

## CHAPTER 5

# Imagining the Future: Humans, Wildlife, and Global Climate Change

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Climate change is an enduring, significant, and complex problem facing humans and wildlife. It is now well established that the Earth has warmed over the past century, due mostly to the emissions of greenhouse gases from human activities (Intergovernmental Panel on Climate Change 2007), and that this warming has had impacts on wildlife and their habitats in important ways (Root et al. 2003; Inkley et al. 2004; Parmesan 2006). More serious climate impacts on wildlife are expected this century, especially if significant steps are not taken to reduce greenhouse gas emissions and to help wildlife cope with changing conditions. As stated by National Wildlife Federation president Larry Schweiger (2006), "Like it or not, global warming will be the defining issue of the 21st century."

### HUMAN-CAUSED CLIMATE CHANGE IS AFFECTING WILDLIFE

Emissions of carbon dioxide (CO<sub>2</sub>) from fossil fuel burning have increased atmospheric CO<sub>2</sub> to 383 parts per million (National Oceanic and Atmospheric Administration 2007), higher than anytime in at least 650,000 years, during which the value did not exceed about 300 parts per million (Siegenthaler et al. 2005). This increase is responsible for most of the global mean temperature increase of about 0.76°C (1.4°F) in the twentieth century (Intergovernmental Panel on Climate Change 2007). Other observed climate changes related to the emission of greenhouse gases include shifts in precipitation and wind patterns, more pronounced droughts and heat waves, and increased intensity of tropical cyclones. Associated with climate change, during the last century the Earth experi-

enced widespread melting of snow and ice, rising sea levels, decreasing ocean salinity, and increasing ocean acidification (Intergovernmental Panel on Climate Change 2007). The terms *climate change* and *global warming* are often used interchangeably. Herein, we use climate change and in so doing reference increasing temperatures and other changing climate parameters. We use global warming when the referenced source uses that term as a general reference to all aspects of the changing climate.

Meta-analyses of published peer-reviewed papers demonstrate that observed changes in phenology, such as earlier springs and later falls, as well as in distribution, such as northward movement of species' ranges in the Northern Hemisphere, are consistent with expectations from climate change (Parmesan 2006; Root et al. 2003). Furthermore, these changes are disrupting predator/prey and plant/insect interactions.

In North America, impacts of climate change on fish, wildlife, and their habitats are increasingly apparent. Since the mid-1980s, drought and warmer temperatures have caused a four- and sixfold increase in the incidence and the size, respectively, of major fires in western forests (Westerling et al. 2006). In Nevada, especially large wildfires in summer 2006 necessitated implementation of emergency regulations to reduce pronghorn populations to levels commensurate with remaining habitat (Griffith 2006). Researchers point to increasing temperatures as the reason that the moose population of northwestern Minnesota has declined by more than 90 percent in twenty years (Smith 2006). Massive coral bleaching events and die-offs due to increasing water temperatures have occurred worldwide, including the continental shelf of North America (Hoegh-Guldberg 1999).

#### POSSIBLE CLIMATE FUTURES AND IMPLICATIONS FOR WILDLIFE

Estimates of future warming range from about 1.1°C to 6.4°C (2.0–11.5°F) by 2100, depending upon the levels of future greenhouse gas emissions (Intergovernmental Panel on Climate Change 2007). However, no matter what steps are taken to reduce emissions, it is projected that we are committed to at least about 0.6°C (1.1°F) warming in this century due to the greenhouse gases that have already been emitted. The Intergovernmental Panel on Climate Change (2007) projects that sea level will rise 0.18 to 0.59 meters (10 to 23 inches) by the end of the twenty-first century, although more recent observations of rapid ice melting in Greenland and Antarctica suggest that these projections are too low (Rahmstorf 2007).

