



The Western Mountain Initiative

A Network of Mountain Protected Areas for Global Change Research

www.cfr.washington.edu/research.fme/wmi/

Program Report 2006



 **USGS**
Biological Resources



About WMI

The objective of the Western Mountain Initiative (WMI) is to understand and predict the responses – emphasizing sensitivities, thresholds, resistance, and resilience – of Western mountain ecosystems to climatic variability and change.

The rate and magnitude of ecosystem responses to changes in the global atmospheric environment are variable and uncertain, ranging from gradual to abrupt, from moderate to profound. The least understood and least predictable responses are those of greatest importance to policy makers and land managers: responses that are both abrupt and profound. Recent examples of such responses include ongoing drought-induced forest mortality on millions of acres in New Mexico, Arizona, and southern California, and the increasingly large area burned by severe wildfires in the western United States during the past two decades. In both cases, ecosystem thresholds were exceeded relatively quickly, leading to large and often unexpected changes that will have long-term consequences for ecosystem structure, function, and production of goods and services.

In the face of expected climatic change over the next several decades, are significant changes in ecosystem structure and processes likely to become more common? Are these changes predictable? What are the characteristics of ecosystems likely to respond quickly or gradually, profoundly or minimally? How will ecological and economic productivity be affected at various spatial and temporal scales?

Mountain ecosystems of the western United States are ideally suited to address these questions. First, they lend themselves to ecological inquiry because they have: 1) compressed climatic and biogeographic zones containing many ecosystems within relatively small areas; 2) rich paleoecological resources, which record past environmental changes and consequent ecosystem responses; and 3) common ecological drivers, such as snowpack, which facilitate comparisons across ecosystems. Second, because national parks and wilderness of the montane West have experienced minimal human disturbance, effects of environmental changes on ecosystems can be inferred with fewer confounding influences than on intensively managed lands. Third, Western mountain ecosystems are important to society, providing water, wood products, carbon sequestration, biodiversity, and recreational and spiritual opportunities. Finally, more than a decade of USGS research at seven Western mountain parks provides the foundation for broad syntheses of existing knowledge.

WMI Highlights in Ecosystem Research - 2006

- ◆ WMI sponsored and funded a synthesis **workshop on tree-ring and charcoal fire history** research in May 2005 (<http://www4.nau.edu/firehistory/index.htm>), organized by Scott Anderson, Tom Swetnam, Cathy Whitlock, Tom Veblen, and Craig Allen. The purpose of the workshop was to assemble fire historians and fire climatologists from across the western US to discuss their most recent research findings and to develop collaborations, research synthesis products, and a plan for future database development and investigations. Tree-ring/fire scar and sediment/charcoal fire historians were invited, along with fire climatologists, and the workshop was structured to provide opportunities for general interactions among researchers, as well as focused discussions on technical topics specific to each field. A pre-workshop field trip to examine (1) a lake sediment record of fire and (2) forest restoration efforts at the Gus Pearson Natural Area (USFS), both near Flagstaff, set the tone for the workshop, touching on many of the themes subsequently developed in plenary and breakout sessions. Research and summary papers and posters were presented on a wide range of topics, including regional fire history and climate, modern fire climatology, sedimentary charcoal and fire-scar comparisons, methods in fire-scar analysis, and alluvial fire history and climate, among other subjects. In all, 75 professionals and students from five countries participated in the workshop. Subsequent discussion in breakout sessions revolved around pertinent questions relating sediment charcoal and tree-ring proxies of fire to climate records, and issues of methodology in construction of fire histories. The group identified key spatial and temporal gaps in the fire history record, debated priorities for future fire history research, and enumerated some key fire climatology questions that need to be addressed in the coming decade.

One key outcome of the workshop was to work toward a standardization of methodologies – in sedimentary charcoal, fire-scar records, and alluvial charcoal records – to construct fire histories, so that records from different areas can be more easily compared. A second outcome was to establish a list-serve for the paleo-fire community (CHAR-TALK [char-talk@lists.Colorado.EDU]), where ideas among the expanding community could be shared on a more timely basis. It is hosted by NOAA as a service of the International Multiproxy Paleofire Database (<http://www.ncdc.noaa.gov/paleo/impd/paleofire.html>). A third key outcome was to establish and maintain a central access point for modern fire history data, which could be used for calibration of the paleo-record among other important uses. In further follow-up to the 2005 WMI fire history workshop, workshop conveners Tom Swetnam and Scott Anderson have arranged to publish a set of resultant summary papers in a special issue of International Journal of Wildland Fire, titled “Advances in Fire Climatology: Using Modern and Paleofire Data to Understand Long-Term and Broad-Scale Fire Regime Changes in the Western US”. These papers will also be presented in a special session at the 3rd International Fire Ecology and Management Congress (San Diego, Nov. 2006), titled: “Advances in Fire Climatology: Using Modern and Paleofire Data to Understand Long-Term and Broad-Scale Fire Regime Changes in Western North America”.

- ◆ The **Treeline workshop** was held in September 2005 in Glacier National Park, sponsored and organized by George Malanson, David Butler, Stephen Walsh and Dan Fagre. Approximately 35 participants spent three days evaluating and synthesizing the state-of-knowledge of alpine treeline ecotones and treeline dynamics through presentations, discussions and writing. A compilation of break-out session group writing was achieved by the end of the workshop and has been edited into a paper for submission to BioScience. A field trip in Glacier Park provided an opportunity for workshop participants to contrast treeline dynamics with those in other mountain areas. The explicit comparison of treeline environments in western mountains continued in 2006, and an update will be provided by George Malanson at the MTNCLIM meeting at Mt. Hood in September 2006.
- ◆ Don McKenzie, representing WMI, was the session chair for "Pollution effects in mountain ecosystems", held at the **Open Science Conference on Global Change in Mountain Regions in Perth, Scotland**, October 2005, also attended by Jill Baron, Dan Fagre, and Craig Allen. While there, Don helped edit the Research Strategy for the GLOCHAMORE consortium, an international group helping guide managers and scientists in planning global change research. With Connie Millar (USFS Research), Craig made overview presentations on behalf of CIRMOUNT and WMI for a working lunch with Russian researchers. Craig also presented an overview paper on climate-induced disturbance interactions in mountains of the Southwest at this international meeting. Jill Baron ran a workshop at the Open Science Conference on the use of models in mountain biosphere reserves.
- ◆ Collaborative research by many cooperators (including Univ. of New Mexico, Los Alamos National Laboratory, New Mexico Tech) continued on the **VC-3 deep sediment core** collected with initial WMI funding support from the Valles Caldera (New Mexico). The basal paleolake sediments found in this ~80 m long core have now been firmly dated to extend back 552,000 years before present. The core is thought to provide a continuous record for at least 150,000 years, covering a time period where almost no paleoenvironmental data exists in western North America, including one full glacial – interglacial – glacial set of climate transitions, as well as major portions of a second interglacial period. Extensive portions of the core exhibit high-resolution laminations, with potential to reconstruct high-resolution (at least decadal to perhaps annual) variations in paleoclimate.
- ◆ Lindsey Christensen is **using the RHESys model as a synthesis tool for WMI** site locations. RHESys is a simulation model that represents multiple and interacting ecological processes both spatially and temporally. The model simulates water, carbon, and nitrogen fluxes over spatially variable terrain and was chosen based on its ability to simulate these fluxes along with climate patterns within a mountainous environment. Model parameterization has been completed for watersheds including the Upper Merced River basin in Yosemite National Park, CA the Snake River basin, CO, and the McDonald Douglas River basin in Glacier

National Park, MO. Modeling parameterization for the Stehekin River basin in North Cascades National Park, WA is underway. Papers are in preparation.

- ◆ Jill Baron is Lead Author for the **Climate Change Science Program Synthesis and Assessment Product** on Adaptation Options for Climate-Sensitive Ecosystems and Resources in National Parks. Her contributing author team includes Craig Allen, Don McKenzie, and Nate Stephenson, in addition to Laura Meyerson, Lance Gunderson, and Erica Fleishman. The writing effort gets underway in 2006, with final products delivered in 2007.
- ◆ Jill Baron represented WMI at the **conference on Ecology in an Era of Globalization: Challenges and Opportunities for Ecological Sciences in the Americas**, Mérida, Mexico in January 2006. She gave an invited talk on “New ecological knowledge? New world order?” in a special session on New Ecological Knowledge and Practices for Society and Sustainability. This information will be included in a workshop summary paper forthcoming in *Frontiers in Ecology and Environment*.
- ◆ Dan Fagre and Nate Stephenson represented WMI at the **CONCORD conference** “Climate Change: Organizing the Science for the American Cordillera” held April 4-6, 2006, in Mendoza, Argentina. Dan and Nate were invited speakers and helped plan for integrated climatic change research along the American Cordillera, from Alaska to Tierra del Fuego.
- ◆ Dan Gavin (Univ. of Oregon) completed WMI-funded work on a **new software package** (CHARSTER) to manage and analyze sedimentary charcoal data that is expected to improve the compatibility of results between researchers, allowing improved data integration between studies and thereby facilitating more extensive geographic syntheses of paleo-fire/climate records.
- ◆ Deborah A. Martin and John A. Moody (USGS-WRD, Boulder, CO) have been partially supported by WMI to compile a cross-site **synthesis of fire-induced changes in runoff and erosion** in Western mountain watersheds, including identification of regional patterns in key knowledge gaps with respect to post-fire watershed behavior. To date they have collected 287 published studies of post-fire runoff and erosion – where possible they have identified the specific latitude and longitude of each fire, extracted information about the scale of the study (plot, hillslope, watershed), and are determining the underlying geology and rainfall regime characteristics. This compilation of post-fire watershed responses will be linked to fire data in the Federal Fire History Database, which currently contains federal land fires from 1980 to 2003. An in-progress manuscript synthesizes their assembled data on post-fire erosion rates for western North America.

