Confronting the Challenge

Climate Change

CALIFORNIA DEPARTMENT OF FISH AND GAME

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This magazine is produced by the

STATE OF CALIFORNIA
Governor Arnold Schwarzenegger

CALIFORNIA NATURAL RESOURCES AGENCY
Secretary Lester Snow

DEPARTMENT OF FISH AND GAME
Director John McCamman
Climate Change Advisor Amber Pairis, Ph.D.

FISH AND GAME COMMISSION
President Jim Kellogg
Vice President Richard Rogers
Commissioner Michael Sutton
Commissioner Daniel W. Richards
Commissioner Jack Baylis
Acting Executive Director Jon Fischer

California Department of Fish and Game
Editor Troy Swauger
Call (916) 322-8911
(USPS 415460) ISSN 0030–7025
Resources Building, 1416 9th Street
Sacramento, CA 95814

Printing of this publication was paid for by The Nature Conservancy.

Photograph © Bradley Mart

About This Issue

Confronting the Challenge

Protecting California's unique array of species and ecosystems from the impacts of climate change will require coordinated and targeted efforts. The challenges posed by climate change that are detailed in this magazine provide a roadmap of areas where the Department of Fish and Game (Department) and our partners intend to focus actions in order to help maintain and restore naturally functioning ecosystems and protect California's natural resources for their many public benefits. A growing body of scientific research indicates California's remarkable diversity of habitats and wildlife is threatened by climate change. Ecological changes, including changes in species' distributions, timing of life cycles, and abundance, have already occurred in California over the past century in concert with increases in average temperature and changes in precipitation patterns.[1] Existing stressors such as population growth and associated land use changes, water management conflicts, invasive species, and other widespread stressors identified in California's Wildlife Action Plan will be exacerbated by climate change.

The Department is an important part of the climate change solution and has been working collaboratively with stakeholders on the creation of climate change adaptation strategies and working to integrate climate change into all core functions and activities. This document is a result of a collaborative partnership with stakeholders to craft messages that can be used to engage the public, landowners, and organizations on a variety of topics that help us as a group tell the story and engage partners in adaptation and mitigation efforts related to biodiversity conservation. One of the key components of the magazine is a short overview of how biodiversity conservation overlaps with other sectors including agriculture, forestry, rangelands, fire, public health, and renewable energy development.

Through past and current efforts the Department is emerging as a leader in climate change adaptation planning to insure that natural resource protection is paramount to future responses to climate change impacts. Supporting and investing in the Department's efforts will increase its capacity to deal with uncertainty and ensure that California's natural resources are maintained for generations to come. An investment of time and resources now will be small compared to the long-term dividends repaid by improving the quality of life for our citizens, sustaining the delivery of ecosystem services from our environment, and benefiting our fish and wildlife.

[1] CA Natural Resources Agency, 2009. 2009 California Climate Adaptation Strategy. California Natural Resources Agency. Sacramento, CA. *http://www.climatechange.ca.gov/adaptation*

Overview of Current and Future Climate Change Impacts to Fish, Wildlife and Habitats

- Changes to the seasonal pattern of snow accumulation and timing of snowmelt
- Changes in seasonal and annual mean temperature
- Changes in seasonal and annual total precipitation
- Increase in the frequency and severity of extreme weather events such as storms, heat waves, flooding, and drought
- Changes in cloud cover and rainfall patterns
- Possible reduction in coastal fog
- Wetland losses due to precipitation and land use change
- Sea level rise and increased wave intensity
- Increased intrusion of seawater into estuaries, freshwater wetlands and aquifers, due to sea level rise
- Altered timing of animal and plant life cycles (phenology)
- Disruption of biotic interactions (pollination, dispersal, predator-prey, etc.)
- Changes in physiological performance, including reproductive success and survival of plants and animals
- Changes in species' ranges and abundance
- Population extirpations and species extinctions
- Increase in invasive species including parasites and disease-causing organisms
- Altered migration patterns of fishes, aquatic-breeding amphibians, birds and mammals
- Changes in forage base by many species
- Vegetation changes
- Changes in fire regimes including increased frequency and intensity of wildfire
- Local extinction of plant and animal populations
- Changes in habitat, vegetation structure and plant and animal communities
- Increased interactions between two or more of the above (i.e. synergistic affects)

Photograph © Alice C. Wallace

From the Director

John McCamman
Director, Department of Fish and Game

Aggressively Managing Climate Change

The California Department of Fish and Game (Department) is aggressively confronting the many challenges associated with climate change and its impacts on fish and wildlife. In keeping with its mission, the Department is committed to reducing the effects of climate on the state's natural resources and helping all species to adapt to these changes, many of which are still largely unknown.

