Climatic Change and Wildland Recreation: Examining the Changing Patterns of Wilderness Recreation in Response to the Effects of Global Climate Change and the El Niño Phenomenon

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Abstract—Impacts of global climate change on the biophysical components of wilderness areas have the potential to alter their recreational utility of wilderness areas. Concomitantly, the frequency and patterns of both land-based and water-based wilderness recreation activities will be affected. Despite the difficulty of responding to the unclear dimensions of global climate change, it is essential for wilderness recreation managers and policy-makers to acknowledge, and make provisions, for the multifaceted implications of these effects. This paper examines the effects of global climatic change on forests and wilderness areas – and, based upon possible scenarios, elucidates some implications of these effects for wildland recreation and for those who plan and manage wilderness recreation resources.

Wilderness management strategies predominantly focus on the regulation, preservation and conservation of wildlife species and ecobiomes by protecting them from human-induced disturbances/interferences such as recreational resource overuse, mining, logging, air and water pollution, acid rain and pesticide contamination, both within and outside designated boundaries (Wright 1992). Today, in addition to the threats posed by anthropogenic activities, natural resource planners and policymakers worldwide are faced with the apparent ecological consequences of global climate change. Changing global climate patterns (global warming, increasing atmospheric CO_2 levels, ozone layer depletion and the El Niño-Southern Oscillation phenomenon) can cumulatively affect wildland ecosystems and environments (Whyte 1995). Effects of climate change on natural ecosystems may be manifested as responses to changes in temperature, precipitation levels, frequency of extreme events (hurricanes, fire, etc.), sea level and soil chemistry, increases in pests and diseases, competition from other ecosystems, and interrelated factors (Houghton and others 1990; Kristiansen 1993; Whyte 1995).

The impacts of global climate change on the biophysical components of wilderness areas will also alter the recreational utility of wilderness areas, affecting the frequency and patterns of both land-based (wilderness camping, hiking/trekking, skiing, snow-boarding, nature study, mountain climbing, etc.) and water-based (fishing, wading, swimming, sailing, canoeing, rafting, etc.) wilderness recreation activities, as well as the safety of wilderness recreationists. Based upon existing research on the effects of global climatic change on forests and wilderness areas, this paper attempts to project possible consequences of this change for wildland recreation and elucidates some implications of these effects for those who plan and manage wilderness recreation resources.

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Impacts of Global Climate Change on Wildlands and Wilderness Recreation

Although the specific impacts of global climate change on wildlands and other natural-ecosystems are uncertain, some clear consequences can be inferred from continuing scientific investigations (Westman and others 1990). Predicted climate changes such as increased atmospheric CO_2 concentrations, global warming and temperature rise, extreme weather events and the El Niño-Southern Oscillation phenomenon are not unique in the Earth's history. However, the predicted changes may occur at a rate that surpasses previously recorded natural fluctuations (Kristiansen 1993). Rapidly changing climatic conditions may severely affect wildland areas and the recreational utility of wilderness regions.

Effects of Increased CO_2 Concentrations

Estimates suggest that atmospheric CO_2 would increase from the present level of approximately 350 ppm (parts per million) to about 450 ppm by the year 2050, and to about 520 ppm by the year 2100 (Houghton and others 1990), even if human-caused emissions of CO_2 could be kept at present rates. Accelerated increase in atmospheric CO_2 will result in the rapid expansion of plant colonies that react positively to increased CO_2 levels (Melillo and others 1990). For example, scrublands will replace grasslands. With increasing levels of atmospheric concentrations of CO_2, the leading greenhouse gas responsible for global warming (now at the highest level in 150,000 years), "the world will likely face a rate of change in the next several decades that exceeds 'natural' rates by a factor of ten" (Flavin and Tunali 1996). While southeastern parts of the United States will experience changes in forest

composition and reductions in the area of healthy forests due to higher temperatures and dry soil conditions that prevent the growth of tree seedlings, the forests of central Michigan (now dominated by sugar maple and oak) might be replaced by grasslands (Hidore 1996). The diminishing capability of these forests to provide suitable resources and opportunities for recreation may decrease participation in wilderness recreation activities by outdoor recreationists and encourage changes in the geographical preferences of wilderness recreationists.

