2013 NPS George M. Wright Climate Change Youth Initiative: Fellowship Program

Selected Fellows

August 26, 2013

Fellow Name: Mariana Abarca Zama
University affiliation: George Washington University
Email: maz@gwmail.gwu.edu
Project Name: Phenology of black cherry and eastern tent caterpillars: the impact of global climate change
National Park(s): Ice Age National Scenic Trail/Chattahoochee River National Recreation Area/Appalachian National Scenic Trail/Rock Creek Park
Award Amount: $19,864

Brief project description:
Phenological shifts and the subsequent disruption of biotic interactions they provoke are among the most evident effects of climate change. The goal of this study is to determine the potential for mismatch between eastern tent caterpillars (Malacosoma americanum, ETC hereafter) and their main host plant (Prunus serotina) as a consequence of global climate change, and to identify the environmental restrictions ETC are likely to face along their distributional range as a consequence of rising temperatures. In particular, my research focuses on: i) Documenting the phenology of ETC and black cherry trees in Rock Creek Park; ii) identifying temperature-related physiological restrictions at different stages of ETC development; iii) assessing the fitness consequences for ETC of early and late hatching; and iv) incorporating this information into a niche model to predict the geographic areas where ETC are more likely to undergo population changes. This study will involve sampling in four national parks (Appalachian National Scenic Trail, Chattahoochee River National Recreation Area, Rock Creek Park, and the Ice Age National Scenic Trail) and all phenology data will be shared with the National Park Service and the National Phenology Network. The results of this study will constitute three dissertation chapters and will be submitted for publication to peer-reviewed journals. While conducting this research I will work with Rock Creek Park's staff to develop a permanent exhibit about the effects of climate change on plant-insect interactions at the Nature Center and I will present a talk as part of their ongoing environmental education program.

Fellow Name: Jeffrey Canon
University affiliation: University of Georgia
Email: jbc165@gmail.com
Project Name: Oh, the Damage Done: Assessing the Patterns and Future Risk of Tornado Damage in Great Smoky Mountains National Park
National Park(s): Great Smoky Mountains National Park
Award Amount: $18,921.00

Brief project description:
Wind damage can affect 1.6 million ha of forest annually, leading to substantial damage to some national parks and causing closure of parks for costly repairs. Global climate change may increase the frequency and intensity of such windstorms, resulting in an increase in resources that national park managers must dedicate to repairing parks. Providing park

managers more information on the extent and pattern of current damage as well as information on park areas vulnerable to future damage allows them to make optimal resource allocation decisions to manage future disturbances. Providing this information to park managers requires the development of a method that converts aerial photographs of damage into a detailed map of damage severity. The main objective of this proposed study is to create a map of damage severity caused by the April 2011 tornado, which struck the Great Smoky Mountains National Park. The methodology I propose takes information on damage severity from known areas and automatically classifies the damage severity of the aerial photograph. I will then overlay the severity map with maps of features such as topography, soil types, and management regimes to determine which factors increase the risk of damage severity in the park. Lastly, I will assess the pattern of damage, including the number, size, and severity of damaged patches. This study will generate information that can better inform the decisions of Park managers on risk assessment and resource allocation, and will be presented at the GSMNP Research symposium to Park researchers and managers.

Fellow Name: Amber Churchill
University affiliation: University of Colorado Boulder
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Project Name: Alpine moist meadow response to regional gradients of nitrogen deposition and inter-annual variation in winter precipitation
National Park(s): Grand Teton National Park/Rocky Mountain National Park
Award Amount: $19,992.60

Brief project description:
The ambient deposition of reactive nitrogen (N) in alpine ecosystems can have cascading effects on plants, soils and hydrology in both the alpine and areas downstream through leaching and ecosystem export. As between one third to one half of deposition occurs in association with precipitation, changes in climate can have important effects on concentrations and amounts of deposition entering the alpine from the atmosphere. Variation in snow pack and precipitation chemistry for the alpine can have large implications for ecosystem N saturation in association with N deposition and is therefore a concern for the resilience of alpine systems in the long term. Thresholds for monitoring ecosystem resilience to N deposition have been established for lakes, soils and changes in plant community composition at Rocky Mountain National Park (ROMO). These thresholds offer a target for land managers to prevent significant changes in ecosystem function, however, the underlying feedbacks controlling ecosystem resilience have not been fully examined nor the impact of variation in environmental conditions associated with future climate changes. Research proposed in this study aims to examine plant community-ecosystem interactions within alpine moist meadows along a gradient of ambient nitrogen deposition across the Rocky Mountains of CO and WY, in years of high contrasting snow pack depth. The goal is to understand how plant community- ecosystem feedback mechanisms change between sites at different levels of nitrogen deposition and whether these mechanisms are affected by different amounts of precipitation (with associated changes in N deposition) in extreme climate years.