The Department has taken a leadership role among the state fish and wildlife agencies to begin to address the uncertainty associated with our changing climate through landscape-scale efforts that support managing robust populations and healthy habitats—the best way to ensure success in the face of uncertain future. There are many targeted efforts under way focused on climate change research, monitoring and other more specific actions. Specifically, the Department has been meeting with stakeholders to create a collective vision for adaptation planning across the state while also identifying the Department's programs and projects that will help implement the vision. Important products of the Department's adaptation planning efforts include the Department's adaptation plan "Confronting Climate Change: Actions to Conserve California's Natural Resources" and the "California Climate Adaptation Strategy." In addition, there are many Department programs and projects that will be utilized to help implement the vision including California's Wildlife Action Plan, the Natural Community Conservation Planning (NCCP) Program, Conservation and Mitigation Banking Program, Areas of Conservation Emphasis Mapping and Modeling Project (ACE-II), the Essential Habitat Connectivity Project and Regional Advanced Mitigation Program, to name a few.

Preparing for and responding to the challenges associated with climate change requires more than just new tools and resources. Essentially we are changing the culture of the Department, the way in which we approach conservation challenges, and how we plan for management actions

under a wide array of climate change impacts and uncertainty. As a Department we will face many challenges while implementing actions to help species and habitats persist in a time of rapid change. Recent discussions have focused on how we will develop the flexibility to manage resources adaptively, incorporating new knowledge about adaptation techniques and climate change as it becomes available.

Specifically, the Department has been meeting with stakeholders to create a collective vision for adaptation planning across the state while also identifying the Department's programs and projects that will help implement the vision.

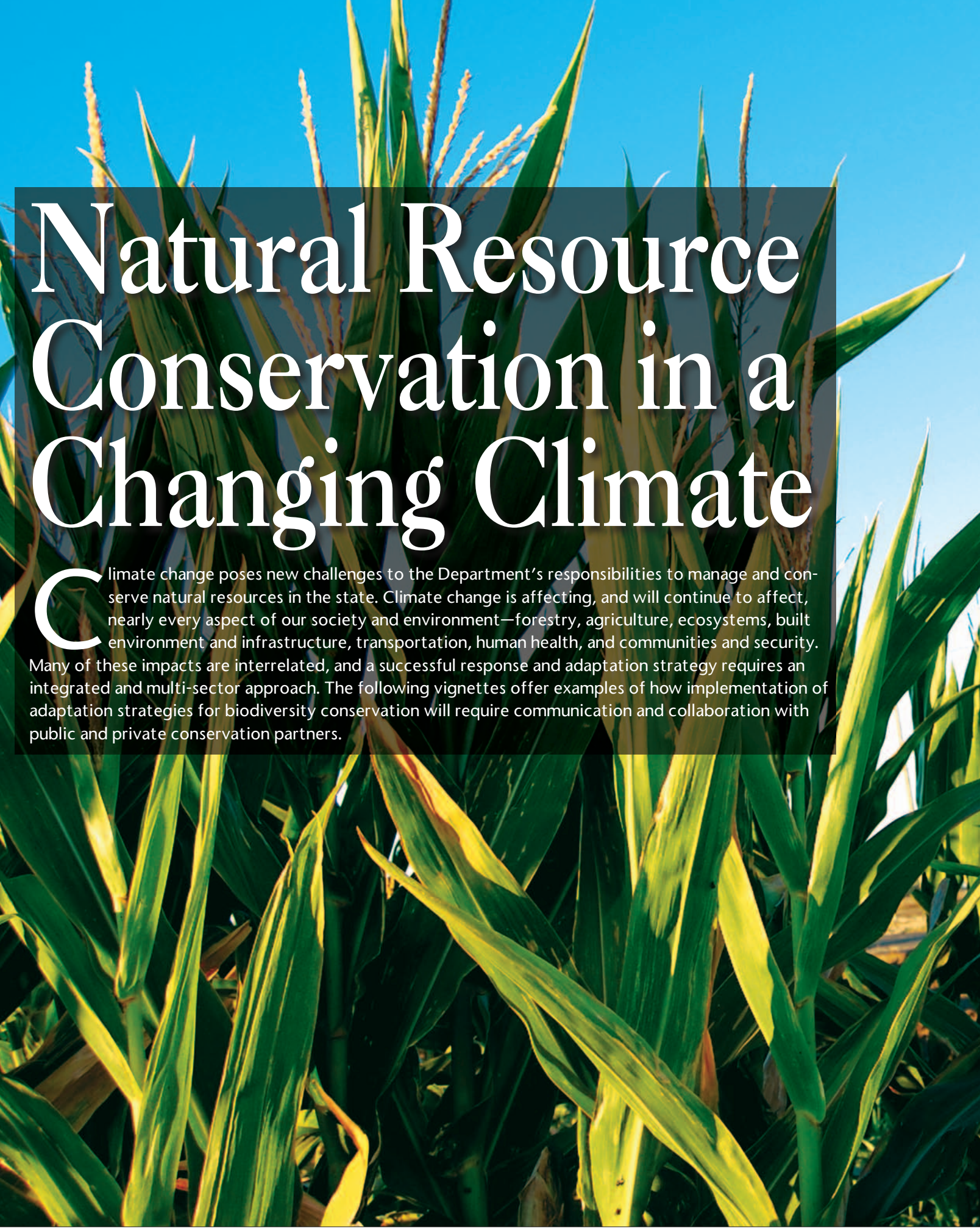
To be successful, we will need to build capacity within existing staff and programs. This will require stable, dedicated funding. Our success will also hinge on our ability to integrate and coordinate our efforts among our partners and expand the conversation to other states and regional efforts since many of the challenges associated with climate change will not end at California's border. Together we can be most successful at crafting and implementing targeted responses to climate change.

