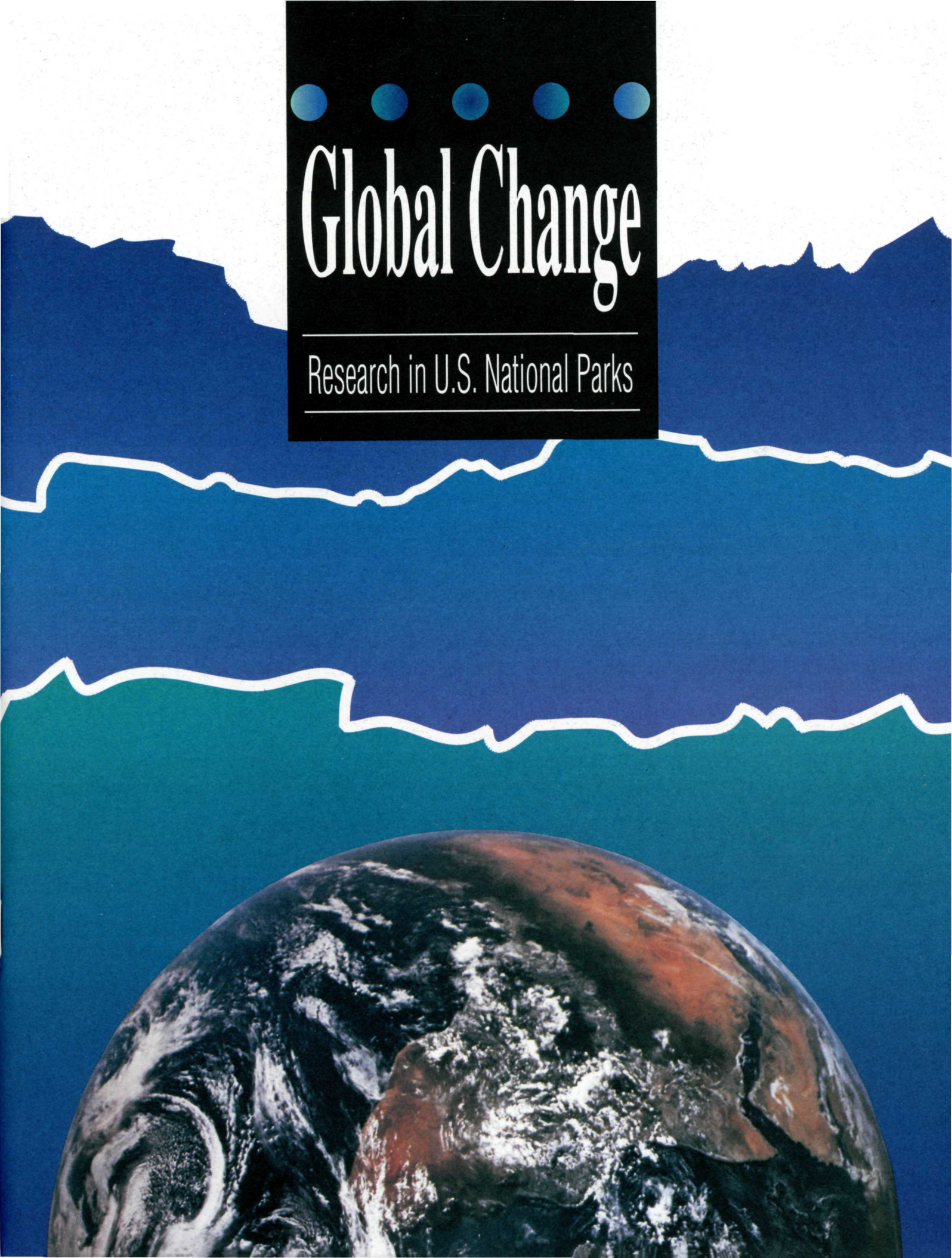
Global Change

Research in U.S. National Parks



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Why Study Global Change in National Parks?

In recognition of the ecological, economic and social implications of global change, the Working Group on Global Change of the Committee on Earth and Environmental Sciences has instituted a comprehensive research program. The focus is on seven scientific areas: ecological systems and dynamics, earth system history, biogeochemical dynamics, solid earth processes, climate and hydrologic systems, human interactions, and solar influences. The National Park Service contributes substantially to the national program through active research in the first five of these areas.

In order to understand and predict the potential impacts of global change, scientists need to study different geographic areas on the ecosystem, landscape, regional and global levels. National parks are ideal laboratories in which to study global change because of their diversity and their comparatively well-preserved ecosystems. Units of the National Park Service (NPS) were established to preserve their natural and cultural resources unimpaired for future generations. Consequently, this system of relatively undisturbed areas across the nation is ideal for the long-term ecological research necessary to study global change and its effects at various scales. National parks contain portions of representative ecosystems in each of the major biogeographic areas of the United States. Furthermore, many parks have site-specific, long-term natural resource data sets that provide the historical framework necessary to interpret existing conditions and predict changes.

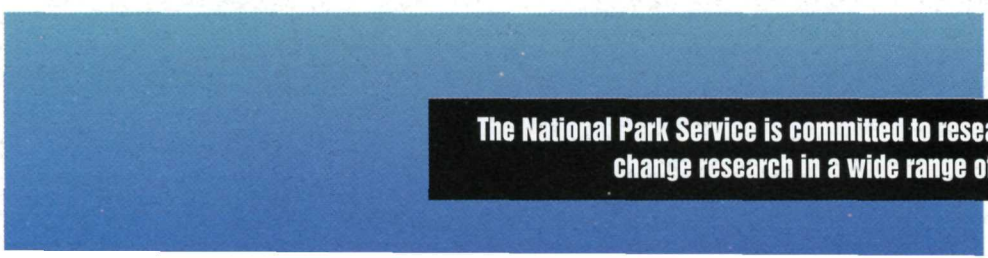
What is the National Park Service Doing?