Temperature Rise and Shift in Forest Boundaries

According to recent climate research findings of the United Kingdom's advanced Hadley Center Meteorological Office, global temperatures "are already some 0.6 °C higher than they were at the end of the last century, and global climate will continue to change throughout the next century" (Department of Environment, Transport and the Regions 1997). Forests and wilderness areas respond to global temperature rise and climate change through changes in the distribution of flora and fauna. With shifts in climate and temperature zones, conditions for species may become more or less favorable, and species may retract their ranges where conditions become unsuitable and expand them where conditions improve (Peters and Darling 1985). Excessive heat and associated decreases in soil moisture may cause species to shift to higher elevations as warmer climatic conditions impair chances for species survival and reproduction (Westman and others 1990).

In temperate zones, temperature rises would result in water stress under warmer conditions, air pollution and insect pests would slow the ability of trees to colonize new areas, thus causing species dieback at the southern boundaries of these zones (Whyte 1995). As a result of global temperature rise, forests may experience northward shifts (forest migrations) in species ranges and dieback along their southern edges, accompanied by changes in productivity, soil characteristics, composition and erosion/runoff (Council of State Governments 1994). Since the southern boundary may advance more quickly than the northern boundary, the geographical area of forests would drop if there were a migration rate of 60 miles per century (Hidore 1996). Increased rates of decomposition, weathering and erosion caused by tree mortality along the southern forest boundary will likely reduce stream quality (Botkin and others 1991) in these areas. In response to the gradual inundation of the southern boundary and poor water quality in these areas, wilderness areas along the temperate zones may experience a shift in recreational use patterns, with an incremental shift in use of wilderness resources toward the northern limits of the forests.

Global climate change is likely to have the most impact on geographically localized species of flora and fauna, those found in wildlife reserves and parks, as artificial boundaries and isolation of these sites enhances their susceptibility and sensitivity to the stress and pressures associated with rapid changes in climatic conditions (Westman and others 1990). The effects of global climate change, and effects of the El Niño phenomenon may manifest in the form of species migration, mortality (Trillmich and Dellinger 1991) and even extinction, in some cases. Isolated wilderness areas that are heavily frequented by visitors may experience a decrease in the number of nature watchers, photographers and other types of nonconsumptive recreationists. Decline in wildlife populations may lead hunters to seek other habitats that offer more substantial populations.

In freshwater ecosystems like lakes and streams, decreases of water supply due to warming, disruption of seasonal flows, changes in seasonal runoff patterns and associated alterations in the quantity of nutrients and sediments may result in exacerbated eutrophication, severe reductions in the rate of fish, amphibian and fish-egg survival, fish mortality and aquatic species displacement (Botkin and others 1991), in addition to migration of marine birds to new nesting grounds (United Nations Environment Program 1992). Distortions in normal fish populations and displacements of trophy fish will then affect recreational fishing patterns as fishermen abandon fishing lakes and streams with low fish populations. Freshwater ecosystems with ample fish supplies will experience simultaneous increases in the frequency of use by fishermen.

Extreme Weather Events and the El Niño-Southern Oscillation Phenomenon

The "climate extreme index" developed by the National Climate Center in Asheville, North Carolina, demonstrates that the frequency of extreme weather events (floods, droughts, blizzards, hurricanes, etc.) has been 1.5 times more frequent since the mid-1970s than in the 65 preceding years (Godbey 1997). Water tables and rivers in wilderness areas will frequently dry up as a direct consequence of increasing evaporation rates, due to high levels of carbon emission, and heightened water demand for irrigation (Ayres 1998). In addition, drought-like conditions in wilderness areas, like those in the western United States and eastern Australia, catalyzed by the El Niño-Southern Oscillation phenomenon, could possibly reduce the recreational demand for wild and scenic rivers, lakes, reservoirs, dams and other water-bodies located within wildlands.

Global climate change is expected to increase the frequency and severity of wildfires in forests and wilderness areas, both because of the projected increases in available fuel with increases in primary productivity and the increased amount of dead fuel accumulating as a result of increased mortality (Westman and others 1990). Increased susceptibility of forests to fire damage has been widely predicted as an accompaniment to hotter, drier climatic regimes in areas such as the western and central United States (Whyte 1995). The frequent closure of wildland recreational areas due to fire in these zones, along with concern for safety, may prompt outdoor recreationists to seek wilderness areas less prone to forest fires, such as northern and eastern United States. The combined effect of global warming and the El Niño phenomenon will increase the occurrences of intense monsoons and accompanying torrential rains, possibly causing severe flooding in previously drought-stricken areas, such as parts of southern United States and South America (Department of Environment, Transport and the Regions 1997). The heightened

vulnerability of areas to catastrophic flash flooding may deter recreationists from utilizing wilderness sites in flood-prone regions, and concomitant increases in the use of 'safer' wilderness zones may become evident.