Every region of the state is unique and will need its own blueprint for balancing the needs of people, fish and wildlife. There is no "one size fits all" solution for fish and wildlife management or the implications of climate change. As our water sources, weather patterns, vegetation and critical food resources are altered, we will adapt well because of the strategies we are putting in place today. While there is always more to do, we will continue to ensure and uphold the Department's mission to protect California's fish and wildlife while facing many challenges, including those from climate change.

A Welcome From The Nature Conservancy

Conservation is a powerful tool to address the impacts of climate change. By preserving and enhancing the benefits that nature provides, we can help protect public safety and strengthen our quality of life, preserve wildlife and fisheries, and reduce impacts from floods, wildfire and sea level rise. And, nature-based solutions like restoring floodplains and conserving wetlands are often cheaper and quicker to implement than engineered actions like building new levees and sea walls, and they don't result in new greenhouse gas emissions. The Nature Conservancy is pleased to be an active partner with the Department of Fish and Game and to support this publication to raise awareness about the critical role that nature plays in society's efforts to craft a comprehensive and effective response to climate change.

Mike Sweeney,
Executive Director,
The Nature Conservancy, California



Natural Resource Conservation in a Changing Climate

Climate change poses new challenges to the Department's responsibilities to manage and conserve natural resources in the state. Climate change is affecting, and will continue to affect, nearly every aspect of our society and environment—forestry, agriculture, ecosystems, built environment and infrastructure, transportation, human health, and communities and security. Many of these impacts are interrelated, and a successful response and adaptation strategy requires an integrated and multi-sector approach. The following vignettes offer examples of how implementation of adaptation strategies for biodiversity conservation will require communication and collaboration with public and private conservation partners.