The National Park Service's biogeographic area research approach is based on the biosphere reserve model, which consists of regional centers for monitoring, research and education in characteristic ecosystems. A typical biogeographic area consists of one or more core research areas, frequently designated as international biosphere reserves, as well as a number of contributing research sites. Altogether, the NPS global-change network consists of 20 biogeographic areas (including 63-plus NPS units) representing all of the United States' major biomes, and three thematic initiatives (involving 15-plus additional NPS units).

The NPS global change research program combines paleostudies, ongoing monitoring, field and laboratory research, and modeling. This will help determine the influence of global change on populations, the structure and functions of ecosystems, and their adaptability.

The program embraces integrated, interdisciplinary studies of park ecosystems, as well as three thematic initiatives that transcend geographic boundaries and study the dynamics of coastal barriers, glaciers and coral reef systems. All of these programs not only increase the understanding of park systems for improved resource management decision-making, but also support the development and testing of regional global-change models.

Throughout its history, the Earth has adapted to both minor and dramatic climatic fluctuations brought on by natural phenomena. Currently, the billions of people that inhabit the planet depend daily on a naturally regulated global system. Population growth, technology and a myriad of other human activities increasingly stress this system, and have the potential to impact the world's natural, cultural and economic resources.



The National Park Service is committed to research and well-appointed to support global change research in a wide range of geographic areas, as detailed herein . . .

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- **10** Channel Islands NP

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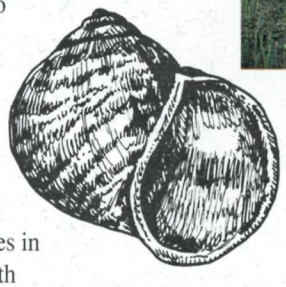
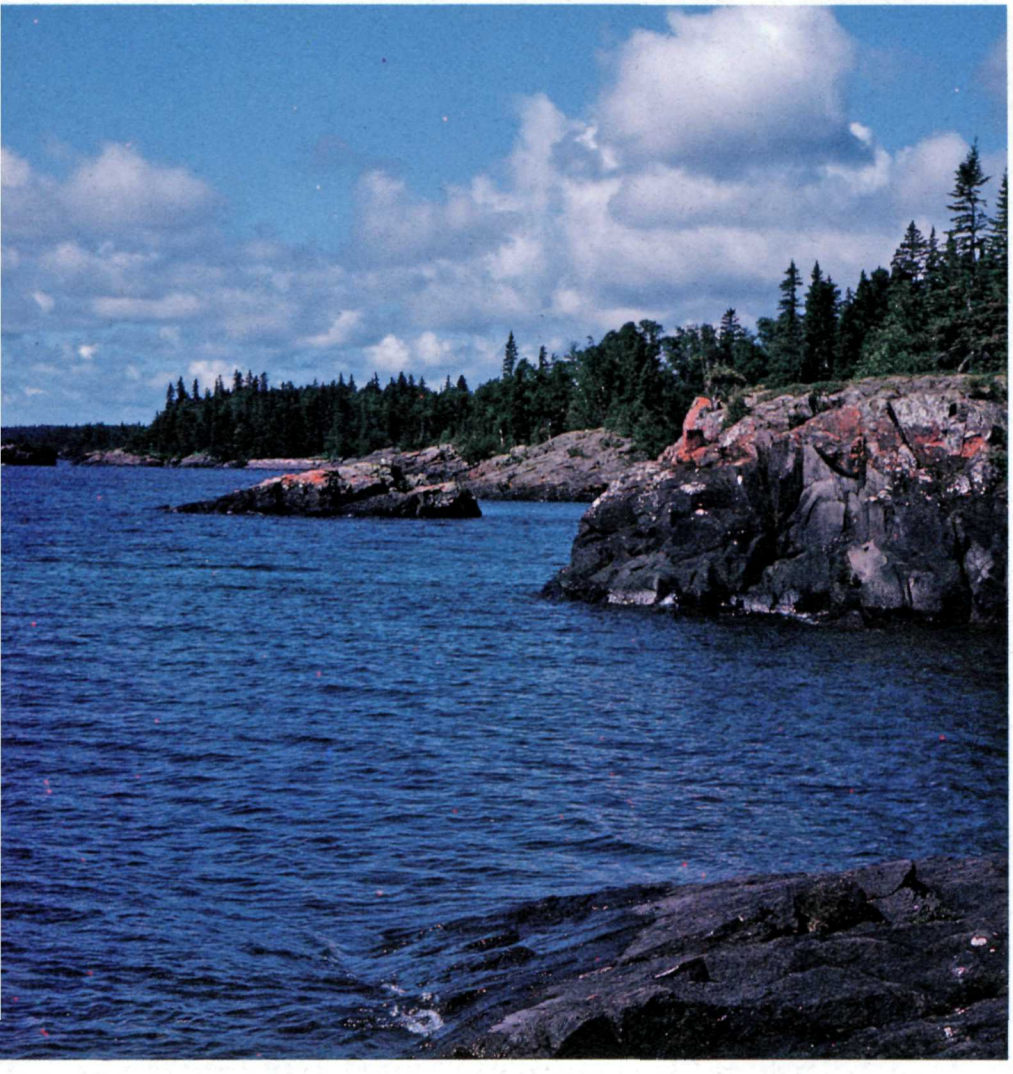
NHP National Historic Park
NHS National Historic Site
NL National Lakeshore
NM National Monument
NP National Park
N PRES National Preserve
NR National River
NRA National Recreation Area
NS National Seashore
NSR National Scenic River or Riverway
PKWY Parkway

South Florida

Covering more than two million acres, Everglades National Park and Big Cypress National Preserve contain the largest remaining subtropical wilderness in the contiguous United States. Extensive wetlands range from saline mangrove forests to freshwater cypress swamps and sawgrass marshes.



These south Florida ecosystems lie within a few meters of sea level. Small changes in global temperature, with corresponding sea level rises, may have dramatic effects. They might inundate freshwater areas and lands near sea level with salt water, dramatically altering the hydrologic balance and delicate ecosystems of the Everglades and Big Cypress. The growing population along the edges of the system depends on water supply from the freshwater wetlands. These conditions make these south Florida NPS units ideal for the study of global change. Global-change research may help determine how to manage the fragile relationship between humans and nature in coastal environments.



