5. Ecosystems, Species, and Habitats

5. Ecosystems, Species, and Habitats

Washington is home to nearly 600 mammals, birds, fish, amphibians, and reptiles. Among these are the iconic salmon, orca, and bald eagle, as well as game species such as elk, mule deer, ducks, and geese. Our diversity of fish, wildlife, and plants is supported by distinctive habitats and ecosystems, from the grasslands of the rolling Palouse prairie to the glaciated alpine tundra of the Cascade mountains, and from towering Douglas fir forests to the teeming Columbia River estuary.

Washington hosts a large number of imperiled species, listed by federal or state agencies as endangered, threatened, or a species of concern. Their populations have been reduced to the point that they require special attention and management to prevent extinction. Most of these species began their decline due to non-climate stressors such as habitat destruction, degradation, and fragmentation (breaking up of a habitat into smaller units); invasive species; or excessive hunting and fishing. Climate change adds a new stressor, however, that may further weaken already reduced populations and may cause formerly healthy populations to decline.

Ecosystem Products and Services

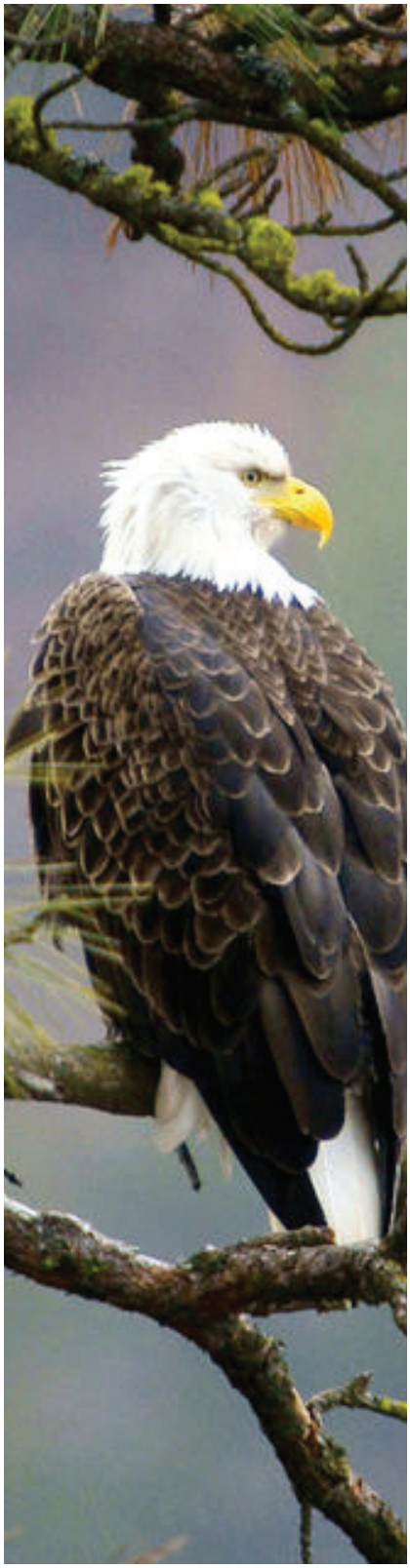
Washington's ecosystems also provide a wide range of products and services that benefit Washington residents, including food, clean water, flood and storm protection, recreation, and cultural heritage. These products and services support millions of dollars of economic activity and a significant number of jobs. Although it is difficult to calculate the full economic contributions of many ecosystem services, the economic value associated with some aspects of ecosystem services have been calculated for Washington. For example:

- Habitat in marine and coastal ecosystems in Washington State sustains commercial and recreational fishing that directly and indirectly supported over 16,000 jobs and $540 million in personal income in 2006.[78]
- Washington's biodiversity supported hunting, fishing, and wildlife viewing activities that added nearly $3.1 billion to Washington's economy in 2006.[79]
- The annual benefit of ecosystem services in the Puget Sound watershed is conservatively estimated to range between $9.7 billion and $83 billion.[80]

Climate change is eroding the valuable benefits and services our diverse ecosystems provide, and the impacts could be costly. The following sections describe the scientific understanding of climate change impacts on Washington's ecosystems, fish, wildlife, plants, and habitats. Following the discussion of impacts are recommended strategies and actions to support state and local efforts to protect these ecosystem assets and lower risks to our environment.

[78] Washington Department of Fish and Wildlife (2008).
[79] U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau (2006).
[80] Batker *et al*. (2010).

