildlife Service elected to focus on four challenging issues that are likely to affect ecological sustainability in ways that relate directly to the bureaus' missions, authorities and responsibilities, and in ways the bureaus can address successfully:

- Global Climate Change
- Biotechnology/Bioengineering
- Invasive Species
- Water Resources

Global Climate Change. Mean surface temperatures are predicted to rise by as much as 5-7^{o}F in parts of the United States over the next half century. Scientists expect increased temperatures to profoundly alter habitat conditions; abundance and distribution of plants and animals; and relationships among plants, animals and abiotic components of their habitats. The potential consequences could either negate or mask the effects of many kinds of fish and wildlife management strategies and activities, or possibly complement them. As a result, we must strengthen our capabilities to predict how climate change will affect fish and wildlife, how it will change ecological functions and relationships, and how we can manage fish and wildlife populations and communities successfully in the face of environmental change.

Biotechnology/Bioengineering. Advances in genetic engineering and genetics capabilities in general have accelerated rapidly in the last two decades, especially in agriculture, forestry and, more recently, in aquaculture. Rapid technological advances have made possible increasingly efficient replication of genetic material, decoding gene sequences, cloning some organisms, and introducing new genetic material into organisms to confer desired traits and suppress genes that produce undesired traits. This capability has lead to new areas of scientific understanding and inquiry, like genomics, and made it possible to design and "engineer" organisms capable of resisting disease more effectively, growing larger and more rapidly, and outcompeting members of the same species that have not been "engineered." It is now feasible to engineer plants and animals that can flourish in degraded environments and to introduce, intentionally and unintentionally, engineered organisms capable of quickly outcompeting and displacing species occurring naturally. Once established, some engineered biotypes are capable of spreading rapidly and occupying vast landscapes. Consequently, this technology holds both promise and peril for the conservation profession, and we must develop scientific, analytical and ethical frameworks to manage and respond to it.

Invasive Species. Species continue to be introduced, intentionally and unintentionally, in record numbers. Much like bioengineered organisms, invasive species have displayed alarming capacities to outcompete and displace native species and significantly reduce biological diversity. They thrive for many of the same reasons that engineered organisms might. Sometimes natural predators are non-existent; sometimes invasive species prey on native species; sometimes the pathogens that invasive species bring cause disease among native species; and sometimes invasive species occupy and defend habitats more vigorously and successfully than native species. Once established, many invasive species spread rapidly and uncontrollably. Consequently, we must develop new science and practice to model, predict and manage invasives, and methods to detect their presence and assess and manage risks associated with them.

Water Resources. Water use nationwide has remained relatively stable since 1985, but competition for water continues to grow and allocation patterns continue to shift in significant ways in much of the country. While power production and agriculture remain the chief uses of surface water, allocations for public uses and ecosystem services continue to increase. In the last decade, the demand for water for ecosystem services, like maintenance of fish and wildlife, has become a major driver of change in water allocation decisions made by public officials. Scientists face growing pressures to identify water requirements for ecological services, predict changes in water availability, and link changes in water availability to changes in ecological

services, especially biodiversity and ecosystem sustainability. As a result, we must develop new tools for modeling, predicting and monitoring changes in availability of ground water and surface water, and we must improve our understanding of relationships between ground water, surface water, and ecosystem services. In short, we must expand our science capabilities so we can be successful in illuminating the consequences of alternative decisions about water management and allocation, pollution management and control, and management of fish and wildlife.

The *Future Challenges Project*

The U.S. Geological Survey and the U.S. Fish and Wildlife Service believe that strengthened science and improved management informed by science hold vast promise for predicting and responding to normal ecological cycles and these challenges. The *Future Challenges Project* will build new partnerships between the two bureaus, enriching their collective capability to address change. Together they will use an adaptive management framework to engage in science and management activities that will enhance understanding, strengthen predictive capabilities and mobilize both bureaus and others to respond successfully to ecological changes expected to result from global climate change, biotechnology/bioengineering, invasive species and water resources for ecological systems.