Western Great Lakes

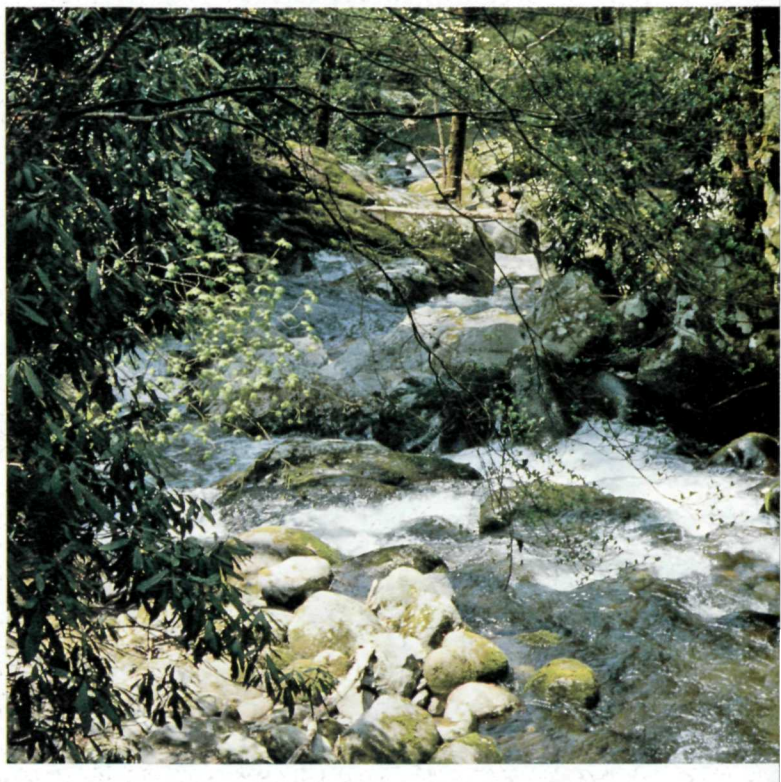
Six NPS units, composed of almost 1.1 million acres, anchor the Western Great Lakes biogeographic area. Within this region are several important ecotones between grasslands, boreal forest and deciduous forest. The NPS units contain portions of these ecotones, providing settings to compare the effects of global change on heavily disturbed areas and relatively undisturbed sites. Their distribution in the region also allows comparative studies of the effects of global change on lake-influenced and continental ecosystems; the isolated species and communities separated from the mainland on Isle Royale National Park are one example.

Global change may create shifts in the locations of ecological boundaries, potentially causing the displacement or migration of species and communities. These ecotonal shifts could be an early indication of climatic change. Such climatic shifts may also affect the traditional small-scale subsistence fishing of Native American societies in the area.

Southern Blue Ridge

Extending through approximately 800,000 acres in the southern Blue Ridge mountains, the Great Smoky Mountains and Shenandoah National Parks and the Blue Ridge Parkway provide outstanding examples of communities within the deciduous forest ecosystems. Several relict species found in the parks exist nowhere else in the region. Global change may cause the loss of species or the migration of others beyond park boundaries, leaving them without a viable range in a fragmented human-dominated landscape. Research may help identify sensitive species and communities, and predict their population dynamics under various scenarios of global change.

The parks also provide settings to study the effects of global change on land-use and visitor-use patterns. Located within a one-day drive of most major eastern U.S. population centers, the parks are important tourist attractions and provide significant economic benefits to the region.



Gulf Coastal Plain

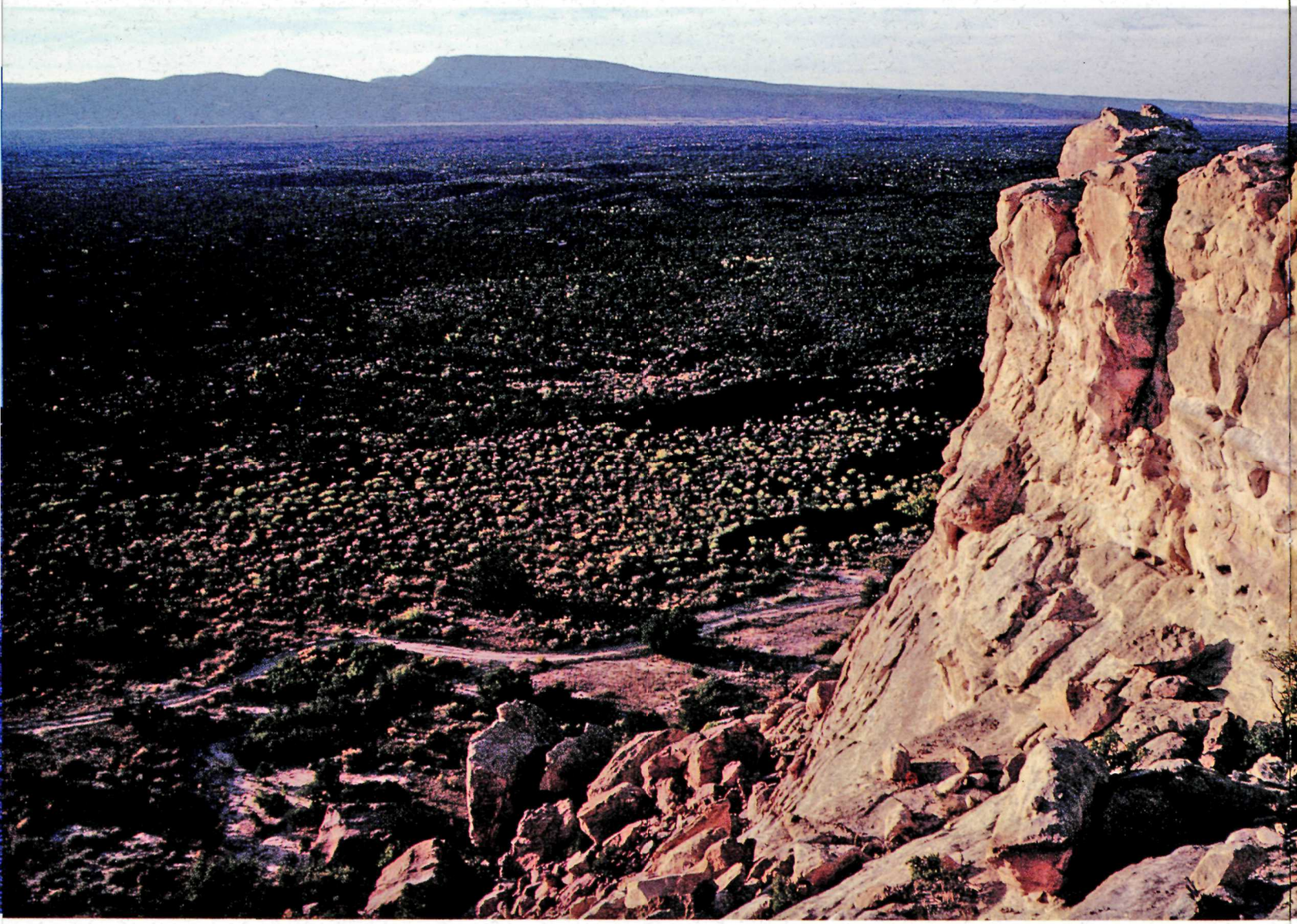
Four NPS units are in the coastal plain and encompass more than 690,000 acres. At the southwestern limit of forested areas in the eastern United States, Big Thicket National Preserve contains a rich array of flora and fauna, many of which may be threatened by global change. The other NPS sites, Jean Lafitte National Historic Park, Big Cypress National Preserve and Congaree Swamp National Monument, contain a variety of swamp communities, allowing comparison of global change effects among similar ecosystems on a bioregional scale.