Impacts of Climate Change on Ecosystems, Species, and Habitats



Climate change is altering Washington's diverse ecosystems, and the effects are projected to harm many of the benefits we gain from ecosystems. Climate change will likely increase the stress on species that are already sensitive or vulnerable and will reduce the potential for their recovery and protection.

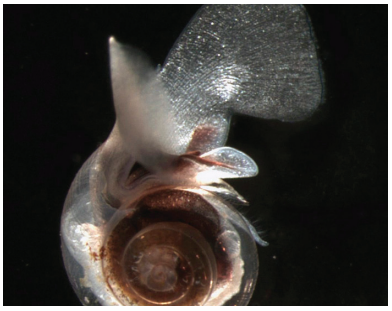
Climate change is expected to affect ecosystems, species, and habitats in at least six key ways:

- Degradation and loss of habitat.
- Increase in major ecosystem disturbances.
- Shifts in geographical ranges of some native plants and animals.
- Change in timing of life history events for plants and animals.
- Declines in species populations and loss of biodiversity.
- Spread of invasive species and disease.

1 Habitat degradation and loss

Changing conditions—such as rising air and water temperatures, increasing sea levels, and acidification of the oceans—will alter, and in some cases, destroy habitats. Existing land use activities and growing pressure from urban development and new infrastructure can increase habitat loss.

The human response to climate change also has implications for species and habitat. As sea levels rise, shoreline armoring may temporarily protect structures from flooding but will also likely eliminate coasts and beaches. Levees installed for flood protection may reduce the quantity, quality, and diversity of riparian habitat for fish.



Coastal areas. Rising sea levels will increase erosion of beaches and flood coastal marshes, tidal flats, and other important habitats for many species of fish and wildlife.[81] In a study of selected sites in Washington, researchers project that a 27-inch rise in sea levels would cause the loss of 58 percent of low tidal areas and 24 percent of freshwater tidal areas. Grays Harbor and Willapa Bay will likely experience the greatest loss of key habitats, although the Lower Columbia estuary will likely gain habitat.[82] Development of coastal areas and shoreline armoring (e.g., bulkheads, seawalls) prevent habitat areas from reestablishing inland.

Marine waters. Ocean waters are becoming warmer, altering the species found in our waters, affecting migration and breeding patterns, and increasing harmful algal blooms. Ocean acidification is a significant problem for species that depend on calcium carbonate to make shells or skeletons, including shellfish, corals, and some types of plankton. This acidification could result in the decline of species that provide the foundation of the marine food web and support commercial fisheries.

Streams and rivers. Warmer temperatures—coupled with resulting reductions in snowpack and water supply, along with increased agricultural and domestic water withdrawals—are projected to further stress the river systems, riparian areas, and springtime pools that are critical to the survival of plants and animals. Rising stream temperatures and lower summer streamflows will reduce the quality and quantity of freshwater habitat for salmon and other coldwater fish.[83]

Mountains. Alpine and subalpine habitats are declining primarily because warmer temperatures are allowing tree lines to advance upwards, thereby squeezing alpine systems. These trends are expected to continue, leading to a substantial decline or potential disappearance of high-elevation tundra and subalpine vegetation in the Olympic Peninsula by 2100. Species that live in these high-elevation systems would need to seek alternative habitats or perish.[84]

Aridlands. Washington's aridlands include habitats ranging from shrub-steppe grasslands, dunes, and the Palouse prairie. These habitats host numerous native plant and animal species. Many of these species already live near their physiological limits for water and temperature

[81] Glick *et al*. (2007).
[82] Ducks Unlimited (2010a, 2010b, 2010c, and 2010d).
[83] Mantua *et al*. (2010).
[84] U.S. Department of Agriculture, U.S. Forest Service (2011).

stress, and projected higher summer temperatures will further stress already vulnerable species. Increased temperatures will also benefit invasive species such as cheatgrass, which thrives in hot, open environments and crowds out native species.