Agriculture

In California a large number of wildlife species depend on privately owned agricultural lands for habitat. As temperature and precipitation patterns change there will be a shift in the intensity and location of agriculture that is likely to impact fish and wildlife resources. Agricultural lands can provide significant habitat and connectivity between protected conservation areas, but can also compete with fish and wildlife for resources that may become limited due to climate change. Predictions of higher proportion of precipitation in the form of rain with associated loss of snow pack suggests more frequent summer droughts thereby creating conflicts between wildlife and crops. Further impact to fish and wildlife may result from chemical treatment of pests and pathogens that may proliferate within agricultural settings with warming temperatures. Loss of biodiversity may also impact bees that play a critical role in pollinating many food crops. In addition, many invasive species impact both agriculture and native habitats and it is essential that both sectors work together to be effective in implementing our respective climate change adaptation efforts.

Photograph © R.L. Doolin

Carbon Sequestration

Photograph © David Schindler

Carbon sequestration will play an increasingly important role in California's efforts to address climate change impacts on the landscape. Our forests, open spaces and wetlands provide a multitude of benefits and are among California's most important tools in the fight to reduce greenhouse gas emissions. They are also home to thousands of native plant and animal species. Forests and other natural landscapes play a key role in regulating the amount of carbon in the atmosphere. If properly managed, our public and private forests, open spaces and wetlands have the potential to capture and sequester a significant amount of greenhouse gases while simultaneously providing habitats necessary for the long-term conservation of California's fish and wildlife. In fact, California's old growth redwood forests are among the most carbon rich forests on the planet. Conversely, the mismanagement and loss of these critical natural landscapes will lead to the continued emissions of greenhouse gases to the atmosphere and accelerate species loss. Resource managers should look for opportunities to support sequestration projects on lands previously converted by urbanization or agriculture. It will be important to identify opportunities for carbon sequestration within conservation areas and other lands when consistent with existing management actions. It will also be critical to avoid converting or degrading existing habitat for unsustainable biofuel production and to avoid use of highly invasive and/or exotic species that could escape and/or spread.