Sierra Nevada

Mixed conifer forests in the Sierra Nevada have experienced drought stress in recent years, with considerable mortality in some areas. These forests are particularly susceptible to large fires because of the additional effects of fire exclusion on stand density and fuel accumulation. Also, elevated tropospheric ozone reduces vigor and increases litterfall in ponderosa pine and Jeffrey pine. Finally, the exotic white pine blister rust has caused mortality of sugar pine and increased canopy and surface fuels. Paleoecological data suggest that a warmer climate may cause treeline to rise significantly at some locations.

Sierra Nevada Science Highlights

- ◆ Analysis of long-term forest dynamics data showed that forest mortality rates have increased in the Sierra Nevada over the last few decades. The increasing mortality rates can be linked to increasing drought. A manuscript is near completion.
- ◆ Last year we demonstrated that forest mortality rates follow global and regional patterns of productivity; this year we have focused on determining why. Part of the reason seems to be that climatic conditions favoring rapid tree growth also favor the herbivores and pathogens that attack trees, with implications for how forests might respond to otherwise “benign” climatic changes. A manuscript is near completion.
- ◆ Phil van Mantgem, Nate Stephenson, and Jon Keeley published a paper in *Forest Ecology and Management* analyzing forest reproduction along a climatic (elevation) gradient in the Sierra Nevada. Similar to what we had previously demonstrated for saplings and mature trees, turnover rates (mortality and recruitment) of seedlings decline with increasing elevation (decreasing temperature).
- ◆ The RHESys model was used to assess elevational differences in sensitivity of transpiration rates to climate across the Upper Merced River in Yosemite National Park, CA. At the basin scale, annual transpiration was lowest in both driest and wettest years, and greatest in years of moderate precipitation. Elevational differences in vegetation water use and sensitivity to climate were significant and will likely play a key role in controlling the responses and vulnerability of Sierra Nevada ecosystems to climate change. This manuscript is in internal review prior to submission to *Global Biogeochemical Cycles*.
- ◆ Furthering our efforts to understand climatic controls of forest dynamics, in collaborative work with Adrian Das and John Battles (U.C. Berkeley) we found that probability of tree survival or death can be most accurately predicted if three measures of tree growth are considered: growth rate, growth trend (increasing or decreasing), and number of abrupt growth declines. Our findings have been accepted for publication in *Canadian Journal of Forest Research*.

- ◆ Meghna Tare completed her M.S. thesis on how wildfire risk potential might change in the Sierra Nevada in the face of climatic changes. Low- and high-emission greenhouse gas scenarios both resulted in substantial increases in wildfire risk through the 21st century.

Sierra Nevada Management / Policy Highlights

- ◆ Nate Stephenson addressed several groups of land managers and policy makers at conferences organized by the National Park Service, Society for Conservation Biology, World Wilderness Congress, and National Commission on Science for Sustainable Forestry. In this era of global changes, efforts to restore ecosystems to their “natural” states might inadvertently result in ecosystems that are inherently unstable to novel environmental conditions, potentially leading to the sudden loss of some of the resources we are trying to protect. Useful management alternatives might instead focus on enhancing ecosystem resistance and resilience to stresses, even if resulting ecosystems have “unnatural” structure and composition.
- ◆ Phil van Mantgem spoke to National Park Service managers about the role of park fires and fire management actions (such as prescribed fire and mechanical fuels thinning) in the global carbon cycle. Forested parks can play significant roles as sources or sinks of the greenhouse gas carbon dioxide.
- ◆ Nate Stephenson has been working with Connie Millar (U.S. Forest Service) and Scott Stephens (U.C. Berkeley) on a paper entitled “Global changes and Sierra Nevada forests of the future: managing in the face of uncertainty.” The authors’ premise is that in the face of rapid environmental changes, forest management targets based on the “natural” range of variability are no longer adequate, and new approaches must be developed.

Pacific Northwest

During the past year, WMI PIs in the Pacific Northwest and their collaborators focused on associations between tree growth and climate, particularly for Douglas-fir, fire and climate in the historical and modern record, and the effects of wildfires on air quality in mountain ecosystems. We are also continuing a simulation experiment to examine future scenarios for ecosystem productivity, forest species succession, and changes in disturbance regimes on six representative watersheds across a maritime-continental gradient from the Olympic Mountains to Glacier National Park.

Empirical studies have demonstrated that growth is predominantly water-limited, except for the wettest sites in the Olympic Mountains. This portends broad-scale productivity decreases across the Northwest, as warmer temperatures increase moisture stress in trees at all but the highest elevations. We conducted a regional-scale analysis of historical fire-climate interactions, using 15 sites from southwestern British Columbia to northeastern Oregon. Synchronous fire years, where more than half the sites recorded

wildfires, are strongly associated with extreme drought. Expected associations with multi-year drivers such as ENSO, PDO, and AMO were not evident. This is in marked contrast to historical fire regimes in the Southwest, where ENSO cycles are significantly associated with synchronous fire years. This Northwestern pattern was confirmed by ongoing studies of climate variability and the modern fire record, which show that previous-years' climate is important for predicting wildfire area in the Southwest, but not in northern montane ecosystems. We simulated smoke emissions from wildfires across the western United States for a future decade (2045-2054), using mesoscale climate projections, our climate-fire area models, and the BlueSkyEM smoke-modeling framework. Results suggest increased smoke emissions and decreased air quality will affect northern mountains (particularly the Northern Rockies) in the future.

Based on historical reconstructions and statistical models of 20th century fires, increased fire severity and area burned are expected across the Northwest in response to prolonged and more severe droughts in the 21st century. Forest landscapes across the region may become increasingly vulnerable to synergistic disturbances such as the combination of fires, insect outbreaks, and possible drought-induced mortality such as already being seen in the Southwest. In the Pacific Northwest, disturbance will almost certainly be the dominant force in ecosystem change, acting over much a shorter time span than changes induced by climate warming alone.

Pacific Northwest Science Highlights

- ◆ Models of fire area burned in response to climate were developed for 16 ecoprovinces across the West for the period 1916-2003. Four different patterns of climatic forcings were found, with implications for the relative contribution of climate and fuels to fire extent. The importance of various drought parameters from current and previous year data varied regionally, with different mechanisms in the Northwest vs. the Southwest.
- ◆ A regional-scale, replicated study of the response of montane Douglas-fir to climate was completed, with trees sampled from western Washington (maritime climate) to western Montana (continental climate). The predominant finding is that growth is water limited across the entire region at all elevations. Therefore, increased temperature is expected to cause widespread reductions in growth of Douglas-fir across much of its range.
- ◆ Simulations of future fire scenarios under climate change were conducted for the continental United States, by integrating several models and data bases. Results indicate that warmer temperatures will result in increased fire area, smoke emissions, and regional haze across the northwestern United States.

Pacific Northwest Management / Policy Highlights

- ◆ Large fire years are controlled by climate, principally drought, and only secondarily by fuel configurations, particularly in the interior Northwest. We can therefore expect

overall increases in fire area burned and fire effects in the Pacific Northwest even with increased attention to fuel management or fire suppression.

- ◆ Given the likely increase in fire extent and resulting increase in smoke emissions in the western United States, many areas of the West will not be in compliance with USEPA standards for regional haze. This will have major and potentially costly implications for fire management, prescribed burning, and reduction of emissions from non-fire sources.

Northern Rocky Mountains

Similar to the Pacific Northwest, this region also is experiencing rapid establishment of subalpine forests in meadows. Although the location of altitudinal treeline has not changed in response to climate, there is currently a trend of more upright growth of trees from previous krummholz (shrubby) form. Tree regeneration and growth in this location are also strongly affected by the PDO, with growth and regeneration being high during warm phases the PDO (less snow) and low during cool phases (more snow). Glaciers continue to recede and in some cases disappear as temperatures grow warmer. Crown fire has spread through a large portion of lower-elevation forests during the past decade.

Northern Rockies Science Highlight

- ◆ The past year saw the successful establishment of an index glacier monitoring program at Glacier National Park that is designed to complement glacier monitoring in the North Cascades and Olympic Mountains. The data generated from the Glacier National Park monitoring will directly contribute to the inventory of glaciers in the American West, a WMI effort headed by Andrew Fountain. High-resolution snow measurements and snow density pits provided accumulation data for Sperry Glacier, the primary index glacier. A time-lapse camera, a network of ablation stakes and GPS-mapping of glacier margins provided the ablation data for calculating mass-balance. An automated, remote climate station was installed next to the glacier to provide basin-specific climatic data for possible use in energy balance models of Sperry Glacier. Repeat photography and margin measurements were completed on secondary glaciers in a N-S transect of the northern Rocky Mountains. Significant collaborations were established with Canadian and other partners to extend the tree-ring based reconstruction of past snow and ice balances in mountain areas.