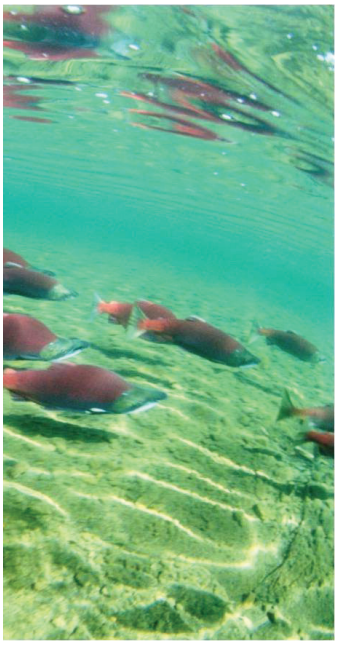
2 Increase in major disturbances

Climate impacts may occur rapidly through major disturbance events such as wildfires, floods, drought, or disease or insect outbreaks. When climate change exceeds a species' physical or ecological tolerance thresholds, it can trigger rapid and potentially widespread responses. Disturbances are a natural part of ecosystem dynamics, and some disturbances are integral to maintaining healthy ecosystems. However, climate change is affecting when and how often disturbances occur and how large they are, and these events are likely to significantly alter many ecosystems and the animals and plants that depend on them.

In some cases, multiple climate-related disturbances can combine, such as when forest systems are stressed by increased temperatures, reduced snowpack, and reduced summer soil moisture—and then further weakened by mountain pine beetle or other insects or disease.

3 Shifts in geographic range

With higher temperatures and shifts in precipitation patterns, some native plants and animals will no longer be able to thrive in their current ranges. The ranges of many species in the U.S. have shifted northward and upward in elevation.[85] These changes are likely to continue. Shifts in geographic range depend on the availability and accessibility of appropriate habitat and the behavior of the species. Species that can shift their range will require migration corridors that are not restricted by natural landscape features or human development. Freshwater species are likely to be particularly susceptible to climate change impacts because their opportunities for migration and movement may be especially limited.



[85] U.S. Global Change Research Program (2009).

4 Change in timing of life history events

Shifts have already occurred in the timing of the seasons, animal migrations, and other life history events for plants and animals.[86] Spring now arrives on average of 10 days to two weeks earlier than it did 20 years ago in the U.S., the growing season is longer, and many migratory bird species are arriving earlier.[87] Climate change is likely to further alter the timing of life history events for plants and animals.

Of particular concern is the potential for interrupting lifecycle events among species, such as when a bird or insect relies on the timing of a flowering plant. If climate change prevents interactions needed for survival or reproduction, both species could perish.

5 Declines in species populations and diversity

While plants and animals can often accommodate a range of temperature, moisture, and other conditions, climate change is causing changes that occur at a faster rate, with greater intensity, in different patterns, or on a broader spatial scale than many species have previously experienced. Those species that cannot adapt are at risk of extinction.[88] Scientists estimate that 20 to 30 percent of the earth's plant and animal species assessed to date could be at increased risk of extinction if average temperatures increase 2.7°F to 4.5°F.[89]

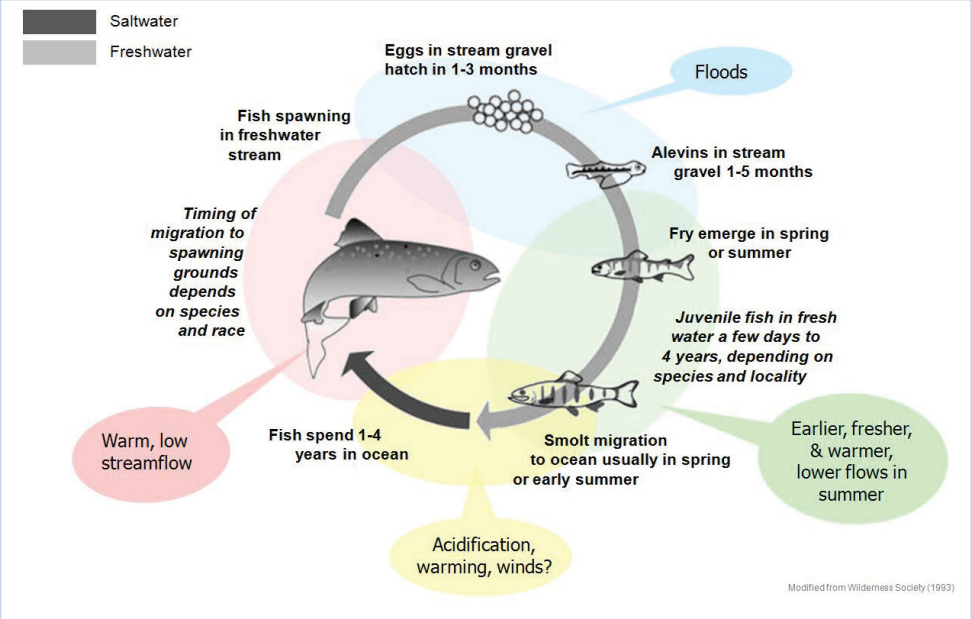


Figure 2. Effects of climate change across salmon life cycle[90]

[86] U.S. Global Change Research Program (2009).
[87] U.S. Global Change Research Program (2009).
[88] Noss (2001).
[89] IPCC (2007a).
[90] Littell *et al.* (2009).