Energy Development

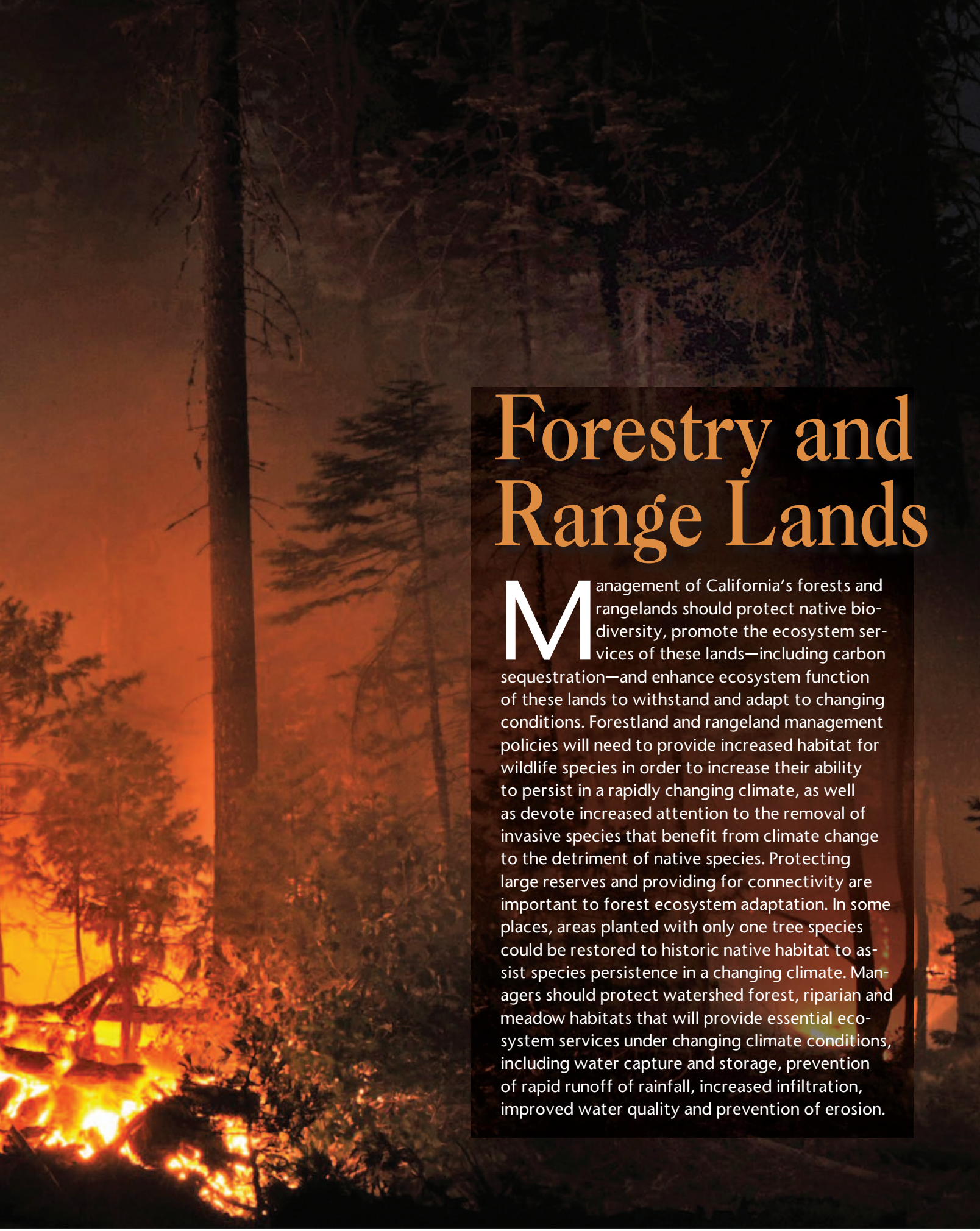
Significant emissions reductions are needed quickly to reduce the rate of climate change to levels that can be managed. However, even if mitigation efforts are successful, the current levels of CO_2 in the atmosphere will continue to cause significant impacts for decades to come. A strategy for meeting the renewable energy goals of the state provides an opportunity to promote the use of ecological conservation, not only for adaptation, but also as a potential component of mitigation strategies. Meeting these important renewable energy development needs in the state will need to be achieved in a collaborative manner to ensure that there is a balance between species conservation requirements and energy siting. Even though each state, federal and provincial agency has specific mandates, authorities and missions, we will all be faced with similar challenges in managing natural resources in the face of growing energy demands. In light of this, collaborative efforts across state lines and across organizations and agencies will be imperative to protect and conserve natural resources while appropriately siting energy projects and creating green jobs. Environmental concerns associated with energy development and production include direct and indirect environmental impacts like habitat fragmentation, habitat loss and mitigation, as well as legal issues; the foremost being the incidental take of sensitive, rare, and state and federally listed species. For example, avoiding the use of highly invasive plants as biofuel crops will diminish the risks of invasions. Managers need to provide energy developers with a better understanding of the impacts of biofuels, wind, ocean/wave, geothermal and solar development on natural resources, including developing eco-friendly standards to guide alternative energy development and requiring pre- and post-project site monitoring to document and address potential ecological impacts in order to strike a balance between energy security/independence and conservation.

Wildfire

Most California natural communities are dependant on fire. Fire suppression or altering wildfire regimes and patterns alters and destabilizes ecosystems resulting in losses to biodiversity. Some of the wildlife benefits of wildfire include the 1) recycling of dead and downed vegetation and creation of new deadwood and snags[2], 2) cycling of soil nutrients, 3) removal of excess, woody vegetation, stimulating herbaceous plants and younger plants to grow and providing food for herbivores, 4) opening up of the under story for browsing and for movement of larger wildlife species and 5) creation of tree holes utilized by cavity-nesting birds, bats and arboreal mammals. These benefits are typically derived from low- to moderate-intensity fires. The more frequent high-intensity wildfires that California has experienced in recent years, especially in conifer forest systems in the western Sierra Nevada and chaparral communities in southern California, usually do not provide these benefits. In addition, scientists predict that the incidence of high severity wildfire will increase in the southern half of the state as the average temperature continues to rise. Fire management can make our forest more resilient to climate change by restoring natural levels of fire to California's ecosystems where it is appropriate. Increasing encroachment of residential development into the wildlands increases fire risk and complicates fire suppression. Managers across the state must better coordinate to protect the public by making structures in the wildland and urban interface fire-safe while maintaining the important ecological role fire plays on the landscape. Local land use decisions that discourage further conversion of wildlands will help reduce risk to people and wildlife as the climate changes.

[2]One of the most crucial habitat elements for woodland and forest invertebrates, vertebrates, and fungi.