Northern Rockies Management/Policy Highlight

- ◆ A high-resolution tree-ring based reconstruction of natural avalanche frequency and spatial extent in the SW corner of Glacier National Park was completed during the past year. This reconstruction doubled the known avalanches compiled from historic records and recast the role of avalanches for ecologists and policy makers in a different light. Frequency of avalanches also reflected the Pacific Decadal

Oscillation, providing a basis for estimating future avalanche frequency (i.e. multidecadal patterns) and effects of climate change. National Park Service managers are interested in avalanche frequency because of the annual opening of the Going-to-the-Sun Road, concerns about safety for road employees and park visitors, and the central role the Road plays in the regional economy. Avalanche frequency information also is of direct interest to the Burlington Northern railroad and the Montana Highway Department on the southern edge of Glacier National Park.

Central Rocky Mountains

To date, climatic variability has had minimal effects on forests of this region, although some data suggest that upright growth of krummholz trees may be increasing near altitudinal treeline. As in other forests throughout the West, fire exclusion has increased stand density and fuel loading in lower elevation mixed conifer forests. Increased nitrogen deposition appears to be having significant effects on aquatic systems and soils and is a chronic stressor at high elevations. It is anticipated that altered climate and nitrogen deposition may affect biogeochemical cycling in this region.

Central Rockies Science Highlights

- ◆ A climate-plotting web page for analyzing temperature patterns in the United States was developed, including mountainous ecoregions, available at www.nrel.colostate.edu/~jhicke/climate_data. As noted in *Science* magazine, it allows users to specify ecoregions using Bailey's vegetation provinces, and plot long-term temperature records by choosing from three climate data sources: the Historical Climate network (monthly or daily), SNOTEL, or VEMAP 0.5 degree gridded weather data derived from HCN data. The website provides access to temperature data useable for anyone wanting to examine trends over time by elevation, vegetation type, or region.
- ◆ Forest insect outbreaks are postulated to increase with climate change, and with prominent insect outbreaks gaining attention in recent years, the topic has been a source of concern for forest managers throughout the West. Using vegetation and mountain pine beetle life cycle models, spatial patterns of potential outbreaks were analyzed under climate scenarios. They found that the area of climate suitability decreases with warming, except at the highest elevations (3000-3500 m). As climate warms over the next 100 years, the availability of suitable habitat and temperatures become less conducive to bark beetles.

Central Rockies Policy Highlight

- ◆ Atmospheric nitrogen deposition and its effects on Rocky Mountain ecosystems continue as a regional focus. The State, USEPA, and National Park Service signed a Memorandum of Agreement in 2006 that will foster communication on reversing the trend of atmospheric nitrogen deposition increases in the Colorado Front Range. A plan for reversing this trend will be in place by December 2006.

- ◆ The USEPA has notified the State of Colorado that, since Rocky Mountain National Park waters are designated Outstanding Natural Waters, trends of increasing nitrate concentrations in high elevation lakes may constitute impairment under Section 303d of the Clean Water Act. State and WMI scientists are evaluating whether the strong increase in nitrate concentrations since 1998 is due at least in part to significant regional drought conditions. The work provides insight into how climate variability and anomalies influence biogeochemical cycles.
- ◆ The Fort Collins Science Center features long-term research by Jill Baron and colleagues in a special section called “It’s in the air: the ecological effects of nitrogen deposition in Rocky Mountain National Park.” The web site <http://www.fort.usgs.gov/resources/spotlight/itsintheair> links to WMI and other collaborators, along with providing easy-to-understand descriptions and pictures of long-term research in Loch Vale Watershed.

Southern Rocky Mountains (American Southwest)

This region exhibits effects of climatically induced stress, with extensive mortality in forest ecosystems subjected to prolonged drought. Dieback is most prominent in lower elevation and drier conifer forests, with mortality caused directly by insufficient soil moisture in combination with beetle outbreaks. Fuel accumulations throughout Southwestern mountains have created the potential for large wildfires, which are also linked to ENSO cycles (fewer fires during wet El Niño, more fires during dry La Niña). Southwestern forests may be exhibiting some of the first signs of the effects of climatic change in arid Western forests. It remains to be seen whether conifer forests with extensive dieback will regenerate or will change to woodlands and shrublands.

Southern Rockies Science Highlights

- ◆ Craig Allen was a co-author on a widely-publicized article addressing “Regional vegetation die-off in response to global-change type drought”, published in the Proceedings of the National Academy of Sciences, U.S.A. and featured in Science “Editor’s Choice”.
- ◆ Collaborative research continued with Dr. Scott Anderson (Northern Arizona Univ.) on paleoclimate and fire histories from sedimentary records in the Southern Rocky Mountains, including the VC-3 core which shows the potential to reveal climate and fire history patterns across glacial/interglacial climate cycles.
- ◆ Research continued on ecosystem responses to climate variability across montane elevational gradients at Bandelier National Monument (New Mexico), showing strong climate signals in patterns of tree growth, surface-dwelling arthropod abundance and diversity, and runoff and erosion. Hydrologic research is revealing the importance of

climate-sensitive land surface cover characteristics in controlling patterns and rates of soil erosion across multiple spatial scales in semiarid landscapes.

- ◆ WMI provided partial support to initiate dendrochronological research by Dr. Tom Swetnam and Ellis Margolis (Univ. of Arizona) on historic climate/fire relationships in high elevation forests of the Santa Fe River watershed in the Sangre de Cristo Mountains (New Mexico), which was leveraged to secure full support by the City of Santa Fe in a watershed that provides 40% of the water supply for Santa Fe.

Southern Rockies Management / Policy Highlights

- ◆ Craig Allen was an invited participant in the Global Fire Workshop (sponsored by IUCN, TNC, Univ. California-Berkeley) to develop consensus fire regimes for North America, Feb. 2006.
- ◆ Craig Allen is a participant in a group process (initiated with August 2006 workshop in Colorado) to develop state-of-knowledge overviews on historical fire regimes and landscape dynamics in pinyon-juniper woodlands of the West, to support informed land management efforts.
- ◆ Craig Allen provided perspectives in support of a variety of management issues in the Southwest, including (1) sustainability of a proposed biomass-fueled electric generating facility in New Mexico, and (2) state-of-knowledge summaries of historical range of ecological dynamics for the region's primary ecosystems to support new management plans in Arizona and New Mexico national forests.
- ◆ Reprints of two formerly published research articles (on applied historical ecology and ecological restoration of ponderosa pine forests) co-authored by Craig were re-published in the glossy coffee-table book: *Wildfire: A Century of Failed Forest Policy*.

Synthesis and Integration Activities

- ◆ The RHESSys model is being used as a synthesis tool for WMI site locations. RHESSys is a simulation model that represents multiple and interacting ecological processes both spatially and temporally. The model simulates water, carbon, and nitrogen fluxes over spatially variable terrain and can simulate these fluxes along with climate patterns within a mountainous environment. Model parameterization has been completed for watersheds including the Upper Merced River basin in Yosemite National Park, CA the Snake River basin, CO, and the McDonald Douglas River basin in Glacier National Park, MO. Modeling parameterization for the Stehekin River basin in North Cascades National Park, WA is underway.
- ◆ Fire data from throughout the western United States has been analyzed for the period 1916-2003 by Jeremy Littell (Univ. Washington) in collaboration with Dave Peterson, Don McKenzie, and Anthony Westerling (Univ. California-Merced). The

results indicate that the effects of climatic variability and change on annual area burned differ greatly by ecoprovinces, with the relative importance of climatic forcing and fuels varying regionally. The effects of drought (and precipitation) on predisposition to burning vary from one to two years.

- ◆ In the largest study ever conducted on growth of Douglas-fir, Jeremy Littell (Univ. Washington) analyzed the effects of climatic variability on this species ranging from western Washington to western Montana. Sampling was designed to include most of the bioclimatic domain of Douglas-fir throughout its range, thereby allowing broad inferences about growth-climate relationships. The strong effects of drought in nearly all locations provide a unifying principle for interpreting the effects of climate change on this ecologically and economically important species, namely that warmer temperatures will invariably result in widespread growth decreases.
- ◆ Working with Jorge Castro and Regino Zamora of the Universidad de Granada (Spain), Craig Allen has begun three WMI-related collaborations: 1) assessment of climate-induced forest dieback in the mountains of southern Spain (along with linked Glochamore-supported initial efforts to develop a proposal for Europe-wide research on montane forest dieback through the 7th Framework Programme of the European Union); 2) ecosystem effects of post-fire forest treatments in the Sierra Nevada National Park; and 3) discussions on potentials to link the incipient global change research program of the University of Granada with WMI.
- ◆ Craig Allen spent most of Sept-Oct. 2005 on an invited scholar visit to Spain, supported by the Univ. of Alicante and the Valencia regional government. He was hosted by Susana Bautista (Univ. of Alicante) but participated in field reviews of research with many other researchers, focused on post-fire watershed responses and the effects of drought and desertification on runoff, erosion, vegetation dieback, and ecological restoration. Included invited participation in the Society for Ecological Restoration International meeting in Zaragoza, and a restoration workshop in Portugal in October. Craig reciprocally hosted Bautista in New Mexico, continuing collaborative work on these research topics.
- ◆ Working with Alvaro Duque (Universidad Nacional de Colombia, Medellín), Nate Stephenson has begun organizing the Cordillera Forest Dynamics Network of long-term forest research plots. This project is a working group of the larger America Cordillera Transect of climate-related scientific research (<http://mri.scnatweb.ch/content/category/3/45/67/>), born at the CONCORD conference held April 4-6 in Mendoza, Argentina.
- ◆ Jill Baron hosted Dr. Manuel Toro from the Department of Ecology of Inland Aquatic Ecosystems, Center for Hydrographic Studies in Madrid, Spain, for the 2006 year. Dr. Toro assisted with field work and advised on instrumentation issues. Comparisons of lake processes of the Central Rockies with the Sierra de Gredos in Central Spain have begun. Dr. Toro's Fullbright Fellowship enabled him to work with the RHESSys model and adapt it for a watershed in the Sierra de Gredos.