Big Thicket contains representatives of many of the primary southeastern vegetation types within a relatively small geographic area. Despite its proximity to major developed areas, Big Thicket National Preserve provides an opportunity to study the effects of global change on the prairie/savannah-forest ecotone. The other areas offer a variety of community types that may aid in comparative studies.

Ozark Highlands

The Ozark Highlands biogeographic area centers on two NPS units: Ozark National Scenic Riverways in Missouri and Buffalo National River in Arkansas. Together they encompass almost 200,000 protected acres and more than 260 miles of free-flowing streams.

The Ozark Highlands climate-change program will focus on aquatic resources. Both spring-fed and precipitation-fed streams lie within the park, providing opportunities to compare the effects of global change on different stream systems. Studies such as historic and proxy stream flow records, fluvial geomorphology, and multiple trophic level responses will aid in understanding and modeling the aquatic system under predicted climate change scenarios. Because Ozark Highlands streams are popular for recreation, research on global change effects on Ozark streams could be useful to determine future regional recreation use patterns. This region provides the setting for a variety of integrated social, economic and ecological studies of global change effects.



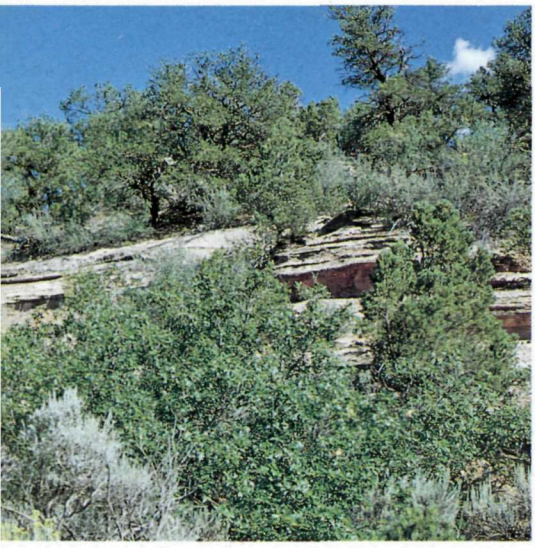
Central Grasslands

Global change models predict that the effects of global change will be more pronounced in the mid-continental areas. The NPS units in the Central Grasslands, containing more than 400,000 acres, are ideal locations to research the effects of global change on the mid-continental grasslands because they preserve much of the intact prairie in the United States.

These units are also widely distributed geographically to permit research and monitoring at both the community and landscape levels. If global temperatures increase, or precipitation or other climatic patterns change, certain species native to grasslands may not survive in the new conditions. The results may have economic implications as well. Changes in grasslands ecosystems may help researchers understand potential variations in the productivity and viability of the agriculture that now dominates the region.

Upper Rio Grande Basin

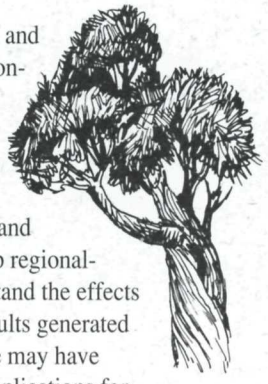
Bandelier and El Malpais National Monuments, almost 150,000 acres combined, are at the core of a Southwestern landscape rich in biological and cultural diversity. This marginal area is potentially sensitive to global change. Records of rapid responses to climate change are written in tree rings and fire scars, ice caves, and flood deposits. Pack rat middens and other historic data reveal shifts in moisture associated with the El Niño phenomenon. Human responses to climate change are found in the well-preserved ruins of transitory hunting camps, cave and cliff dwellings, and pueblos scattered through time as well as space. As a result, this biogeographic region offers unique opportunities to study human interactions with earlier periods of climate change and to predict adaptive human responses to future global climate change.



Colorado Plateau

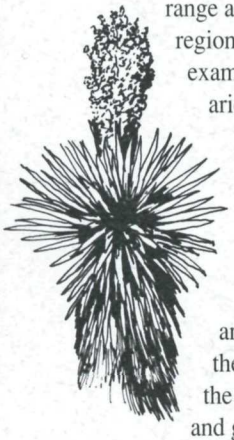
Traversing the Colorado Plateau are more than five million acres of NPS lands. Situated in a transition zone between the hot deserts (e.g, Chihuahuan, Sonoran, Mojave) and the Great Basin cold desert, the plateau has affinities with both. The Colorado Plateau is a large and geographically dispersed unit. It features a wide variety of vegetation types, ranging from subalpine to desert, all potentially subject to impacts from global change.