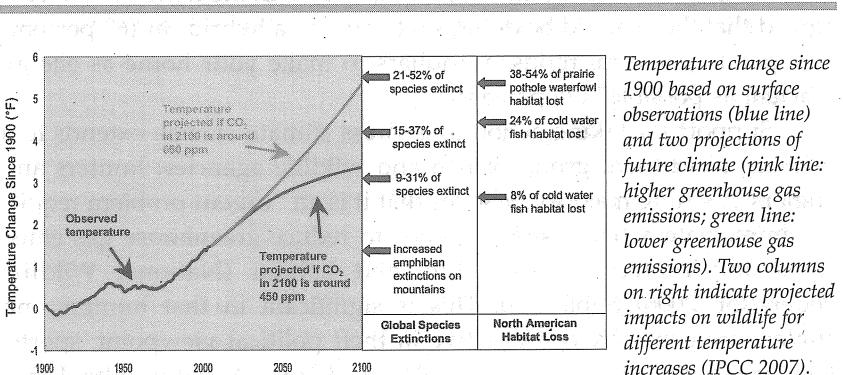
Future climate change will have profound impacts on wildlife,

especially if changing climate conditions are outside a species' historical tolerance range, such that it cannot adapt quickly enough to accommodate the new climate conditions or cannot move to more suitable habitat because of natural or human-built barriers. Sophisticated global climate models project potential future climate conditions, which have been connected to possible species extinctions, habitat loss, and other impacts on wildlife (e.g., see fig. 5.1).

Let's imagine two different futures for wildlife. In the first scenario, greenhouse gas emissions are allowed to continue increasing unabated over the next century, allowing CO<sub>2</sub> levels to reach about 650 parts per million and global mean temperatures to increase by about 2.2°C (4°F) above current levels by 2100. In this scenario, up to half of all species worldwide will be committed to extinction (Thomas et al. 2004). In North America, the prairie pothole region, which serves as a major breeding ground for waterfowl, would be diminished by 38 to 54 percent due largely to drier conditions (Parry et al. 2007). Streams and rivers across North America would also warm up, reducing habitat for cold-water fish by about a quarter (O'Neal 2002; Preston 2006). These habitat changes would pose major challenges for fish and wildlife.

If instead we limit greenhouse gas emissions to achieve CO<sub>2</sub> levels in the atmosphere at about 450 parts per million with associated temperature increases to less than 1.3°C (2°F) above today, the impacts on wildlife will be significantly less dire. In this scenario, there will still

**FIGURE 5.1** Temperature change since 1900 based on surface observations and two projections of future climate



Source: IPCC 2007

be some extinctions, such as amphibians in mountainous regions that already have been occurring (Pounds et al. 2006), but the overall fish and wildlife losses are projected to be much less. For example, only some 8 percent of cold-water fish habitat would be lost in North America (O'Neal 2002; Preston 2006). Although the impacts will be less, it is important to note that ecosystems will change even in this more optimistic scenario of less warming. Concerted efforts will still be required to ensure that wildlife species are best able to survive.

### HUMAN ATTITUDES ON CLIMATE CHANGE

A public survey in 2003 examining environmental concerns found climate change ranked sixth behind water pollution, destruction of ecosystems, toxic waste, overpopulation, and ozone depletion (Curry, Ansolabehere, and Herzog 2007). But by 2006 climate change had become the top environmental concern (Curry, Ansolabehere, and Herzog 2007). Furthermore, polls of the U.S. public in spring 2007 indicate that a strong majority of the population is convinced that climate change is real (table 5.1).

In light of the public concern about climate change, it is not surprising that there is also widespread support for taking action to address climate change (see table 5.1). Solutions could include limiting greenhouse gas emissions by fostering development of alternate fuels, setting emissions standards for business and industry, or imposing mandatory controls on greenhouse gas emissions. In addition, Gallup (2007) found broad support for various actions that individuals could take, ranging from using fluorescent lightbulbs in the home (69 percent agreed that they should be doing so) to buying a hybrid car (62 percent) to "spending several thousand dollars to make your home as energy efficient as possible" (78 percent).