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Abstracts and Presentations

- Allen, C. D. 2005. Bark beetles, climate, and regional-scale vegetation dieback in the Southwestern US. Bark beetle symposium. Snowbird, UT.
- Allen, C. D. 2005. Climate and land use interactions with vegetation change and disturbance processes in mountain ecosystems of the Southwestern USA. Open Science Conference on Global Change in Mountain Regions. Perth, Scotland.
- Allen, C. D. 2005. Cross-scale nonlinearities and interactions among forest dieback, fire, and erosion in northern New Mexico landscapes. Ecological Society of America Annual Meeting. Montreal, Canada.
- Allen, C. D. 2005. Fire in the Southwest. Fourth USGS Fire Science Workshop. Tucson, AZ.
- Allen, C. D. 2005. Landscape change in mountains of the Southwestern USA: Fire, forest dieback, and erosion. Invited open lecture, University of Alicante. Alicante, Spain.
- Allen, C. D. 2005. Water as an ecological factor in the Southwestern USA. Guest lecture, general ecology course, University of Alicante. Alicante, Spain.
- Allen, C. D., K. L. Beeley, and B. F. Jacobs. 2005. Long-term ecological monitoring and restoration of piñon-juniper woodlands at Bandelier National Monument, New Mexico, USA. Society for Ecological Restoration International Annual Meeting. Zaragoza, Spain.
- Allen, C. D. 2006. Climate-induced forest dieback: An emergent global phenomenon? MTCLIM 2006 meeting. Mt. Hood, OR.
- Allen, C. D. 2006. Climate, land use history, forest dieback, fire, and erosion in mountain landscapes of Northern New Mexico. Open lecture, Pajarito Environmental Education Center. Los Alamos, NM.
- Allen, C. D. 2006. Disturbance interactions in mountain landscapes of the Southwestern USA: Climate, land use history, forest dieback, fire, and erosion. Open lecture at University of Granada. Granada, Spain.

- Allen, C. D. 2006. Ecohydrology of pinyon-juniper woodlands in the Jemez Mountains, New Mexico: Runoff, erosion, and restoration. USFS and Society of American Foresters meeting on Ecology and Management of Pinyon-Juniper Ecosystems. Albuquerque, NM.
- Allen, C. D. 2006. Fire, thresholds, and wildland restoration. Invited lecture to University of New Mexico graduate watershed management course. Albuquerque, NM.
- Allen, C. D. 2006. Fire-Human interactions as linked cascading events in the Americas. Ecological Society of America international conference "Ecology in an Era of Globalization: Challenges and Opportunities for Environmental Scientists in the Americas". Merida, Mexico.
- Allen, C. D. 2006. Global change research in the western U.S.: The Western Mountain Initiative. Guest lecture for graduate global change research course, Environmental Studies Dept., Northern Arizona University, Flagstaff, AZ.
- Allen, C. D. 2006. Interactions among climate, dieback, fire, and erosion in forests and woodlands in the Southwest. Presentation to Public Service Company of New Mexico. Albuquerque, NM.
- Allen, C. D. 2006. Interactions among climate, land use history, forest dieback, fire, and erosion in mountain landscapes of Northern New Mexico. Distinguished guest speaker series, Forestry Dept., Northern Arizona University. Flagstaff, AZ.
- Allen, C. D. 2006. Landscape changes, long-term monitoring, and ecological restoration of pinyon-juniper woodlands at Bandelier National Monument, New Mexico. Lecture to "Interpreting and Measuring Indicators of Rangeland Health", BLM National Training Center Course # 1730-37, Santa Fe, NM.
- Allen, C. D., R. S. Anderson, R. B. Jass, J. L. Toney, and C. H. Baisan. 2006. Paired charcoal and tree-ring records of high-frequency Holocene fire from two New Mexico bog sites. Third international fire ecology and management congress. San Diego, CA.
- Allen, C. D. and D. D. Breshears. 2006. Climate-induced forest dieback: A global phenomenon. DIRENET annual meeting. Flagstaff, AZ.
- Baron, J. S. 2005. Consequences of nitrogen deposition in Rocky Mountain National Park - reprise. Colorado Air Quality Control Commission, Denver, CO.
- Baron, J. S. 2005. Consequences of nitrogen deposition in Rocky Mountain National Park. Presentation and field trip, Scripps Howard Institute on the Environment, Boulder and Rocky Mountain National Park CO.
- Baron, J. S. 2005. Consequences of nitrogen deposition in Rocky Mountain National Park. Colorado Institute for Leadership Training, Fort Collins, CO.
- Baron, J. S. 2005. Consequences of nitrogen deposition to Rocky Mountain National Park. Colorado Departments of Environmental Health annual meeting, Aspen, CO.
- Baron, J. S. 2005. Environmental consequences of atmospheric nitrogen deposition to Rocky Mountain National Park. Poudre Golden K Kiwanis Club, Fort Collins, CO.
- Baron, J. S. 2005. Field trip for air quality managers from Colorado Department of Environmental Health and Environment to Loch Vale Watershed.
- Baron, J. S. 2005. Hindcasting nitrogen to determine and ecological critical load. Poster presented at the NADP annual meeting, Jackson, WY.

- Baron, J. S. 2005. Led official field trip on Front Range air pollution issues for American Association of Geographers annual meeting in Denver, CO.
- Baron, J. S. 2005. Rocky Mountain Environment and Society. NREL Fall seminar.
- Baron, J. S. 2006. Mountain Hydrology. Lecture to Colorado State University Watershed hydrology class.
- Baron, J. S. 2006. New ecological knowledge? New ecological order? The scope of human activities on Earth. Symposium "New ecological knowledge and practices for society and sustainability," organized as part of the Ecological Society of America (ESA) Conference on "Ecology in an Era of Globalization," Merida, Mexico.
- Baron, J. S., C. D. Allen, D. McKenzie, N. L. Stephenson, D. Fagre, D. L. Peterson, J. Hicke, P. G. Van Mantgem, L. Christensen, and C. Tague. 2006. Synthesis activities of the Western Mountain Initiative [Abstract]. MTNCLIM conference, Timberline Lodge, Mt. Hood, OR. September 19-22, 2006.
- Baron, J. S., M. D. Hartman, and D. S. Ojima. 2006. Determining critical loads for eutrophication and acidification for alpine ecosystems of the Colorado Rocky Mountains, USA [Abstract]. Proceedings of the Open Science Conference on Global Change in Mountain Regions, Perth, Scotland. In *Global Change in Mountain Regions*, ed. Martin Price, 131-132. Duncow, UK: Sapiens Publishing.
- Baron, J. S., M. Hartman, D. Ojima, B. M. Lafrancois, K. Nydick, H. Rueth, A. Wolfe, and J. Botte. 2005. Nitrogen deposition in the Rocky Mountains: Causes and consequences. Symposium on nitrogen eutrophication in xeric and agricultural systems. Riverside, CA.
- Butler, D. R., G. P. Malanson, S. J. Walsh, L. M. Resler, D. B. Fagre, and C. F. Sawyer. 2005. Multi-scale geomorphic impacts and controls on alpine treeline [Poster]. 36th International Binghamton Geomorphology Symposium, University at Buffalo, SUNY, October 7-9, 2005.
- Christensen, L., J. S. Baron, and C. Tague. 2005. Application of RHESys model to environmental change in western mountain national parks. American Association of Geographers annual meeting, Denver, CO.
- Fagre, D. B. 2005. Adapting to the reality of climate change at Glacier National Park, Montana, USA. First international conference on impacts of climate change on high-mountain systems, University of Zurich and Instituto de Hidrologia, Meteorologia y Estudios Ambientales. Bogota, Colombia, November 21-23, 2005.
- Fagre, D. B. 2005. Climatic variability drives changes to the U.S. Northern Rocky Mountains. Open science conference: Global change in mountain regions, Perth Scotland, October 2-6, 2005.
- Fagre, D. B. 2006. Attended forum "UNESCO-Pro-Natura International Forum on Bio-Carbon Sequestration and Conservation to Combat Climate Change: Promoting Rural Development, Energy Solutions and Biodiversity", UNESCO (United Nations Education, Science, and Cultural Organization) World Headquarters, Paris, France.
- Fagre, D. B. 2006. AWRA banquet speaker, annual meeting, Polson, MT, Oct. 2006
- Fagre, D. B. 2006. Changing climates, changing resources – the future of Glacier National Park. 17th Annual Rocky Mountain State Parks Executive Conference, "State Parks and Tourism – Roles, Relationships and Responsibilities", Glacier National Park, West Glacier, MT.
- Fagre, D. B. 2006. Climate change research networks in western mountains: Added value from scaling up our science. USGS Global Change Research Program Strategic Planning Workshop, Denver, CO.