Changes in storm tracks and precipitation patterns could have significant effects in this transition zone between the winter precipitation-dominated Great Basin and the summer precipitation-dominated Southwest. Observations throughout the region can be made in relatively unimpaired park areas and may be used to develop regional-level models to understand the effects of climate change. Results generated by research of this type may have important economic implications for communities that rely on the Colorado River for electricity, household uses, irrigation and recreation.



Chihuahuan Desert

The four NPS units representative of the Chihuahuan Desert include more than one million acres of west Texas and southern New Mexico. They contain examples of virtually all significant Chihuahuan Desert ecosystems. The parks are the most sizable protected areas within the Chihuahuan Desert, spanning most of the latitudinal extent, elevational range and biological diversity of the region. These parks preserve examples of riparian, desert shrub, arid grassland, and pinyon-juniper communities, as well as relict forest communities comprised of a number of species not found elsewhere in the immediate area.



Because many of the animal and plant populations of the Chihuahuan Desert exist at the margins of their elevational and geographical ranges, they may be particularly sensitive to increasing annual temperatures and decreasing annual precipitation. Therefore, they may be used to provide clues about potential desertification. Data from the Chihuahuan Desert studies may be useful to future studies of global change impacts on economically important rangelands in the region.

Colorado Rockies

With more than 250,000 acres, Rocky Mountain National Park and the surrounding region sit at the headwaters of two major river systems and provide an excellent location to study the effects of global change. The park offers an array of physical and biological systems at high elevations, including glaciers and snow fields, forest-grassland ecotones, diversity of flora and fauna, and vast areas of alpine tundra. The park ecosystems are influenced by the junction of the North Pacific subtropical high pressure system and the jet stream, making them likely to respond rapidly to climatic changes.

Global change may threaten the alpine tundra due to climatic shifts, making vulnerable one of the ecosystems that the park was established to protect. Global change is likely to affect the park's glaciers and permanent snowfields, and therefore alter constant stream flow. The potential for altered stream flow patterns and quantities may have both ecological and economic significance. These river systems feed a rich agricultural region of the Midwest and provide water for communities, agriculture and recreation throughout the Intermountain West.

Greater Yellowstone

Few places capture the world's imagination like the Greater Yellowstone area. Central to the region are the more than 2.5 million acres of Yellowstone and Grand Teton National Parks. Home of one of the world's most active hydrothermal areas, the region provides a rare opportunity to study the effects of global change on such features.

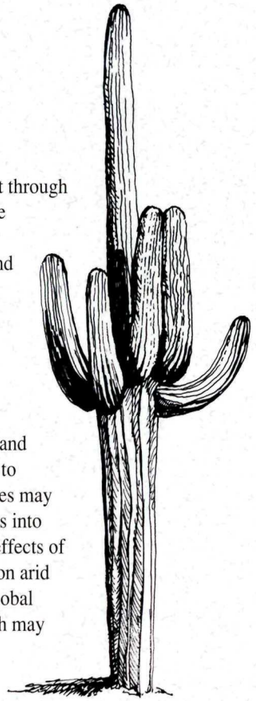
Within this vast Yellowstone territory are many ecosystems intact with minimal disturbance. Terrestrial ecosystems include tundra, boreal forest, dry coniferous forest, and grassland. The parks also contain some of the few remaining watershed systems free from regulation or diversion.

Here are the highest population densities of large and small mammals in the contiguous United States, with many home ranges entirely enclosed within park boundaries. The parks' plant communities contain transitional or ecotonal boundaries that may shift or become less stable under varying global change scenarios.

Sonoran Desert

Covering more than 400,000 acres, the NPS units in the Sonoran Desert preserve desert plant and animal species and communities found nowhere else in the United States. Comparative studies of Organ Pipe Cactus and Saguaro National Monuments provide opportunities to distinguish between species and ecosystem responses to abiotic factors and global change effects as compared with urbanization effects.

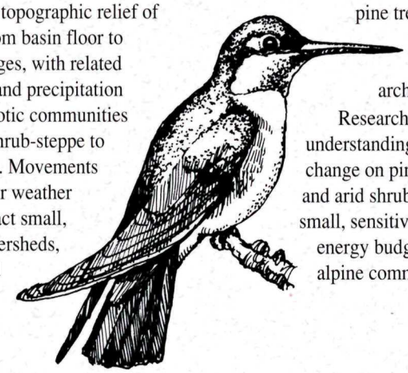
Both NPS units are suitable for monitoring migration and distribution of species and their interactions in changed environments. Small global climate changes may produce large changes in the Sonoran Desert through alteration of the Pacific high pressure cell and its relationship to El Niño and the Arizona summer monsoon. The reactions of sensitive plant and animal species to climate extremes may provide insights into the long-term effects of global change on arid ecosystems. Global change research may also help generate sustainable development strategies for the Sonoran Desert region.



Great Basin

Great Basin National Park encompasses approximately 77,000 acres in east central Nevada. Adjoining federal lands embrace successive north-south-aligned high desert basins and mountain ranges. The park offers abrupt topographic relief of 7,000 feet from basin floor to mountain ridges, with related temperature and precipitation gradients. Biotic communities range from shrub-steppe to alpine tundra. Movements of three major weather systems impact small, sensitive watersheds, unique island biogeography and pristine air quality in the region. These changes are recorded for the last 37,000 years in paleoecological records assembled from fossil woodrat nests and pollen, ancient bristlecone pine tree rings, glacial and cave ice, cave speleothems, and archaeology.

Research may focus on understanding the impacts of global change on pinyon-juniper woodland and arid shrub-steppe dynamics, small, sensitive watershed water/energy budgets, and sub-alpine/alpine community biodiversity.