Support for taking action to address climate change extends to a primary constituent group of fish and wildlife agencies: hunters and anglers. A strong majority believes that it is an "urgent problem requiring immediate action," such as steps to reduce greenhouse gas emissions and protect fish, wildlife, and habitat (National Wildlife Federation 2006) (table 5.2). This is significant in that hunters and anglers are generally conservative in their political viewpoint; sportsmen voted for President George W. Bush over Senator John Kerry almost two to one in the 2004 presidential election (National Wildlife Federation 2006). Furthermore, the results suggest that hunters and

**TABLE 5.1. Results from Selected Polls on Global Warming, 2007**

POLL	GLOBAL WARMING VIEWS	GOVERNMENT ACTION VIEWS
<b>January 30-31, 2007</b> Fox News/Opinion Dynamics Corp. (2007) poll of 900 registered voters nationwide	82% believe that global warming exists.	N/A
<b>March 11-14, 2007</b> Gallup poll of 1,009 adults nationwide (Saad 2007)	59% think that the effects of global warming have already begun to happen.	N/A
<b>April 5-10, 2007</b> Washington Post-ABC News-Stanford University (2007) poll of 1,002 adults nationwide	84% think that the world's temperature probably has been going up slowly over the past 100 years.	49% think that the federal government should do much more to deal with global warming, and 20% think that it should do somewhat more.
<b>March 19-22, 2007</b> Center for American Progress poll of 500 registered voters nationwide (Podesta, Weiss, and Nichols 2007)	76% believe that the effects of global warming are apparent now.	60% believe that we must take action now or it will be too late to stop global warming.
<b>April 20-24, 2007</b> CBS News/New York Times (2007) poll of 1,052 adults nationwide	49% believe that global warming is having a serious impact now. 36% believe that global warming will have an impact in the future.	52% think that global warming should be a high priority for government leaders.

anglers would be receptive to actions by fish and wildlife agencies to address climate change impacts to fish and wildlife resources.

### HUMAN ATTITUDES ON WILDLIFE

Why do humans care about wildlife? To professionals involved in wildlife conservation, it seems so natural to be passionate about wildlife that we may give little thought to why we care or simply attribute it to childhood experiences in the out-of-doors. Wilson (1984) hypothesized

TABLE 5.2. Results from a Nationwide Poll of Hunters and Anglers on Global Warming

DO YOU AGREE OR DISAGREE THAT ...	RESPONSE
global warming is currently occurring.	76% agree
global warming is primarily caused by pollution from burning fossil fuels.	56% agree
global warming is a serious threat to fish and wildlife.	71% agree
global warming is an urgent problem requiring immediate action.	67% agree
the United States should reduce its emissions of greenhouse gases like carbon dioxide that contribute to global warming and threaten fish and wildlife habitat.	78% agree
Congress should pass legislation that sets a clear national goal for reducing global-warming pollution with mandatory timelines because industry has already had enough time to clean up voluntarily.	75% agree
legislation to address global warming should include funding to protect fish, wildlife, and their habitat from the impacts of global warming.	76% agree

Source: National Wildlife Federation 2006. Nationwide opinion survey of hunters and anglers. Conducted by Responsive Management. [www.targetglobalwarming.org/files/Toplines\\_National\\_FINAL.pdf](http://www.targetglobalwarming.org/files/Toplines_National_FINAL.pdf).

that the drive to conserve wildlife extends from a deep-rooted connection of humans to wildlife, termed *biophilia*. This instinctive bond or connection between humans and wildlife is, according to the hypothesis, essentially an innate human preference for things in nature. Although the biophilia hypothesis is controversial (Kellert and Wilson 1993), what is clear is that humans care about the environment, wildlife, and wildlife conservation. In a nationwide study conducted by Yale University (2004), an overwhelming majority (95 percent) of Americans said that, in comparison to other issues, the environment was important to them, and more than half indicated that the environment was *very* important. Furthermore, a substantial percentage (13 percent) said the environment was the *most* important issue.

It is also clear that the public enjoys wildlife as part of a healthy environment. Studies in the northeastern and southeastern United States found that overwhelming majorities (91 percent and 90 percent, respectively) of respondents indicated that it was *very* important to them to know that wildlife exists in their state (Responsive Management 2003, 2005). Furthermore, various surveys of residents' opinions on the proposed reintroduction of wolves, panthers, and grizzly bears in their states demonstrated overwhelming public support (Responsive Management 1998).