- Fagre, D. B. 2006. Climatic change and atmospheric deposition: Global changes to a pristine national park. Western Regional Air Partnership meeting, Glacier National Park, West Glacier, MT. September 13, 2006.
- Fagre, D. B. 2006. Glacier National Park and climate change: Past, present and future. Academic awards banquet, Northfield High School, Northfield, Minnesota. Also taped for showing on local Public Broadcasting System TV station.
- Fagre, D. B. 2006. How Glacier National Park responds to climate change: Cascading ecological effects reflect changing water balance. Climate change – organizing the science for the American Cordillera (CONCORD), Mendoza, Argentina, April 4-6, 2006.
- Fagre, D. B. 2006. How Glacier National Park responds to climate change: Cascading ecological effects reflect changing water balance [Abstract]. Symposium on Climate Change: Organizing the Science in the American Cordillera (CONCORD), Instituto Argentino de Nivologia, Glaciologia y Ciencias Ambientales (IANIGLA), Mendoza, Argentina.
- Fagre, D. B. 2006. How Glacier National Park responds to climate change and what it tells us about the future. Community lecture, United Methodist Church, Columbia Falls, MT.
- Fagre, D. B. 2006. How Glacier National Park responds to climate change: Past, present and future. Presentation to Glacier Park Associates, Central School Museum, Kalispell, MT.
- Fagre, D. B. 2006. Invited and sponsored speaker and panel discussant in water resources and climate change session. All South American countries present except Venezuela and all North American countries present as well as multiple international representatives (e.g. World Bank).
- Fagre, D. B. 2006. Invited and sponsored by National Park Service WASO to participate in workshop “World heritage and climate change: expert meeting”, World Heritage Centre, UNESCO (United Nations Education, Science, and Cultural Organization) Headquarters, Paris, France. Provided background materials on Waterton-Glacier International Peace Park, consulted with Deputy Assistant Secretary of the Interior Paul Hoffman and U.S. Ambassador to UNESCO Louise Oliver on climate change issues and the nomination for endangered World Heritage Site status for Waterton-Glacier. Primary emphasis was on adaptation to climate change with endangered status to be decided at July meeting in Lithuania.
- Fagre, D. B. 2006. North-south transect workshop participant, sponsored by Mountain Research Initiative in Bern, Switzerland and Instituto Argentino de Nivologia, Glaciologia y Ciencias Ambientales (IANIGLA), Mendoza, Argentina. Committees are working in hydrology, glaciers, forest dynamics.
- Fagre, D. B. 2006. Participated in CONCORD meeting: Climate Change: Organizing the Science in the American Cordillera, Instituto Argentino de Nivologia, Glaciologia y Ciencias Ambientales (IANIGLA), Mendoza, Argentina.
- Fagre, D. B. 2006. Repeat photos from Grinnell Glacier. Professor Harvard Ayers used these in lecture on climate change. Appalachian State University. Natural resource economics class, Boone, NC.
- Fagre, D. B. 2006. Rocky Mountain high: Global warming in the west. City club of Boise forum, the Grove hotel, Boise, ID. July 24, 2006.
- Fagre, D. B. 2006. Update on glacier and snow research. Western Mountain Initiative annual meeting, Skamania, WA. September 16-18, 2006.
- Fagre, D. B. 2006. The effects of climatic change on Glacier National Park: Past, present, and future. Glacier National Park annual interpreter training workshop, Glacier National Park, West Glacier, MT.

- Fagre, D. B, K. Holzer, B. Reardon, G. Pederson, and L. McKeon. 2006. Repeat photography [Poster]. Waterton-Glacier science and history day, Waterton Lakes, Alberta, July 27, 2006.
- Fagre, D. B, K. Holzer, B. Reardon, G. Pederson, and L. McKeon. 2006. The disappearing glaciers of Glacier National Park, MT [Poster]. Waterton-Glacier science and history day, Waterton Lakes, Alberta, July 27, 2006.
- Fagre, D. B., L. M. McKeon, R. Menicke, and B. Reardon. 2006. Geospatial technologies document the disappearing glaciers of Glacier National Park [poster], 26th Annual ESRI International User Conference.
- Fagre, D. B., G. T. Pederson, S. T. Gray and L. J. Graumlich. 2006. Teleconnections through space and time: Glaciers, water and the West. Session: Climate variability, natural resources, and societies: Perspectives from the past. 36th AMQUA biennial meeting, Bozeman, MT. August 18-20, 2006.
- Fagre, D., G. Pederson, B. Reardon, K. Holzer, and L. McKeon. Climate change in the northern Rockies. USGS Northern Rocky Mountain Science Center all hands meeting and science review, Bozeman, MT.
- Fagre, D. B. and B. A. Reardon. 2005. Glacier studies in Glacier National Park. Brown bag seminar, Glacier National Park. September 14, 2005. West Glacier, MT.
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- Stephenson, N. L. 2005. Biotic consequences of climatic change. Joint USGS - FWS Future Challenges Project, Southwestern Regional Workshop. Sacramento, California.
- Stephenson, N. L. 2005. Biotic consequences of climatic change, and some implications for wildlands management. 8th World Wilderness Congress, "Wilderness, Wildlands and People – A Partnership for the Future," Anchorage, Alaska.
- Stephenson, N. L. 2005. Fire management and the National Park Service mission in an era of rapid global changes. Annual Fire Ecology Meeting, National Park Service, Pacific West Region. Sequoia National Park, California.
- Stephenson, N. L. 2005. Models of vegetation responses to global changes: How good are our assumptions? Seminar Series in Environmental Systems, University of California, Merced.
- Stephenson, N. L. 2005. The era of rapid climatic changes: "Natural" is dead, so now what? Caring for Parks, Caring for People, Acting for the Future, Annual Meeting of the Superintendents of the Pacific West Region of the National Park Service. Portland, Oregon.
- Stephenson, N. L. 2005. The National Park Service mission in an era of rapid global changes: A dinosaur that must evolve or die? Abstracts, *The George Wright Society Biennial Conference on Parks, Protected Areas, and Cultural Sites*, Philadelphia, Pennsylvania.
- Stephenson, N. L. 2005. Three issues with restoring fire and forests. Invited presentation for panel on "Forest Health, Fire, and Biodiversity." The George Wright Society Biennial Conference on Parks, Protected Areas, and Cultural Sites. Philadelphia, Pennsylvania.
- Stephenson, N. L. 2005. Wilderness management in an era of rapid global changes: The death of "natural," and redefinition of goals. Abstracts, 8th World Wilderness Congress, "Wilderness, Wildlands and People – A Partnership for the Planet," Anchorage, Alaska.
- Stephenson, N. L. 2006. A short, biased history of fire ecology and management in the Sierra Nevada. Where fire ecology and management meet (a review of fire research findings and their application in Sequoia and Kings Canyon National Parks). Sequoia National Park, CA.
- Stephenson, N. L. 2006. Ecological restoration in an era of rapid global changes: Potential pitfalls and redefinition of goals. Symposium on Ecological Restoration in a Changing World, annual meeting of the Society for Conservation Biology, San Jose, California.

- Stephenson, N. L. 2006. Fire and climatic change. Where fire ecology and management meet (a review of fire research findings and their application in Sequoia and Kings Canyon National Parks). Sequoia National Park, CA.
- Stephenson, N. L. 2006. Forest management in an era of rapid global changes: Managing in the face of uncertainty. 22nd meeting of the Research Group on Impact of Air Pollution and Climate Change on Forest Ecosystems, International Union of Forest Research Organizations (IUFRO). Sequoia National Park, CA.
- Stephenson, N. L. 2006. Is it possible or desirable to restore "natural" forests and fire regimes in the face of rapid global changes? Forest disturbance, management and biodiversity. Special symposium of the National Commission on Science for Sustainable Forestry. Denver, Colorado.
- Stephenson, N. L. 2006. Organizing a forest monitoring network along the American cordillera. Climate change: Organizing the science for the American Cordillera (CONCORD). Mendoza, Argentina.
- Stephenson, N. L. 2006. Park management in an era of rapid global changes. Where fire ecology and management meet (a review of fire research findings and their application in Sequoia and Kings Canyon National Parks). Sequoia National Park, CA.
- Stephenson, N. L. 2006. Progress toward setting forest structural goals for fire management. Where fire ecology and management meet (a review of fire research findings and their application in Sequoia and Kings Canyon National Parks). Sequoia National Park, CA.
- Stephenson, N. L. 2006. The National Park Service mission in an era of rapid global changes: A dinosaur that must evolve or die? Western ecological research center all-staff training, Bodega Bay, CA.
- Stephenson, N. L. 2006. The National Park Service mission in an era of rapid global changes: A dinosaur that must evolve or die? Sequoia and Kings Canyon management team retreat, Three Rivers, CA.
- Stephenson, N. L. 2006. Understanding and predicting the effects of climatic change on mountain forests. Climate change: Organizing the science for the American Cordillera (CONCORD). Mendoza, Argentina.
- Stephenson, N. L., J. S. Littell, P. J. van Mantgem, D. L. Peterson, and D. McKenzie. 2006. Pervasive climate-mediated changes in Western forests. MTNCLIM 2006 Conference, sponsored by the Consortium for Integrated Climate Research in Western Mountains (CIRMOUNT). Mt. Hood, OR.
- Tague, C., G. Grant, L. Christensen, and J. Baron. 2006. Scale effects underlying spatial patterns of eco-hydrologic processes and their sensitivity to climate variability in the mountains of the western US. AGU Spring Meeting.
- van Mantgem, P. J. 2005. The role of USGS science in America's National Parks. A presentation for a visiting delegation of the Hungarian National Park Service. Sequoia National Park, CA.
- van Mantgem, P. J. 2006. Climate change and the consequences for Sierran forests. A presentation for the interpretive staff of Sequoia and Kings Canyon National Parks. Kings Canyon National Park, CA.
- van Mantgem, P. J. 2006. Forest fires, climatic changes, and climate-friendly parks. Climate Friendly Parks Workshop, Yosemite National Park, California.
- van Mantgem, P. J., and N. L. Stephenson. 2005. Forest changes following first and second entry burns: Twenty-one years of monitoring at Tharp Creek, Sequoia National Park, California. USGS Fire Sciences Workshop, Tucson, Arizona.