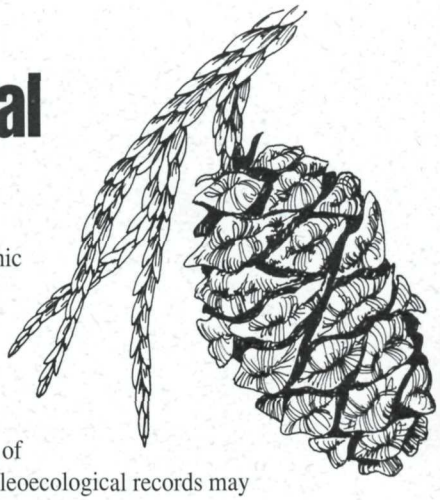
Glacier National Park Area

Covering more than one million acres in northwest Montana and containing almost 50 glaciers, Glacier National Park is exceptionally suited to global change research. The park has international linkages, sharing a common border and a strong cooperative working relationship with Canada's Waterton Lakes National Park. This area affords a vast landscape for study of species, communities, and associated processes. The park contains abundant diversity as a result of its dramatic elevational zonation and uncommon geographic position at the convergence of five floristic provinces and three major watersheds.

Lying between the Rocky Mountains and the Great Plains, the park is influenced climatically by the Pacific Ocean to the west and the arctic-boreal region to the north.

Because of the park's geographic location and topography, many species exist at range margins. The park has a number of isolated populations in distinct elevational zones. These factors increase resource sensitivity to climatic change and thus are important elements in global change research and modeling.

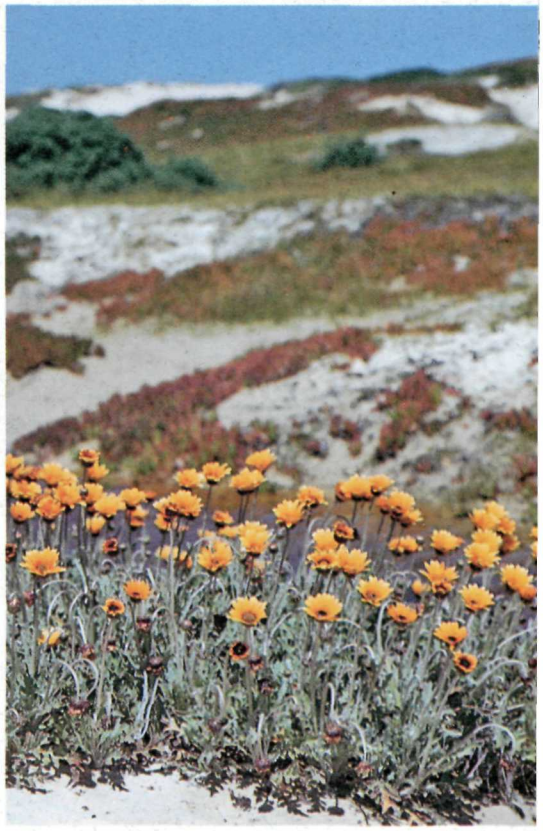
Southern and Central Sierra Nevada



The Southern and Central Sierra Nevada biogeographic area contains two-thirds of the mountain range. It includes more than 1.6 million protected acres in Sequoia, Kings Canyon and Yosemite National Parks, and in adjacent national forests, which contain large tracts of wilderness. This area provides opportunities to develop forest dynamics models and to study the effects of climate change on biological communities. Extensive paleoecological records may help predict future biological effects by chronicling past responses to climate. Elevational gradients in the Sierra range from rolling foothills to the highest point in the contiguous United States. Oak savannahs, chaparral, hardwood forests, dry coniferous and boreal forests, and alpine communities all provide research opportunities.

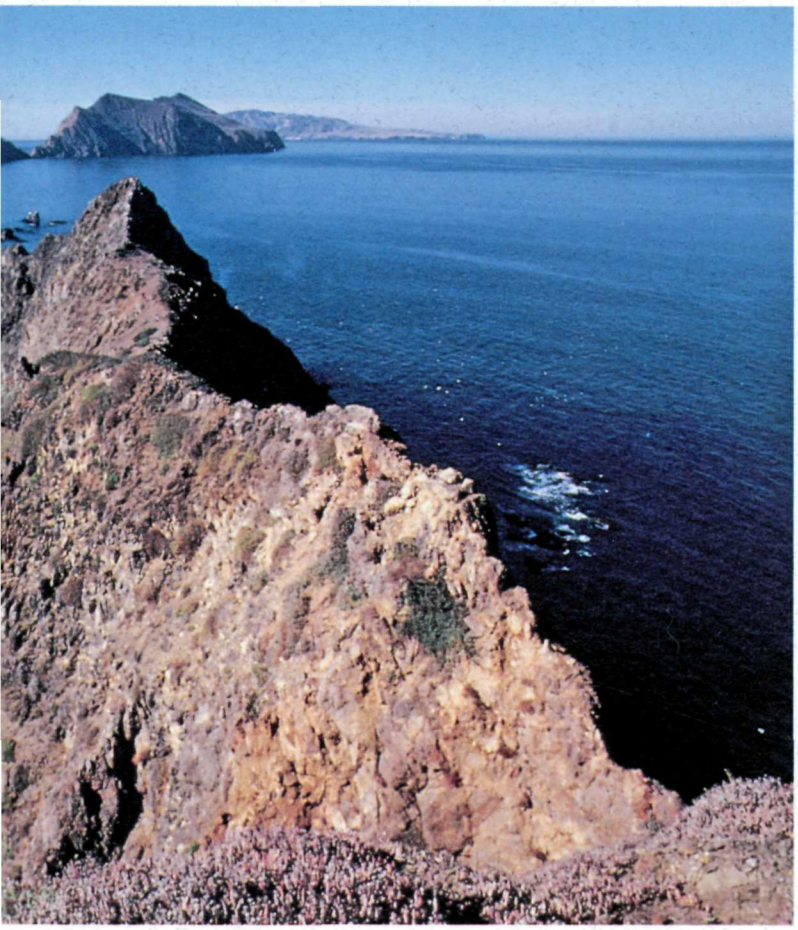
The watersheds of the Sierra Nevada provide much of the water used by agriculture and households in California. Changes in the hydrological regime of these watersheds will provide an early warning of altered future water supplies.