Sportsmen and sportswomen have demonstrated their concern for fish and wildlife many times by persuading Congress to enact legislation funding wildlife conservation. These laws included the Migratory Bird Hunting and Conservation Stamp Act of 1934 ("Duck Stamp Act"), the Federal Aid in Wildlife Restoration Act of 1937 ("Pittman-Robertson"), and the Federal Aid in Fisheries Restoration Acts of 1950 and 1984 ("Dingell-Johnson" and "Wallop-Breaux," respectively). Combined, these four acts alone have generated more than \$11 billion from sportsmen and sportswomen for conservation purposes (U.S. Fish and Wildlife Service 2007).

Public concern about the disappearance of wildlife led to enactment of the Endangered Species Act in 1973. Now, over thirty-five years later, the continuing passion for wildlife conservation was demonstrated by the response to the U.S. Fish and Wildlife Service's 2007 proposal to list the polar bear as a threatened species owing to declining sea ice from climate change. The U.S. Fish and Wildlife Service received about 600,000 comments (2007a), most in support of listing the polar bear (Woods 2007), even though most respondents likely never will see a polar bear in the wild.

#### MOTIVATION FOR ACTION: INTERSECTION OF CONSERVATION AND HUMAN SELF-INTEREST

In addition to an innate love for wildlife, the conservation movement grew out of the understanding that a healthy environment is essential for the well-being of humans. For example, widespread public concern over the impacts of polluted air and water on humans and ecosystems led the United States Congress to enact in the 1970s a number of important laws, including the Clean Air Act (1970) and the Clean Water Act (1972, 1977). Similar recognition of the potential harm to humans and wildlife from climate change is a driving force behind calls for action today.

In 2005, the Wildlife Society adopted the position statement “Global Climate Change and Wildlife,” calling for reductions in greenhouse gas emissions and for professional wildlife managers to take actions to help wildlife survive climate change. The American Geophysical Union and the American Meteorological Society, the two professional societies to which most U.S. climate scientists belong, have issued strong position statements on climate change. The U.S. National Academy of Sciences joined the scientific academies of ten other nations in 2005 to affirm that climate change is happening, humans are causing the observed changes, and actions are needed to reduce greenhouse gas emissions and enable humans and wildlife to adapt to some changes that will be inevitable.

Diverse groups have added their voices to the call for action on climate change. The U.S. Climate Action Partnership (USCAP) includes twenty-six large international corporations and six nongovernmental conservation organizations that together are calling on the federal government to enact mandatory legislation to reduce greenhouse gas emissions by 60 to 80 percent by 2050 (U.S. Climate Action Partnership 2007). Many companies cite their financial well-being as a reason to be proactive in their approach to climate change, seeing the opportunities of new green markets as well as the potential liabilities associated with continuing with business as usual. The faith community—including organizations representing Evangelical Christian, Roman Catholic, Jewish, and other religions—have argued that humankind has a responsibility to be good stewards of the Earth and to address international and intergenerational social justice issues.

The increasing engagement among diverse constituencies that have not traditionally been interested in climate change underscores that the issue is no longer the domain of narrow interest groups. Hunters and anglers, business leaders and church leaders, scientists and environmentalists, and liberals and conservatives all share an innate affection for wildlife, a sense of responsibility for stewardship of the Earth, and the recognition that the future of humankind could be profoundly affected if steps are not taken to address climate change.

#### CONSERVATION ACTIONS FOR WILDLIFE IN A CHANGING CLIMATE

The practical implications of the nexus among humans, climate change, and wildlife are complex but fall into three primary categories. First, the global climate changes that have already occurred are having an impact on fish and wildlife resources and will continue to do so. Wildlife profes-



sionals can mitigate these impacts by taking actions to help fish, animals, and their habitats survive climate change. Second, reducing greenhouse gas pollution can minimize the total impact of climate change on wildlife. Finally, natural ecosystems are an important reservoir of carbon in plants and soils. Strategic efforts to conserve these areas can prevent this organic material from decaying and releasing CO<sub>2</sub> into the atmosphere. Likewise, appropriate habitat restoration can remove CO<sub>2</sub> from the atmosphere.