Salmon, already disturbed by a variety of human activities, will be affected by climate change at every stage of their life cycle. Warmer stream temperatures, lower summer streamflows, and changes in the size and frequency of floods will put increasing stress on salmon (see Figure 2). The relative importance of climate factors will vary for different salmon stocks.[91]

The greater sage-grouse is another population that climate change will likely affect. As the impacts of climate change interact with other stressors such as disease and habitat degradation, these birds may be at increased risk of extinction. Under projected future temperature conditions, the cover of sagebrush within sage-grouse territory is anticipated to be reduced due to non-native grass invasions, making the areas prone to destructive fires.

6 Spread of invasive species and disease

Warmer temperatures allow insects and pathogens to expand their range and increase winter survival. Mountain pine beetle, western spruce budworm, blister rust, and needle blight are just a few of the insects and pathogens on the increase in our forests because of climate change. Insects and pathogens affect approximately 3 million acres of Washington's forests, leaving them susceptible to major tree die-offs or fires in the next 15 years.[92] Mountain pine beetle outbreaks in Washington's lodgepole pine and whitebark pine forests are of particular concern because the beetles are spreading rapidly and migrating to higher-elevation trees.

Cheatgrass, another invasive species thriving because of climate change, is replacing native shrubs and grasses and is transforming the remaining shrub-steppe and grassland habitats.[93] Vast areas of shrub-steppe lands have already been converted to cheatgrass over the past century. Once established, cheatgrass is extremely difficult to eliminate.[94] In concert with hotter temperatures and reduced moisture from climate change, cheatgrass tends to increase the size of wildfires, as well as cause the wildfire season to begin earlier and continue longer into the fall. Cheatgrass and other invasive species recover quickly and thrive after fires, at the expense of many native species. Consequently, more frequent fires can lead to irreversible loss of native shrubs and grasses, threatening the habitat of species dependent on the shrub-steppe environment.[95]

[91] Mantua *et al*. (2010).

[92] Seattle Times (2011) citing DNR. See http://seattletimes.nwsource.com/html/localnews/2016699269_barkbeetle06m.html.

[93] Bradley (2009).

[94] Bradley (2009).

[95] Bradley (2009).

Recommended Adaptation Strategies and Actions—Ecosystems, Species, and Habitats

The five strategies and accompanying actions included in this section are intended to sustain species and natural systems as well as the critical ecological services they provide for human health and well-being. The strategies focus on the conservation, restoration, and improvement of ecological functions and processes, and promote ways to help species and ecosystems recover from the impacts of climate change and extreme events.

Strategy B-1. Conserve habitat necessary to support healthy fish, wildlife, and plant populations and ecosystem functions in a changing climate, and protect connectivity areas between critical habitats to allow the movement of species in response to climate change.

Actions:

1. Identify opportunities and priorities for habitat connectivity, such as buffers, wildlife corridors, and a connected network of conservation areas in Washington. This action builds on the work of the Washington Wildlife Habitat Connectivity Working Group and the Western Governors' Wildlife Corridors Initiative.

2. Increase the quantity, quality, and size of conservation areas, buffers, and connectivity corridors using the full range of conservation tools available. This action will enhance key habitat areas, facilitate migration opportunities for species vulnerable to climate change, and increase connectivity in areas at high risk from climate impacts, such as coastal habitats at risk of sea level rise.

3. Encourage partnerships with federal, tribal, and local government, private landowners, and conservation organizations to implement landscape planning and foster adaptation strategies and actions that protect and restore habitat corridors across jurisdictional and land ownership boundaries.

The Western Governors' Wildlife Corridors Initiative: Multi-state collaboration to protect migration corridors

In 2007, the Western Governors' Association (WGA) launched the Wildlife Corridors Initiative as part of its focus on "Protecting Wildlife Migration Corridors and Crucial Wildlife Habitat in the West." The Initiative is a multi-state, collaborative effort to improve knowledge and management of wildlife corridors and crucial habitat. Its main objective is to develop policies and tools to help states integrate important wildlife corridor and crucial habitat values proactively into planning decisions, promote best practices for development, and reduce harmful impacts on wildlife. A 2008 report presents several recommendations, including establishing a regional climate change adaptation information clearinghouse relevant to wildlife corridors and crucial habitat. The clearinghouse should include data and analysis tools, visualization and interactive mapping tools, and state-of-the-art tools to integrate climate predictions with current and future wildlife corridors and crucial habitat.