Central California Coast



Point Reyes National Seashore and Golden Gate National Recreation Area, with close to 150,000 acres, are the core of the Central California Coast biogeographic area. Located near the boundaries of three terrestrial biogeographic provinces, in an area affected by both maritime and continental climates, they boast a variety of species, including many that are endemic. Seabird and mammal colonies are especially prominent in the area, and the coastal communities offer opportunities for various kinds of research.

Global change may affect the extensive wetlands, marine, intertidal, and terrestrial communities. The range and abundance of species, some at their distributional limits, may also be altered significantly.



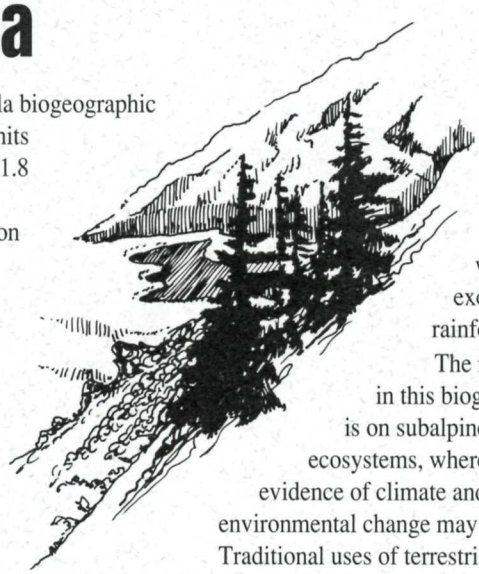
Channel Islands

The five islands and surrounding waters that constitute Channel Islands National Park encompass approximately 250,000 acres off the southern California coast. The park's ecosystems are dominated by the effects of oceanic circulation and upwelling, which could be significantly altered by global change. Its location along a major biogeographic boundary results in high biological diversity and productivity, including many endemic species and other species at their range boundaries, with marine mammals and seabird rookeries that are found few other places in the world. Fourteen federally protected or threatened and endangered species are found in the park. Some of the few remaining examples of natural Mediterranean ecosystems in North America also exist on the islands. Global change may adversely modify these select habitats and ecosystems.

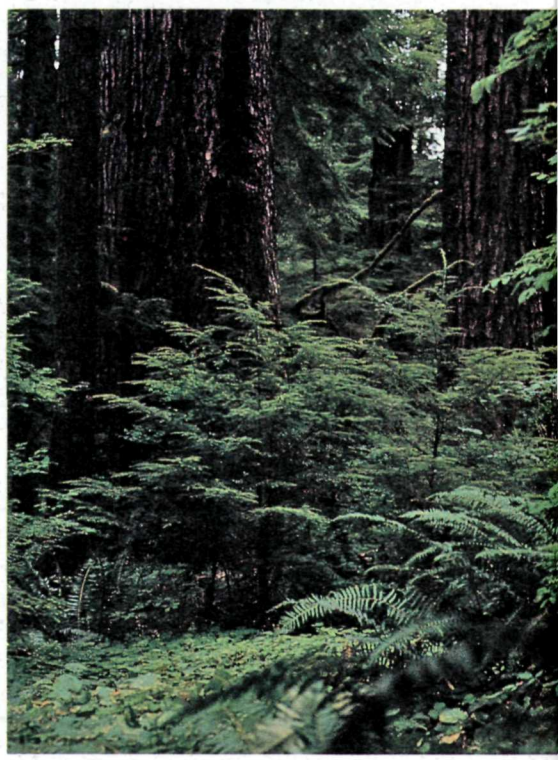
The Channel Islands feature these attributes in a well-defined setting within close proximity to one of the world's largest urban areas. Thus, the site is suitable for both studies that require relatively undisturbed systems and for studies of human-impacted systems, such as global change effects on economics of coastal fisheries.

Olympic Peninsula

The Olympic Peninsula biogeographic area includes four NPS units encompassing more than 1.8 million acres. The steep altitudinal and precipitation gradients of the Olympic Peninsula provide opportunities to analyze the effects of global change on adjacent ecosystems. Temperate rain forest, lowland, montane and subalpine ecosystems all exist along a 6,600-foot elevation gradient within virtually undisturbed wilderness. Other national parks located on the steep slopes of the Cascade Range also contain these ecosystems, with the exception of rainforest.



The research focus in this biogeographic area is on subalpine and alpine ecosystems, where some evidence of climate and associated environmental change may already exist. Traditional uses of terrestrial and aquatic resources by Native Americans provide additional opportunities for ethnographic research.



Northwest Alaska

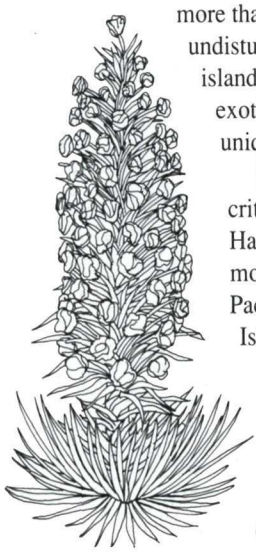
General circulation models suggest that global climate change will be most severe and first detected at high latitudes. The five NPS units in northwest Alaska protect nearly 20 million acres, at or above the Arctic Circle. One of the world's largest river basins with an intact, unaltered ecosystem is also found here.