Overall, global climate change studies suggest that increasing atmospheric CO_2 concentrations, global warming and temperature rise, extreme weather events, the El Niño-Southern Oscillation phenomenon and other changing climatic conditions are likely to intensify already increasing pressures on some wilderness areas. Although the impact of global climate change may, in some cases, be less adverse than other pressures on wilderness areas, even relatively small changes can have detrimental effects on the biophysical composition of these regions. Undesirable environmental impacts associated with global climate change on wilderness zones will, undeniably, have far-reaching influences on the use patterns and frequency of wilderness recreation activities in impacted zones.

Implications for Wilderness Recreation Management

Currently, little is known about the problems associated with global climate change, and further scientific inquiry is essential for better understanding of the implications of this phenomenon for wilderness area management and recreation planning in wildland zones. Moreover, current wilderness management policies need to be reevaluated, and new practices will have to be adopted, to counteract the challenges posed to wilderness areas and other natural ecosystems by our planet's changing climatic conditions.

In response to potential reductions in the area of healthy forests due to global warming, ecosystem researchers need to develop measures for reducing species mortality and for re-establishing those habitats prone to deterioration, especially along southern forest boundaries, by providing suitable soil conditions. Wilderness recreation areas susceptible to deterioration from increased atmospheric CO_2 levels will have to be managed with the objective of maintaining habitats that would continue supporting wilderness recreation activities while tolerating increased CO_2 levels. This would be done by developing diversified and resilient ecosystems with higher CO_2 absorption rates capable of effectively withstanding the effects of global climate change (Council of State Governments 1994) and recreation activities in wilderness recreation areas. Worldwide attempts to reduce CO_2 emissions will be accompanied by the replacement of fossil fuels, primarily oil and coal, by solar, geothermal, wind and other renewable forms of energy (Godbey 1997). Accordingly, recreational resource planning and management agencies will be required to enforce rules and regulations designed to minimize and, possibly, exclude fossil fuel-based equipment, devices and vehicles from forests and recreational areas currently allowing their use near wilderness zones. Stringent laws, and growing awareness among recreationists about the effects of human-induced global climate change, will stimulate the use of renewable energy-based recreational equipment in wilderness areas. In the case of wildlife reserves, parks and freshwater ecosystems, information will have to be gathered and disseminated on the relative sensitivities of species to climate and climate change (Westman and others 1990). Based on this information, new conservation strategies will have to be adopted in order to protect individual species according to how tolerant they are to climate change variables. In wilderness areas prone to drought-like conditions, it will be necessary to promote alternative seasons for water-based recreational activities. Scientific techniques and simulation models for determining areas susceptible to forest fires need to be developed to predict occurrences and distributions of forest fires and to prevent recreationists from entering/approaching these wilderness areas during such seasons.

While predictions of global climatic change remain ill-defined and unclear, 'the key climate change issue becomes how to prepare in the intervening years' (McAnally and others 1997). Above all, establishment and implementation of appropriate intervention measures for managing the impacts of global climate change on wilderness areas, as well as wilderness recreation activities, must be based on sound and comprehensive information.

Conclusion

The coming period of global climatic change is likely to be erratic and disruptive, and recent studies, as well as reliable global climate change models, predict an increase in the occurrences of floods, cyclones, hurricanes, blizzards and winter storms, droughts, fires and heat outbreaks during the next several decades (Flavin and Tunali 1996). The combined effects of global warming, increasing atmospheric CO_2 levels, ozone layer depletion and the El Niño-Southern Oscillation phenomenon will severely affect the world's natural ecosystems (Kristiansen 1993), including wilderness areas and the recreational use of wildland resources. Despite the difficulty in responding to the unclear dimensions of global climate change, it is essential for wilderness recreational resource managers and policy-makers to acknowledge, and make provisions for, the multifaceted implications of these effects, within current as well as future recreation planning and management policies.

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