Photograph by Robert A. Eplett, California Office of Emergency Service



Forestry and Range Lands

Management of California's forests and rangelands should protect native biodiversity, promote the ecosystem services of these lands—including carbon sequestration—and enhance ecosystem function of these lands to withstand and adapt to changing conditions. Forestland and rangeland management policies will need to provide increased habitat for wildlife species in order to increase their ability to persist in a rapidly changing climate, as well as devote increased attention to the removal of invasive species that benefit from climate change to the detriment of native species. Protecting large reserves and providing for connectivity are important to forest ecosystem adaptation. In some places, areas planted with only one tree species could be restored to historic native habitat to assist species persistence in a changing climate. Managers should protect watershed forest, riparian and meadow habitats that will provide essential ecosystem services under changing climate conditions, including water capture and storage, prevention of rapid runoff of rainfall, increased infiltration, improved water quality and prevention of erosion.

Oceans and Coastal Areas

Climate change will have direct impacts on existing coastal protected areas such as ecological reserves, wildlife areas, undesignated lands, mitigations sites and easements (including conservation/mitigation banks). Sea level rise and changes in the intensity of storm events could impact low lying coastal areas and result in the loss or inundation of coastal wetlands and dune habitat. Such events could lead to salt water intrusion and loss of fresh water resources for fish and wildlife. Changes in ocean circulation and ocean warming will impact pelagic species distribution and community structure. In addition, ocean acidification is already impacting shellfish species as well as their prey base. Changes to the timing and intensity of freshwater input may impact marine and near shore populations through increased runoff resulting in pollution and sedimentation contamination and shifts in urban growth and development that will place new or increased pressure on existing coastal resources and available habitat. Inundation of coastal infrastructure will cause widespread pollution and contamination further jeopardizing marine and near-marine environments.

Photograph @ Julie Owen

Public Health

The effects of climate change will impact natural ecosystems and species directly and may have substantial public health implications. Changing climates could shift the abundance and geographic distribution of disease vectors and parasites and affect the seasonal occurrence of many infectious diseases causing them to spread or increase their virulence. Specifically, changes in temperature, surface water and humidity may change the habitat of organisms such as mosquitoes and parasites carried by many rodent and bird species. Control, eradication and abatement actions intended to protect public health could result in contamination of water and terrestrial environments and affect the survival and behavior of many non-target organisms. The loss of species could also result in missed opportunities to discover new medicines from plants and animals like the power cancer drug, Taxol, found originally in the Pacific Yew tree. Coordination between the public health community and the Department will help minimize the treatment effect on species and habitats and benefit from combined knowledge and expertise regarding invasive and nuisance species control as well as maximizing continued public use and enjoyment of natural resources.

Photograph @ Kim Cabrera

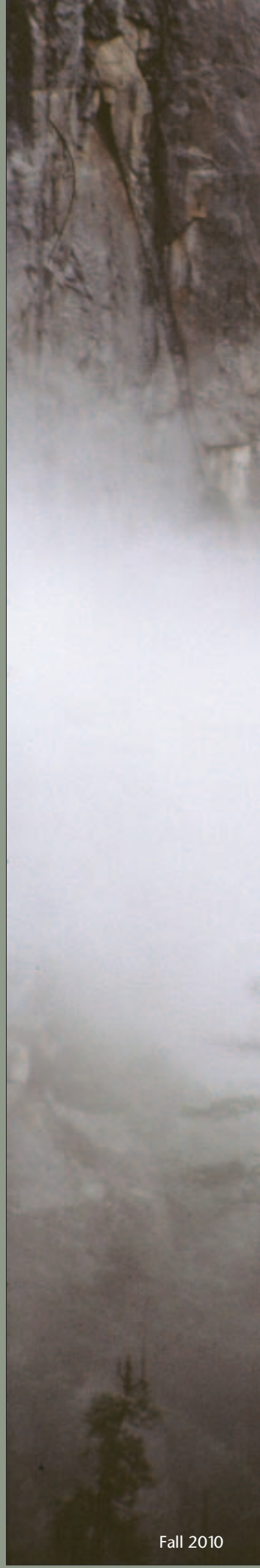
Climate change is expected to have an impact on transportation infrastructure. Issues such as rising sea level and changes in regional temperature may change the nation's road and rail network that could eventually require construction of new infrastructure to respond to the impacts. In planning for expected impacts from climate change the transportation sector should communicate and collaborate broadly to insure that adaptation strategies for protecting natural resources are considered in transportation plans. New and enlarged transportation routes can be designed to create or expand existing conservation areas, promote habitat connectivity, minimize the potential for invasive species and enhance ecosystem function. Care must be taken to avoid the building of new facilities or structures that create unforeseen problems or become out of date—known as maladaptation.