The clearinghouse will ensure that decision makers can easily obtain the best and most up-to-date scientific and policy information.

www.westgov.org/wga/publicat/wildlife08.pdf

4. Identify high-quality habitats and conservation areas that are minimally affected by (or resistant to) climate change, able to sustain diverse and healthy populations, and can be used as refugia for species under stress from climate change. Prioritize these areas for protection and ecosystem management.

5. Protect and restore high-quality freshwater habitat through the reintroduction of beavers, wetland mitigation and creation, groundwater recharge, flow augmentation, and protection of coldwater springs.

Climate refugia are areas where climate change is likely to occur more slowly or to a lesser extent than other areas, due to physical landscape features, such as north-facing slopes, valleys or other low areas that act as sinks for cold air, or streams fed by deep coldwater springs. These areas provide refuge to species under stress from climate change.

Wildlife habitat connectivity through a climate lens

The Washington Wildlife Habitat Connectivity Working Group is a science-based partnership of land and natural resource management agencies, organizations, tribes, and universities. The Washington Department of Fish and Wildlife and the Washington State Department of Transportation co-lead the working group. The group is conducting detailed analyses aimed at identifying habitat and linkage areas that will most likely continue to provide connectivity as climate changes and to accommodate climate-driven shifts in species ranges.

The first products addressing habitat connectivity and climate change can be found on the Working Group website.

www.waconnected.org/climate-change-analysis

Strategy B-2. Reduce non-climate stressors to help fish, wildlife, plants, and ecosystems be more resilient to the effects of climate change.

Actions:

1. Use and improve existing regulatory and enforcement programs to build the resilience of natural systems to climate change, including such efforts as the following:
   - *Protect and restore the connections between rivers and their floodplains.*
   - *Reduce existing pollution and contamination of freshwaters.*
   - *Manage freshwater withdrawals.*
   - *Maintain and restore streamflows and lake levels.*
   - *Reduce forest fuel buildup.*
   - *Reduce other human-induced impacts in watersheds most vulnerable to climate change.*
2. Define priorities for land management in areas important to biodiversity to emphasize resilience to fire and decrease the likelihood of severe fires.
3. Take early action to eliminate or control non-native invasive species that take advantage of climate changes, especially where they threaten native species or current ecosystem function.
4. Restore riparian zones, estuaries, wetlands, and floodplains by implementing appropriate conservation, restoration, and other land stewardship actions and practices, such as mitigation banking.
5. Collaborate with local governments to reduce and reverse habitat fragmentation and loss through comprehensive land use policies, zoning regulations, critical area ordinances, and other regulatory and non-regulatory approaches.

Changes in hunting and fishing opportunities

In 2008, the Theodore Roosevelt Conservation Partnership (TRCP) and a number of other national hunting and fishing groups produced a successful publication, Seasons' End: Global Warming's Threat to Hunting and Fishing, detailing the predicted impacts of global climate change in the habitat and distribution of fish and wildlife in the United States.

In the 2010 sequel, Beyond Seasons' End: A Path Forward for Fish and Wildlife in the Era of Climate Change, the TRCP and its partners provide recommendations to address the effects of climate change. Since the publication of these reports, the need for adaptation strategies to help fish and wildlife cope with our changing climate has become increasingly clear.

www.trcp.org/issues/climate-change

Mitigation banking is the restoration, creation, enhancement, or preservation of a wetland, stream, or habitat conservation area, for the purpose of providing compensation for unavoidable impacts to ecosystem resources that a proposed project would adversely affect.

Strategy B-3. Manage species and habitats to protect ecosystem functions and provide sustainable cultural, recreational, and commercial use in a changing climate.

Actions:

1. Incorporate climate change considerations into existing and new management plans for protecting sensitive and vulnerable species, using best available science regarding projected climate changes and trends as well as vulnerability and risk assessments. Modify protection and recovery plans to accommodate migration as well as longer-term shifts in species range associated with climate change and its effects.

2. Conduct and refine species and habitat vulnerability assessments (such as the Pacific Northwest Climate Change Vulnerability Assessment for Habitats and Species) and other scientific studies to determine appropriate management approaches.