WMI in the News

ABC News. By Justin Weinstein. 2006. Made inquiry about the recession on Grinnell Glacier for possible filming project at the glacier as a follow up to Peter Jennings interview with Al Gore in 1997. Provided recent photos of Grinnell Glacier to show how glacier has melted since ABC's visit in 1997.

ABC News Online. 2006. The evidence of global warming around the globe. MT Governor Brian Schweitzer quoted USGS glacier recession prediction for Glacier National Park in interview/helicopter tour with George Stephanopoulos.

ABC TV "This Week with George Stephanopoulos". March 26, 2006. Stephanopoulos and Governor Schweitzer filmed portions of the program during a helicopter tour of Glacier National Park which highlighted the recessions of glaciers in Glacier National Park as one example used for the larger segment.

The American Spectator. By David Holman. March 28, 2006. Schweitzer's Folly. Critical analysis of Schweitzer's climate change stance and climate change research, cites USGS work, repeat photos, and links to USGS web pages.

An Inconvenient Truth. By Al Gore. 2006. Features repeat photos of Boulder Glacier and mention of Gore's 1997 visit to Grinnell Glacier where he learned that the park's glaciers would be gone "within 15 years."

Associated Press. March 10, 2006. Waterton-Glacier conditions up for discussion in Paris. Article about the World Heritage and Climate Change UNESCO meeting, including quote by Dan Fagre about receding glaciers in Glacier National Park.

Associated Press. By Susan M. Castro. June 12, 2006. Received USGS repeat photography website as a resource via Glacier National Park in reference to glacier recession photos of Glacier National Park.

Associated Press. By Susan Gallagher. July 2006. Interviewed Dan Fagre on glaciers and climate change.

Audubon Magazine. By Tom Yulsman. January 2006. Snow Daze. Article about habitat created by avalanches quotes Dan Fagre.

Bakersfield Californian. September 6, 2006. Nate Stephenson was interviewed for an article on the tradeoffs between the two primary tools for reducing wildfire hazard in forests: prescribed fire and mechanical forest thinning.

BBC News. By Richard Black. February 16, 2006. Legal case against US on Climate. Conservation groups file a legal case against the US, arguing that its emissions damage Glacier National Park, article includes USGS data.

Bernice Pauahi Bishop Museum, Honolulu, HI. By Heidi A. Lennstrom. August 11, 2006. Science education group obtained high resolution repeat photos of Boulder Glacier for upcoming exhibit about global warming.

Billings Gazette. By Susan Gallagher (AP). February 17, 2006. Dan Fagre was interviewed and quoted in this article announcing a petition submitted to The World Heritage Committee to list Glacier-Waterton National Park as a UNESCO World Heritage Site in Danger because of climate change effects on glaciers and environment.

Billings Gazette. By Paul Nussbaum. July 17, 2006. Climate changes put national parks at risk. Story on effects of climate change in national parks, including quotes by Dan Fagre.

Billings Gazette. By Michael Stark. November 2005. Requested repeat photographs of glaciers for article on climate change.

Black Diamond Catalog. Keep winter cool, 2004/2005 snow catalog. Cites Glacier National Park glaciers being gone in 25 years, an example of USGS research becoming almost subliminal and in the advertising industry.

Boise Public Radio broadcast. July 24, 2006. Rocky Mountain high: Global warming in the West. Dan Fagre, guest speaker for City Club of Boise Forum, Boise, ID. Radio broadcast of presentation at City Club.

Bozeman Daily Chronicle. Associated Press. February 17, 2006, p. A1, A12. Retreating Glaciers. Front page photo of Dan Fagre, quoted in article about Glacier National Park's bid for 'endangered' status as World Heritage Site, as proposed by ten environmental groups.

Calgary Herald. March 13, 2006. Warming panel looks at Waterton: Group to report to UN on fate of glaciers. Article cites USGS prediction about glaciers melting by 2030 in Glacier National Park.

California Coast & Ocean Magazine. August 8, 2006. Nate Stephenson was interviewed for an article on approaches to managing ecosystems in the face of rapid environmental changes, including climatic change.

CBC TV, Toronto Canada. "The National". By Mirijka Hurko, documentary producer for CBC TV. August 14, 2006. Requested repeat photographs for Canadian TV documentary on climate change.

CBS Radio Network, New York. March 10, 2006. Stephan Kaufman interviewed Dan Fagre about glaciers receding and climate change.

CBSNEWS.com. March 13, 2006. Glaciers melting in Montana park. Dan Fagre quoted about glaciers melting in Glacier National Park in article about its designation as a "World Heritage Site in danger".

The Daily Inter Lake. March 10, 2006. Waterton-Glacier conditions up for discussion in Paris. Article about the World Heritage and Climate Change UNESCO meeting, including quote by Dan Fagre about receding glaciers in Glacier National Park.

The Daily Inter Lake. March 27, 2006. Receding glaciers depicted on new web site. Article about new repeat photography project and website.

The Daily Inter Lake. By Frank Bass and Rita Beamish (AP). June 19 and 20, 2006. Parks under pressure. Two part article about threats to national park lands, included climate change threat in Glacier National Park with statistics on the number of glaciers that have melted.

The Daily Inter Lake. By Susan Gallagher (AP). February 17, 2006, p. A1-A3. Groups: Parks need 'endangered' status. Dan Fagre was interviewed and quoted in this article announcing a petition submitted to The World Heritage Committee to list Glacier-Waterton National Park as a UNESCO World Heritage Site in Danger because of climate change effects on glaciers and environment.

The Daily Inter Lake. By Jim Mann. December 19, 2005. Science such a cool adventure. Article about Dan Fagre's scientific interest, research and newly published book, "National parks and protected areas: Approaches for balancing social, economic and ecological values".

The Daily Inter Lake. By Bill Spence. May 8, 2006. Interviewed Blase Reardon regarding avalanche research and forecasting.

The Daily Inter Lake. By Bill Spence. May 21, 2006. In the start zone. Front page article and photos about Blase Reardon's avalanche research and forecasting position with Glacier National Park road crew.

Digital Library for Earth System Education. November 2005. Has included USGS website "Modeled climate-induced glacier change in Glacier National Park, 1850-2100" to its online library as a resource for electronic materials for scientists, teachers, and the public.

Dinardo Designs. October 2005. Jennifer Brown requested high resolution repeat photo images of Grinnell Glacier for a project called TKF.MMH Science Readers 08, article on fossil fuels in science text.

Discovery TV Channel. March 3, 2006. World premiere at O'Shanaughssy Theatre, Whitefish, MT of film featuring Dan Fagre and climate change research for daily showing to park visitors in visitor centers.

Discovery TV Channel. July 16, 2006. TV Special. Climate change special with Tom Brokaw. Dan Fagre's photos and other USGS climate change materials were requested and sent at their request.

Environmental Defense Fund. January 24, 2006. Statistics to think about during the State of the Union Address, cited USGS prediction that Glacier National Park will lose all glaciers by 2030. Part of "take action" button to send message to congress to take a stand on global warming.

Flathead Living. By Becky Lomax. Nov./Dec. 2005. As glaciers go by - Northwest Montana's ice follows the dodo. Interview with Dan Fagre produced article about receding glaciers and ecosystem changes in Glacier National Park.

The Fort Collins Coloradoan. By Douglas Crowl and AP. March 13-18, 2006. Nitrogen levels growing in nearby national park. Also published in the Estes Park Trail Gazette, the Longmont Daily Times Call, the Loveland Herald, and the Denver Post.

FOX News Channel. By Robert F. Kennedy, Jr. November 13, 2005. The heat is on: The case of global warming. Segment of one hour nationally broadcast TV special, including footage of interview with Dan Fagre at Grinnell Glacier and narrating during helicopter overflight.

France 2 (French Television). June 6, 2006. Nate Stephenson was interviewed for a news piece regarding possible effects of climatic changes on giant sequoias.

Free New Mexican. By the Associate Press. February 17, 2006. Groups: Glacial retreat 'endangers' parks. Dan Fagre was quoted on receding glaciers in article announcing a petition submitted to The World Heritage Committee to list Glacier-Waterton National Park as a UNESCO World Heritage Site in Danger due to climate change impacts on environment.

George Wright Society Book Spotlight. 2006. Fagre and Prato's book, National Parks and protected areas: Approaches for balancing social, economic and ecological values.

Geotimes Magazine. By Jennifer Yauck. July 11, 2006. Contacted Lisa McKeon about using repeat photo images and requested other information for segment in the 'Geomedia' section of Geotimes September issue.

Glacier National Park Wayside Exhibit. May, 2006. Dan Fagre reviewed text for three wayside exhibit panels on glaciers and climate change to be installed on the Going-to-the-Sun Road in Glacier National Park. Consulted with Dave Dahlen, Leigh Welling and Bill Hayden of Glacier National Park several times.

Globe Pequot Publishing. By David Rockwell. 2006. Exploring Glacier National Park. Dan Fagre helped update glacier recession data and climate change research for this book.

Governmental Accountability Office. 2006. Dan Fagre provided expert evaluation of climate change impacts to federal lands.

Great Falls Tribune. Susan Gallagher (AP). February 17, 2006. Groups say retreat warrants “endangered” status for parks. Dan Fagre was interviewed and quoted in this article announcing a petition submitted to The World Heritage Committee to list Glacier-Waterton National Park as a UNESCO World Heritage Site in Danger because of climate change effects on glaciers and environment.