### *Helping Wildlife Survive Climate Change*

A report by the Wildlife Society (Inkley et al. 2004) describes eighteen actions wildlife managers can implement now to help wildlife survive climate change, even when the potential impacts of climate change to a specific species or area are not precisely known. Their recommendations include:

**Maintain healthy, connected, genetically diverse populations.**

Small isolated populations are more prone to local extirpations. Although managers already encourage healthy populations, climate change increases the importance of meeting this goal.

**Reduce nonclimate stressors on ecosystems.** Reducing other human-induced stressors such as toxic pollution and habitat loss will minimize negative impacts synergistic with climate change and increase the resiliency of habitats and species to the effects of climate change.

**Prevent and control invasive species.** Rapidly changing climates disturb habitats, thereby increasing opportunities for invasive species to spread. Extensive monitoring and control will be necessary to limit the negative impacts of invasive species.

**Help wildlife cope with unexpected weather events.** As climate changes, the response of wildlife and their habitats may be surprising; therefore, natural resource management must be flexible.

**Reduce the risk of catastrophic fires.** Although fire is a natural part of many ecosystems, climate change has led to more frequent fires and more damaging catastrophic fires (Westerling et al. 2006). Managers can use prescribed fires and other techniques to reduce fuel load and the potential for catastrophic fires.

**Protect coastal wetlands and accommodate sea level rise.** Managers can defend against the negative impacts associated with sea level rise through conservation easements and the

acquisition of inland buffer zones to provide areas for habitats and wildlife to shift inland.

**Adjust yield and harvest models.** As fish and wildlife populations respond to climate change, their productivity and sustainability may increase or decrease. Managers will need to adapt yield and harvest regulations in anticipation and response to these changes.

**Consider climate change models as well as historical data when making projections.** Managers must be aware that, because the climate is changing, historical climate, habitat, and wildlife conditions are not reliable indicators of future conditions. Projections and planning should take into account expected changes in climate.

**Employ monitoring and adaptive management.** Owing to uncertainty concerning climate change, wildlife managers must anticipate the impacts on wildlife and use monitoring data to quickly adjust management techniques and strategies.

**Look for new opportunities.** Managers must be ready to anticipate and take advantage of new opportunities. For example, if climatic conditions leave existing agricultural areas unusable for agriculture, they could become important wildlife conservation areas.

### *Reducing Global Greenhouse Gas Emissions*

Addressing climate change requires extensive changes in the way humans generate and use power. Energy use has grown exponentially (fig. 5.2) since the beginning of the Industrial Revolution, and carbon-based fuels (oil, coal, natural gas) have provided 80 percent of today's energy supply (Nakicenovic, Grubler, and MacDonald 1998). Governments can lead the way by reducing these emissions through legislation and by adopting new energy policies in their own operations. Conservation agencies can and should demonstrate to other government agencies means by which they can reduce agency greenhouse gas emissions in the course of their official duties and actions.

Reducing carbon emissions requires development of more-efficient power generation from fossil fuel sources, as well as the use of noncarbon-based alternative energy sources. Extensive research and development are under way to further develop solar and water power, biofuels, wind-generated energy, nuclear fusion and fission, and geo-

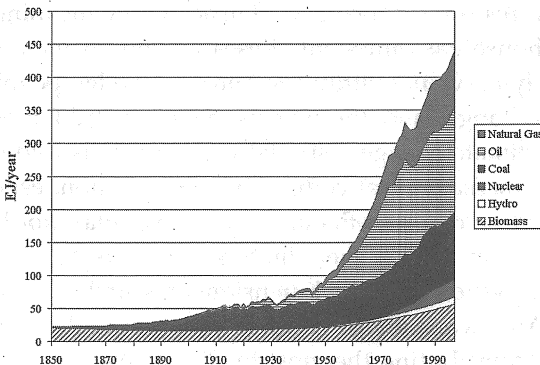
thermal energy sources. Wildlife professionals will need to pay attention to minimizing or mitigating the impacts on wildlife of alternative energy sources. For example, Arnett and colleagues (2007) caution that development of wind power should consider impacts on wildlife, including mortality of birds and bats, as well as the habitat disruption and fragmentation associated with building new sites.