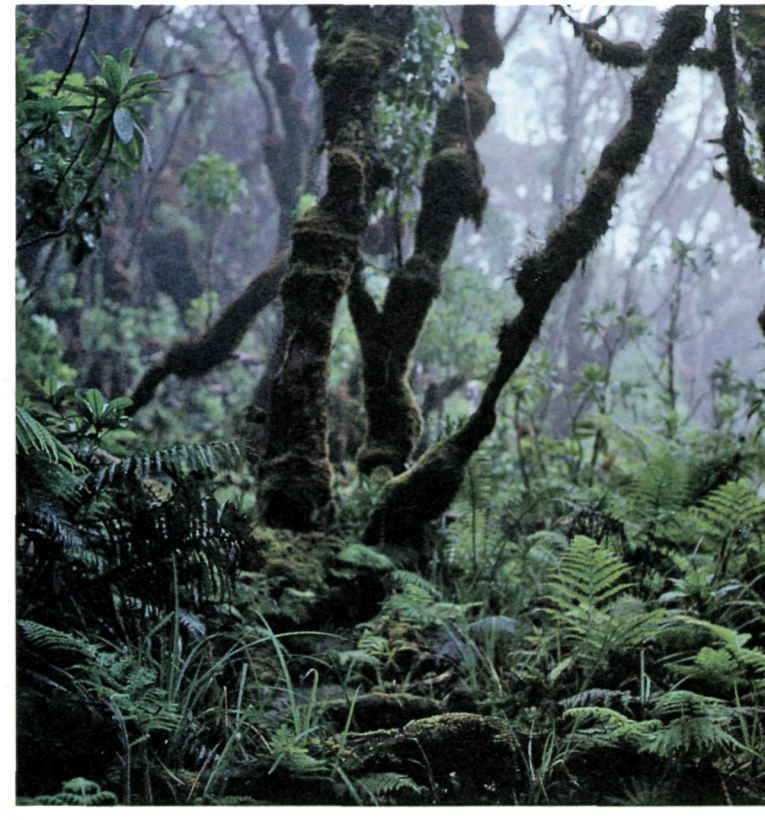
The area's archeological records preserve a history of climate-dependent human and land relations for more than 10,000 years. Global change might significantly affect the subsistence lifestyles of the local people. Thus, this region offers an excellent opportunity to study and predict the responses of indigenous people to climate change across a variety of ecological settings. Research may address many topics relevant to current socioeconomic concerns, such as ecosystem dynamics and biotic community change at the treeline, global gas interactions, permafrost dynamics, biogeochemical cycling, watershed and stream interactions, human ecology, and past changes in Beringian climate and biogeography.

Hawaiian Islands

Haleakala and Hawaii Volcanoes National Parks, with more than 250,000 acres, provide a large-scale, relatively undisturbed wilderness with largely intact ecosystems. The islands' biogeographic history, array of endemic and exotic species, and history of speciation provide a unique laboratory in a vertically zoned environment.

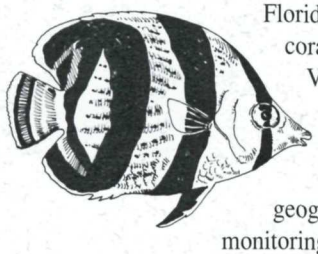
Located to the west of North America and in the critical area of Pacific weather development, the Hawaiian Islands may make a unique contribution to monitoring climatic change. Global change may shift Pacific weather patterns and may make the Hawaiian Islands ecosystems even more vulnerable to the alien species invasions common to island systems. Therefore, prediction of the effects, scale, and scope of global change may play a significant role in decisions affecting park resource management as well as economic and agricultural concerns external to the parks.





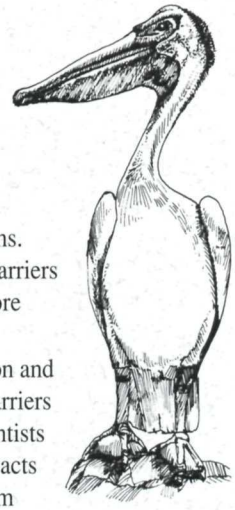
Coral Reefs

NPS units in the Florida Keys and the Virgin Islands contain extensive coral reef systems, all of which may be highly susceptible to the effects of global change. The Biscayne National Park and Fort Jefferson sites anchor both ends of the 200-mile-long Florida Keys coral reef track, and NPS units feature coral reefs off two of the three principal U.S. Virgin Islands.



The distribution of these NPS sites offers opportunities to study the sensitivity of corals to global change factors across a wide geographic area. Comparative research and monitoring are also areas of study among similar coral reef systems that are subject to different degrees of human influence. The predicted effects of global change, such as sea-level rise and temperature increases, may result in a drowning or bleaching of the coral reef systems. Coral-reef research is a critical element in efforts to understand the impact of global change on marine systems.

Coastal Barriers



The coastal barriers are very dynamic systems. NPS units along the Atlantic and Gulf coastal barriers and their low-energy estuarine areas contain more than 500,000 acres.

Because of the wide geographical distribution and relatively undisturbed quality of NPS coastal barriers and their ecologically significant environs, scientists may investigate the physical and biological impacts of changing sea level, storm frequency and storm magnitude on these habitats. Climatic influences on biological communities, coastal barrier transgression and erosion, and the dynamics of tidal marshes may also be studied.

The heavily developed nature of most Atlantic and Gulf coastal areas means that research results could have direct relevance to the economic and social well-being of millions of Americans. These coastal barriers provide protection from the effects of storm surges and severe weather for much of the eastern U.S. coastline.

Glaciers

Accelerated glacial melting, caused by global change, may potentially have tremendous socioeconomic impacts on commercial and subsistence fisheries in downstream areas. Glacial recession may also affect sea level, biodiversity, human water supplies and recreation.

Climate change may be most quickly detected in glacier terminus fluctuations and changes in mass balance. Glaciers store information on past temperature and atmospheric composition.

The NPS units with glaciers are well-distributed for research and offer a range of climates from coastal maritime to interior continental. Glaciers are important in maintaining both world hydrologic balance and sea levels. Isolated, high-elevation glaciers may be greatly reduced or disappear with increased warming.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IN REPLY REFER TO:

January 24, 1992

Dear Colleague:

I am pleased to provide a copy of the National Park Service Global Change Research Program informational booklet. This booklet provides an overview of the Service's program, as well as thumbnail sketches of current and planned research interests.

We are excited by the opportunities that the Global Change Research Program presents for park management and our understanding of global change. We welcome the participation of scientists and managers both within and outside the National Park Service in our efforts.

Peter L. Comanor
Global Change Program Coordinator

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