Greenwire. By Dan Berman. July 11, 2006. UN panel says global warming threatens parks, but decides against action. Report on UN’s response to the resolution to list Glacier National Park and other parks on “endangered” list due to effects of climate change. USGS research on glacial recession mentioned in article.

Helena Independent. By Martin J. Kidston. July 30, 2006. Breaking the ice. Article about global warming highlighted receding glaciers of Glacier National Park. Quotes by Lisa McKeon and Blase Reardon and several repeat photos in layout.

Helena Independent Record. By Susan Gallagher (AP). July 13, 2006. Glacier National Park is subject of UN proposal on climate change, report on UN’s response to the resolution to list Glacier National Park and other parks on “endangered” list due to effects of climate change. USGS research on glacial recession mentioned in article.

High Country Citizens’ Alliance, Crested Butte, CO. By Amy Shellenberger. August 8, 2006. Symposium coordinator inquired about obtaining high resolution repeat photo images for a symposium brochure for the sustainable communities symposium.

High Country News. By Michelle Nijhuis. Vol. 37, No. 19, 2005. The Ghosts of Yosemite. Article on climate change research in Yosemite included USGS repeat photo pair of Boulder Glacier and mentioned predicted loss of glaciers by 2030.

High Country News. USGS scientist Nate Stephenson of the Western Ecological Research Center was interviewed by High Country News for an upcoming article on national parks and climatic variability and changes. Stephenson posed some issues that may need to be considered by the National Park Service (NPS). For example, should NPS goals evolve to include more emphasis on enhancing or maintaining ecosystems that are best able to resist and recover from stresses?

Hungry Horse News. December 29, 2005. Fagre Co-authors book on national parks. Press release for “National parks and protected areas: Approaches for balancing social, economic and ecological values.”

Hungry Horse News. April 13, 2006. USGS site showcase disappearing glaciers. Article announcing USGS repeat photography website.

Hungry Horse News. By Chris Peterson. 2006. Winter hangs on to make things hairy. Article on National Park Service blasting avalanches in Steven’s Canyon with photo by Blase Reardon.

IMAX film. 2006. Dan Fagre consulted film project with photographer Catherine Cunningham.

Independent Record. By Martin Kidston. July 19, 2006. Interviewed Blase Reardon and Lisa McKeon about repeat photography project and glacier studies.

Irregular Times.com. February 2006. Straight talk about climate change. Article includes a quote by Dan Fagre in reference to climate change models.

Jumbo Creek Conservation Society. 2006. Cites USGS climate prediction that glaciers will be gone by 2030.

KCFW TV, Kalispell, MT. March 22, 2006. Chie Sarto interviewed Dan Fagre about his upcoming trip to Paris for the UNESCO meeting of climate change experts.

KGVO AM Radio, Missoula MT. By Don Pizini. March 22, 2006. Interviewed Lisa McKeon about new repeat photo website.

Live Science.com. By Bjorn Carey. March 24, 2006. Glaciers disappear in before & after photos. Segment on glacial recession highlighting USGS research in Glacier National Park, including a gallery that was created at this site from USGS repeat photos.

Los Angeles Times. August 10, 2006. Nate Stephenson was interviewed for an article on the tradeoffs between the two primary tools for reducing wildfire hazard in forests: prescribed fire and mechanical forest thinning.

Los Angeles Times. July 7, 2006. Don McKenzie was interviewed for an article about the effects of climatic change on wildfires across the West.

Melcher Media. By Al Gore. 2006. An inconvenient truth. Book follow up to documentary film by same name. USGS provided repeat photos as well as photo of Mr. Gore with Dan Fagre at Grinnell Glacier in 1997.

Melting Mountains website. 2006. Quote by Dan Fagre is the opening line for the 'Melting Glaciers' page.

Film by Ron Meyer. March 2006. Craig Allen was interviewed in the field at length for an upcoming film about global change.

Missoula Independent. By Sam Adams. June 29-July6, 2006. The Earth hugger returns. Interview with Al Gore includes repeat photos of Boulder Glacier.

Missoula Independent. By Jessie McQuillan. February 23, 2006, Vol. 17(10). Reicing Glacier. Info section, article about an effort to launch a proposal to list Glacier National Park as a "World Heritage Site in Danger", quote about the receding number of glaciers by Dan Fagre.

Missoula Independent. By Jessie McQuillan. June 15-22, 2006. Thinning the ranks. Mentions loss of Glacier National Park's glaciers by 2030 in introduction to article on dismantling of the Forest Service.

Missoulian. March 10, 2006. Waterton-Glacier conditions up for discussion in Paris. Article about the World Heritage and Climate Change UNESCO meeting, including quote by Dan Fagre about receding glaciers in Glacier National Park.

Missoulian. By AP. June 15, 2006. Environmental chief announces climate committee's advisers. Dan Fagre named as scientific advisers for Montana's new state committee on climate change. Environmental Quality Director Richard Opper formed the committee earlier this year at the request of Gov. Brian Schweitzer.

Missoulian. By Rob Chaney. September 2, 2006. Carved in Stone, Erased by Time. Article about receding glaciers of Glacier National Park. Quotes and background information by Dan Fagre.

Missoulian. By Susan Gallagher (AP). February 16, 2006. Groups Say retreat warrants "endangered" status for parks. Dan Fagre was interviewed and quoted in this article announcing a petition submitted to The World Heritage Committee to list Glacier-Waterton National Park as a UNESCO World Heritage Site in Danger because of climate change effects on glaciers and environment.

Missoulian. By Michael Jamison. April 13, 2006, p. C1-C2. Glacier Park going gray: Photographs taken decades apart clearly reveal the shrinking of the park's glaciers - to the point they could no longer exist in 25 years.

Montana Quarterly. Summer 2006 issue. Thomas Lee, chief photographer, requested four sets of high resolution repeat photographs for story about glacier recession.

Montana Quarterly. By Todd Wilkerson. Summer 2006, vol. 2(2). Glacier and our changing climate. Article on climate change effects highlights USGS research, quotes by Greg Pederson, and two pairs of USGS repeat photos.

Montana State Climatology Office. 2006. Steve Running, Director, Numerical Terradynamic Simulation Group inquired about linking Repeat Photo website to MT State Climatology website <http://climate.ntsug.umt.edu/index.html>. He also mentioned that he'd be using the photos in presentations on global warming.

MSNBC.com. By Associated Press. February 16, 2006. Endangered status for Glacier National Park? Article with repeat photo of Grinnell Glacier and quotes by Dan Fagre addressing bid to declare Glacier National Park a World Heritage Site in Danger.

MSNBC.com. By Associated Press. June 19, 2006. Parks in Peril. Photo of Grinnell Glacier (by Karen Holzer) headlined web page with the four-panel repeat photo group from Grinnell Glacier as lead photo on article, additional repeat photo pair (Boulder) appeared in slideshow, and text about the number of glaciers that have disappeared from GNP in segment about threats to national park lands nationwide.

MSNBC.com. By Charles Hanley (AP). February 10, 2006. Melting glaciers seen as warming beacons. Article mentions glaciers melting in Glacier National Park.

National Climatic Data Center. February 14, 2006. Long-duration drought variability and impacts on ecosystem services: A case study from Glacier National Park, Montana. Earth interactions paper highlighted in the NOAA Paleoclimatology Program.

National Geographic. 2006. Dan Fagre was interviewed for a story on Glacier National Park, to be published in winter 2007.

National Geographic Traveler Magazine. By Jonathan B. Tourtellot. July/August issue, 2006. The climate bomb. Article on effects that climate change has on world wide travel destinations mentions USGS research that glaciers in Glacier National Park are predicted to melt by 2030.

National Snow and Ice Data Center. 2006. A link to USGS repeat photography website was added to NSIDC website.

Natural Resource Defense Council Report and website. By Stephen Saunders and Tom Easley (principal authors). July 25, 2006. Losing ground: Western National Parks endangered by climate disruption. Glacier National Park highlighted as one of twelve western parks at risk from climate change with much of the Glacier National Park research based on Dan Fagre's climate change program. Repeat photos for report, executive summary and website supplied by USGS, quotes from Dan Fagre, graphics from climate model, and six citations from Dan Fagre's publications.

The Natural Resource Ecology Laboratory, Colorado State University. The Climate Data Plotting Page. Development of this web page for analyzing temporal temperature patterns in the US, including mountainous ecoregions.

Natural Resource Year in Review – 2005. By Katie Keller Lynn. April, 2006. Tromping around on glaciers: A profile of research ecologist Dan Fagre. Overview of Dan Fagre's program and NPS award, with quotes and photos.

Nature. January 28, 2005. Fire and Grassland Evolution. USGS scientist Jon Keeley of the Western Ecological Research Center was interviewed for a story by the journal Nature regarding a fellow researcher's recent study in the journal New Phytologist, in which global modeling shows many of the world's great grasslands disappearing in the absence of fire. Keeley has been investigating a related topic, fire and the expansion of tropical and subtropical (e.g., southern Arizona) grasslands and how previous models of global CO₂ changes do not seem to explain changes in grasslands documented for the Late Miocene.

NBC affiliate in Bozeman, MT. June 23, 2006. Interview with Greg Pederson about the National Academies report on temperature change.

NBC-TV. By Tom Brokaw and Michael Oppenheim. July 16, 2006. Interviewed Dan Fagre for Discovery Channel segment. Dan Fagre provided repeat photos and background information on glaciers and their retreat.