Energy must also be used more efficiently as a part of the overall strategy to reduce greenhouse gas emissions. Opportunities for increased efficiency are available in transportation, manufacturing, building practices, and consumer choices for appliances, lighting, and other electrical devices. Numerous federal, state, and business initiatives are either in place or being considered to promote energy efficiency. Conservation agencies also can reduce their emissions and at the same time possibly reduce costs by exploring ways to reduce everyday power usage. Just two of many possible options are replacing incandescent lightbulbs with compact fluorescent bulbs that consume nearly 70 percent less energy or using vehicles and motors with higher fuel efficiency.

#### *Sequestering Carbon through Habitat Conservation and Restoration*

Sequestering atmospheric CO<sub>2</sub> in plants and soils is a third category of conservation actions that can help reduce greenhouse gas levels in the atmosphere, while at the same time providing important benefits for wildlife. Significant amounts of CO<sub>2</sub> and other greenhouse gases can be

**FIGURE 5.2 World primary energy source by supply**



Currently over 30 billion tons of CO<sub>2</sub> are emitted to the atmosphere from fossil fuel burning each year. As a result, atmospheric CO<sub>2</sub> levels have risen more than 30% from 280 ppm to 383 ppm in the last two centuries.

released into the atmosphere when natural forests, prairies, and wetlands are altered either for agricultural uses or for development. Restoring these lands to their natural ecosystems can allow them to begin removing CO<sub>2</sub> from the atmosphere through photosynthesis. Conservation agencies have an important role to play in identifying opportunities to enhance carbon sequestration through land conservation and restoration.

### HUMAN DIMENSION RESEARCH NEEDS

Herein we have demonstrated the role of humans in causing rapid climate change, the need to reduce greenhouse gas emissions, some management actions that can be taken to help wildlife survive in a changing climate, and the belief of the majority of Americans that the issue must be addressed. Climate change is now a social issue with the challenge of transforming the scientific facts and prevailing concerns into meaningful actions that reduce greenhouse gas emissions to requisite levels.

There are two aspects of the climate change issue that make it particularly challenging for individuals to move from concern to action. These are the global scope of the issue and the longtime lag between action and results. However, these challenging aspects are not unique to climate change. The ban of chlorofluorocarbons (CFCs) overcame the facts that they were used worldwide and that the first signs of a statistically detectable decrease in the ozone hole will likely not be evident until at least the 2020s (Newman et al. 2006). However, addressing climate change is more challenging because climate change will require action by everyone as individuals rather than implementation primarily by industry, as was the case with CFCs.

Human dimensions research will be critical in achieving meaningful reductions in greenhouse gas emissions. Research should include assessment of the underlying values, attitudes, and knowledge people hold regarding climate change, and the actions people would most likely take to minimize climate change. Especially important is understanding the factors and messages that compel people to action, especially when the perceived or real benefits of their actions may not be realized for decades or even within their lifetimes. Because climate change is a worldwide issue, human dimensions research should include not only North America, but also global populations, especially in the countries that are contributing the most to climate change. This would assist in finding ways to compel unified action across vastly different economic levels and cultures to reduce global warming pollution.

## CONCLUSION

We believe that climate change is the greatest environmental challenge for humankind and the greatest threat to wildlife since the evolution of humans. The future for humans and wildlife alike depends on individual and worldwide action to reduce greenhouse gas pollution to minimize rapid climate change caused largely by the burning of fossil fuels. At the same time, concerted actions by fish and wildlife managers will be necessary to help wildlife survive those climate changes that are already inevitable.

The challenge for humankind, in the interest of current and future generations, and in the interest of wildlife conservation, is to address climate change *now*. Compelling factors for addressing climate change are self-interest, humankind's innate attraction for wildlife, and most people's concern for the environment, as evidenced by polls indicating a desire to conserve wildlife, even when that may mean some limitations on human activities. For human dimensions research, the challenge is finding out what makes climate change real to people and motivates the majority to act together, lest climate change become the ultimate "tragedy of the commons."

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