3. Conserve genetic diversity by protecting diverse populations and genetic material across the full range of species. Such efforts may include identifying areas for seed collection across different elevations and across the ranges of target species.

Assessing the Vulnerability of Species and Ecosystems to Projected Future Climate Change in the Pacific Northwest

The Pacific Northwest Vulnerability Assessment project is designed to assist conservation and natural resource managers in understanding the potential effects of climate change on the species and ecosystems they manage. The project has six specific objectives:

- Downscale future climate simulations for the Pacific Northwest.
- Simulate potential future vegetation and habitat changes using vegetation models.
- Model potential shifts in the distributions of 12 or more focal animal species selected based on discussions with land managers from the region.
- Assess the vulnerabilities of species, ecosystems, and managed lands to projected changes in climate, vegetation, and species distributions.
- Summarize uncertainties in the simulated future climate, vegetation, and species distribution changes.
- Work with managers to incorporate research results into management plans.

An important component of this project involves collaborations with managers, scientists, and decision makers to integrate the research results into management and conservation plans, such as state wildlife action plans.

http://esp.cr.usgs.gov/info/nccwsc/vulnerability/index.html

Strategy B-4. Integrate climate adaptation considerations for species and ecosystems into natural resource and conservation planning, land use and infrastructure planning, and resource allocation and public investment initiatives.

Actions:

1. Incorporate climate change considerations for species, habitats, and ecosystem processes into planning and regulatory activities related to implementation of the Growth Management Act, Shoreline Management Act, Watershed Management Act, State Environmental Policy Act, and other state goals and policies.

2. Ensure that land and water resources managers at the state and local levels integrate adaptation options into plans, programs, and practices. These options should address and limit the impacts of climate extremes, such as severe storms, floods, droughts, and heat waves, without causing harm to fish, wildlife, habitats, and ecosystem functions.

3. Engage with cities and counties to support incorporation of climate change considerations into activities, guidelines, and both regulatory and non-regulatory programs that protect or conserve habitats and species. The changes should consider the impacts of climate change on habitats and species and potential for safeguarding priority habitats and species from the effects of climate change and catastrophic events.

4. Update natural resource protection plans, land use plans, and water resources management plans to address climate change considerations for species and ecosystems and to support habitat resilience in a changing climate.

5. Develop criteria and guidance to consider impacts of climate change on species and ecosystems when funding new infrastructure and economic development, mitigating impacts from ongoing degradation associated with human development, and compensating private landowners for conservation practices.

Strategy B-5. Build capacity and support for the adoption of response strategies that help protect and restore ecosystem function and services at risk from climate change.

Actions:

1. Establish an interagency, multidisciplinary forum (such as an interagency climate change task force) to strengthen existing partnerships and build new collaborations across jurisdictions. The forum would facilitate sharing new research and approaches to address climate impacts to ecosystems and to ensure that the needs of species, habitats, and ecosystems are considered in other areas such as agriculture, forests, infrastructure, and human health.

2. Increase coordination and participation in existing regional and national research and policy forums—such as the National Climate Assessment, Climate Science Centers, Regional Integrated Science and Assessment partnerships, and Landscape Conservation Cooperatives—to ensure that regional efforts recognize Washington's unique and important natural resources.

3. Develop and integrate messages about the benefits of ecological services at risk from climate change into education programs and curriculum related to natural resources management.

4. Initiate and support efforts to quantify the benefits of ecological services and natural systems at risk from climate change. Compare lifetime cost-effectiveness of nature-based versus engineered options for climate response to help identify cost-effective adaptation options.

5. Develop programs to engage citizens in monitoring impacts of climate change on our shorelines, forests, rivers and streams, and other natural systems and in sharing their observations, case studies, stewardship efforts, and other activities using multimedia resources.

6. Coordinate development and maintenance of integrated long-term, large-scale monitoring of early-warning indicators of species responses, including range shifts, population status, and changes in ecological systems functions and processes. Reconsider monitoring approaches to ensure that indicators track changes associated with climate change.

7. Develop applied tools for decision makers and land managers to maximize the adoption of climate adaptation strategies for species and ecosystems. Such efforts may include:

   - *Guidance, tools, and technical assistance to local governments to enable them to identify, designate, and protect locally important habitats, corridors, and species at risk from a changing climate.*
   - *Incentives, tools, and information to increase the contribution of working lands to ecological resilience.*
   - *Tools to promote nature-based alternatives to engineered adaptation options such as flood control, erosion control, and protection of water quality and quantity.*