New West. By Courtney Lowery. June 20, 2006. Report: Global warming emissions jump 292 percent in Rocky Mountains. Article about a report on CO₂ emissions features repeat photos of Grinnell Glacier.

New West. By Todd Wilkinson. June 13, 2006. Climate change hits the American West. Greg Pederson and Lisa Graumlich interviewed about climate change impacts in the northern Rockies. The article was also published in the following places: Montana Quarterly, Sun Valley Online, Climate Crisis Coalition website, Rocky Mountain Climate Organization Newsletter, Bozeman Chronicle, Feature of discussion in a commentary by Bill Muhlenfeld, June 18, 2006.

Northfield High School. March 20, 2006. Dan Fagre received the "2005 Distinguished Alumni Award" from Northfield High School, Northfield, Minnesota. Past awardees include state governors, national award-winning authors, and a research scientist on the Manhattan project and consultant to 3 presidents.

The Northfield News. By Michelle Kubitz. March 18, 2006. NHS grads named distinguished alumni. Article naming Dan Fagre 'distinguished alumni' and announcing presentation at Northfield High School's academic awards banquet, including overview of his research.

Northwest Cable News Channel (Seattle). April 6, 2006. Ed Muir interviewed Lisa McKeon on repeat photographs and climate change research in Glacier National Park.

Northwest Travel. 2006. By Becky Lomax. Grinnell Glacier: It melts into extinction like the mammoth. Dan Fagre quoted about climate change in Glacier National Park and prediction that glaciers are predicted to melt by 2030 is highlighted in opening paragraph.

NPS Crown of the Continent Research Learning Center Newsletter. By Sallie Hejl. January, 2006. Vol. 2 (1), p. 2. USGS scientist focuses on impacts of global climate change on mountain ecosystems. Overview of Dan Fagre's climate change and ecosystem research.

NPS: Nature & Science website. May 17, 2006. Critical Issues topic - Global climate change, posted short article on DOE's climate friendly park initiative mentions USGS data, though not credited, on loss of glaciers at Glacier National Park.

NRC Handelsblad. May 4, 2006. Tom-Jan Meeus, interviewed Dan Fagre about climate change. Article will be featured in this magazine from The Netherlands and will include repeat photos from website.

Our Changing Planet, The US Climate Change Science Program Report for FY 2006, Climate Variability, Ecosystem Dynamics, and Disturbance in Mountain Protected Areas. 2006. Update on the CLIMET program and repeat photo trio in the 'Highlights of Recent Research and Plans for FY 2006' section of the report by the Climate Change Science Program and the Subcommittee on Global Change Research.

Our Endangered Values: America's moral crisis. Book by Jimmy Carter. 2005. Mentions USGS 2030 melting of Glacier National Park glaciers prediction.

PBS. November 2, 2005 and January 2006. Global warming: The signs and the science. Featuring Jill Baron and student Sanjay Advani.

PBS. November 3 and 7, 2005. Global warming: The signs and the science. Craig Allen discussed climate-induced forest dieback in the Southwestern US in the hour-long television show.

Philadelphia Inquirer. By Paul Nussbaum. July 2, 2006. Climate change puts park at risk. Article on climate change effects in national parks includes quotes by Dan Fagre, repeat photos of glaciers, and a link to USGS climate change model.

Popular Science. 2006. Dan Fagre was interviewed and provided high resolution image of Grinnell Glacier from Mt. Gould to be featured in the "Megapixel" section of July issue.

Popular Science. July, 2006. Ice, Ice...Maybe, Glacier National Park could be due for a name change. Megapixel pages contain full page repeat photo images of Grinnell Glacier in 1938 and 2005 with paragraph quoting Dan Fagre about glacial recession.

Rock and Ice Magazine. By Colin Wells. March 2006. Hot damned. Article on receding ice with quote by Dan Fagre about glacier's receding in Glacier National Park by 2030.

Rocky Mountain Climate Organization. July 2006. Work, photos, data and graphics featured in national report on how parks are responding to climate change. The Natural Resource Defense Council will post a website to feature this report and they are using a number of products from Dan Fagre's repeat photography website.

Salt Lake City Mayor. October 24, 2005. Lisa Romney requested graphics, photos, and recent publications on climate change to use in a presentation the mayor will be giving at COP8 and COP10 meetings (major planning meetings for the G8 Summit on Climate Change) and the Sundance Summit on Climate Change.

Science. 2005. Review of The Climate Data Plotting Page.

Science Advisory Council. By Richard Opper. May 26, 2006. Dan Fagre was appointed to the Governor of Montana's Climate Change Committee.

Senator John Kerry book. July 6, 2006. By Aimee Molloy and John Kerry on energy and the environment, hiked with and interviewed Dan Fagre. The book is due October 1, 2006 to the publisher, and Dan Fagre's program will be showcased in a chapter.

Sierra Club website. 2006. Glacier National Park is a global warming laboratory. Article features repeat photos of Boulder Glacier, a photo of Dan Fagre and Vice President Gore at Grinnell Glacier and mention of Dan Fagre's research.

Sierra Nevada Alliance. 2005. Sierra Climate Change Toolkit. Publication detailing effects of climate change and ideas for individuals to reduce impact. Section on climate change at the national level references Fagre publication for number and size of remaining glaciers in Glacier National Park.

Sonora Union Democrat. January 20, 2005. White pine blister rust. USGS scientist Phil van Mantgem of the Western Ecological Research Center was interviewed about infections of white pine blister rust in sugar pines in the Sierra Nevada. A USGS and NPS study published in Ecological Applications examined a unique long-term data set that documents 2,168 sugar pines over 15 years at several sites

in the Sierra Nevada. All populations had high frequencies of infections that were often associated with tree death, although crowding was a frequent cause of death as well.

The State.com. By Paul Nussbaum. July 14, 2006. Climate change puts park at risk. Article on climate change effects in national parks includes quotes by Dan Fagre, repeat photos of glaciers, and a link to USGS climate change model.

Sustainability News (NPS publication). By Karen Scott. July 11, 2006. Contacted Dan Fagre about being featured in a special issue on climate change. Karen recommended Dan as a researcher to be featured in an article entitled "Seven Parks and Seven People" which highlights the work of the most interesting people doing climate related work in one of the EPA's "Climate Friendly" parks.

Technology Review. By Jessica Baker. May 17, 2006. Photo essay for issue that will depict how climate change is affecting the earth's geography.

USA Today. March 2006. Craig Allen was interviewed about climate change and fire effects in the Southwest.

USA Today. May 9, 2006. Pat O'Driscoll interviewed Dan Fagre about floral and faunal responses to climate change in Glacier National Park. The article is part of a multi-article series on climate change.

USA Today online. February 27, 2006. Parched New Mexico gets a taste of climate change. Photo of Grinnell Glacier with caption that mentions USGS model prediction of glaciers melting in Glacier National Park by 2030.

USA Today online. February 27, 2006. The West takes lead on climate change. USGS climate prediction model mentioned in article.

USGS. 2006. Repeat photo website was added to the USGS newsroom's photo and image collection website.

USGS. March 22, 2006. USGS press release about new USGS website featuring repeat photography of Glacier National Park glaciers over time.

USGS Central Region Weekly Highlights. Week of March 13, 2006. About Dan Fagre's trip to the UNESCO climate change experts meeting in Paris as representative of the US and USGS.

USGS Highlights. Week of June 26, 2006. Dan Fagre acknowledged for Popular Science Magazine feature and his appointment to the State of Montana Climate Change Advisory Committee.

USGS Science Pick. 2006. Freeze frame photos of Glaciers, submitted by Heather Friesen of USGS, information about new repeat photography website.

VIA Magazine (AAA). By Kristina Malsberger. September/October 2006 issue, p. 30-34. Global warming, vanishing glaciers. Fall issue featured an article about global warming that included quotes by Dan Fagre and repeat photos from USGS Repeat Photo Project (Boulder Glacier). Readership reaches 4 million.

Wallace Stegner Center, University of Utah. February 2006. Symposium on global climate change brochure. Repeat photos of Grinnell Glacier requested for promotional brochure advertising Stegner Center's eleventh annual symposium.

Wallace Stegner Center Newsletter, University of Utah. Fall 2005. Vol. 2, p. 4. Symposium will focus on global warming, article features repeat photos of Grinnell Glacier.

Washington Post.com. By Ashely Ahearn. Posted by Joel Achenbach blog. May 19, 2005. International relations on a glacial scale. Ms. Ahearn interviewed Dan Fagre and wrote article about global change and glacier recession in Glacier National Park.

Water Conflicts (translated). By Piotr Kowalczak. July 10, 2006. Contacted Lisa McKeon to request permission to use Grinnell Glacier repeat photographs in a Polish book entitled Konflikty o wodę (Water Conflicts) to be published in 2006 by Wydawnictwo Kurpisz S.A., Poland.

Watershed Management Council Networker, University of Idaho, Boise, ID. By Don McKenzie and D. L. Peterson. 2005. Wildfire in the West: A look into a greenhouse world.

The weather makers: How man is changing the climate and what it means for life on Earth. By Tim Flannery. 2005. Reference to USGS research pertaining to glaciers melting in Glacier National Park.

World Heritage Committee. February 16, 2006. Petition submitted by group of 10 conservation groups to list Glacier-Waterton International Peace Park on the list of World Heritage Sites in Danger. Petition references climate change research by Dan Fagre and cover displays USGS repeat photos of Grinnell Glacier.

World Wildlife Fund Climate Change Programme. March 6, 2006. Michael Case requested to use repeat photographs for UNESCO World Heritage meeting in Paris.