Transportation

Photograph © R.L. Doolin

Water

Changes in temperature and precipitation will likely alter existing fresh water systems and reduce overall availability of water for fish and wildlife species. An increase in flood events would increase bank erosion and amplify movement of pollutants and contaminants. Temperature and precipitation changes will impact a variety of aquatic species and may result in loss and degradation of sensitive aquatic ecosystems and potentially increase invasive species challenges. In addition, these changes will impact groundwater recharge and over drafting—as well as hydropower and hatchery project operations, fish passage and water diversion projects. Changes in vegetation and water demand could all result in increased management conflicts between people and wildlife, requiring greater and more effective communication and collaboration among managers.



Photograph @ Rob Creer

Responding to Change

Actions to Protect California's Natural Resources

The Department takes seriously its responsibility to respond to the challenges associated with climate change and is actively developing a climate change strategy within its management and policy branches and is elevating consideration of climate change into all of its natural resources activities. The Department is committed to a course of action that will result in the conservation of California's natural resources for generations to come.

Creating and Maintaining Climate Change Partnerships

The Department recognizes that it cannot face this challenge alone and is actively developing collaborative partnerships that are creating a collective vision for conservation in the face of a changing climate.

Planning for the Future

The Department is building a foundation of land and resource management planning grounded in science and informed by stakeholders to form its actions for today and tomorrow. The Department is building on existing programs and conducting climate change related research that will frame current and future efforts to protect California's resources for generations to come.

Creating and Maintaining a National, Regional and State Level Presence

The Department serves in a leadership role at the national, regional, and state level to facilitate coordination and collaboration among partners and ensure that fish and wildlife have a voice at the table in climate change adaptation efforts.

DFG File Photograph

Adaptation Planning for Biodiversity Conservation

The Department is an important part of the climate change solution and has been working collaboratively with stakeholders on the creation of adaptation strategies to respond to the impacts of climate change on fish, wildlife and habitats. The Department's adaptation strategy and objectives provide a big picture collective vision of how to respond to the challenges associated with climate change while key planning tools such as California's Wildlife Action Plan and other Department projects and programs provide the mechanism for implementing actions on the ground.

Photograph by Harry Morse

Objective 1: Statewide System of Conservation Areas

Goal: Create a well connected, sustainable system of large scale conservation areas across the state.

Objective 2: Manage for Enhanced Ecosystem Function

Goal: Manage for restoring and enhancing ecosystem function to conserve species, populations and habitats in a changing climate.

Objective 3: Managing Endemic and Other Priority Species Populations

Goal: Evaluate and modify management actions addressing declining and vulnerable populations to pro mote resiliency.

Objective 4: Prioritize Research and Pursue Partnerships

Goal: Prioritize research needs and pursue collaborative partnerships with the research community to ensure that the best available science is informing management actions.

Objective 5: Incorporate Climate Change into Policies and Programs

Goal: Evaluate existing policies and programs to incorporate climate change and seek regulatory changes as appropriate.

For more on the Department's climate change activities, go to *www.dfg.ca.gov/climatechange/*. For information on the California Climate Adaptation Strategy, go to *www.climatechange.ca.gov/adaptation/*.

The Department looks forward to continuing to work with our stakeholders as we craft targeted efforts to respond to climate change and to conserve and protect natural resources in California for many generations to come. The Department will continue to leverage existing programs, projects and partnerships to begin to meet these challenges and to take actions on the ground to conserve and protect California's natural resources in the face of a changing climate. An investment of time and resources now will be small compared to the long-term dividends it will pay for the quality of life for our citizens, the delivery of ecosystem services and conservation of our fish and wildlife.