Fellow Name: Hollie Emery
University affiliation: Boston University

Email: hemery@bu.edu
Project Name: The Effect of Precipitation Intensification on Salt Marsh Ecosystems and Their Services
National Park(s): Cape Cod National Seashore
Award Amount: $19,921.32

Brief project description:
Precipitation change, and the intensification of precipitation events are expected to occur over the next century as a part of anthropogenic climate change. Changes in annual precipitation totals have the potential to alter ecosystem processes. Some of the effected processes (carbon sequestration, nutrient removal, raw material production) are valued as ecosystem services. I hypothesize that the predicted intensification of precipitation patterns will affect ecosystem processes even if annual precipitation totals remain constant. The first component of this project will be a field experiment in a salt marsh at the Cape Code National Seashore. In this experiment, I will manipulate the incoming precipitation to a set of 1 m2 plots, and measure the response of three ecosystem services: carbon sequestration, nitrogen removal, and biomass production. These plots will receive one of four treatments: Control (ambient precipitation), -precip (all precipitation excluded), +precip (twice ambient precipitation), or Pulsed (ambient precipitation excluded, but rainwater is delivered by hand to plots in a few simulated storm events to equal annual totals in control plots). The second component of this project would use plot sediment data and park long-term data, to make predictions about the marsh's ability to keep up with future sea level rise. Predictions will be made using the SLAMM model. Long-term data from several sites will be used to make a robust prediction of the effects of sea level rise on the marsh system. Data from the plots will be used to estimate how the possible future precipitation regimes may alter this prediction.

Fellow Name: Louise Farquharson
University affiliation: University of Alaska Fairbanks

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Project Name: Assessing the effect of coastal erosion in the Bering Land Bridge National Park and Preserve in a changing climate
National Park(s): Bering Land Bridge National Preserve
Award Amount: $19,193.60

Brief project description:
Coastal erosion rates in the Arctic are among the highest worldwide and have a large impact on cultural and natural resources. The coastline of the Bering Land Bridge National Park and Preserve (BELA) in western Alaska contains critical habitat for protected migratory bird populations, diverse arctic plant communities, irreplaceable archaeological sites and unique palaeoecological records. Climate change is having powerful impacts on this coastline. Ice-free periods are increasing in length: 2012 exhibited the longest ice-free season on record. Because coastal erosion occurs during the ice-free period, an increase in its duration is likely to cause changes in coastal processes and erosion rates, resulting in environmental stressors to the BELA coast and near-coast ecosystems. Understanding coastal dynamics within BELA is of great importance for long-term protection of biological and cultural resources. The objectives of this project are threefold: to classify coastal geomorphology, measure coastal erosion rates between 2004 and 2011, and to establish

whether erosion rates during the last decade are atypical within the spatial data record. I will compare rates of coastal change to results from previous mapping projects focusing on coastal erosion between 1950 and 2003. I will combine geomorphological observations with new data to better understand the factors governing coastal change in BELA and to project future coastal erosion rates within BELA over the next century. Key deliverables will include a report to the NPS containing scientifically credible spatial data sets on coastal movement rates, maps of erosion hotspots, and projected erosion rates for the 21st century.

Fellow Name: Victor Garrett
University affiliation: South Dakota State University
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Project Name: Climate Influences on Beaver Pond Sustainability and Ecosystem Services at Voyageurs National Park
National Park(s): Voyageurs National Park
Award Amount: $10,287.83

Brief project description:
The American beaver, Castor canadensis, is a keystone species in Voyageurs National Park (VOYA). As a semi-aquatic species beaver are vulnerable to the changes in water availability from decreased precipitation and increased evapotranspiration that is expected as a result of climate change. I propose to quantify the duration and frequency of beaver pond inundation, and relate these dynamics to observed climate conditions, landscape characteristics, and beaver presence. I will then classify the vulnerability of beaver ponds to drought, and evaluate the changes to ecosystem services that would result from a loss of beaver ponds in VOYA. I hypothesize that the area and duration of beaver pond inundation will be greatest for early beaver pond cohorts, and for beaver ponds with the greatest contributing areas. I also expect that there will be decreasing ecosystem services provided by beaver ponds as a result of a decrease in the availability of water. There will be an adverse effect on beaver populations which will lead to diminished stream water quality, a loss of prey biomass for carnivores, and a loss of beaver wetlands essential for amphibians, waterfowl, and other mammalian species at VOYA.

Fellow Name: Scarlett Kettwich
University affiliation: University of Hawai'i at Hilo
Email: kettwich@hawaii.edu
Project Name: Elucidating the potential of epiphyte communities on windward Hawaii Island as an indicator of climate change
National Park(s): Hawaii Volcanoes National Park
Award Amount: $19,584.68

Brief project description:
Epiphytes, or the arboreal fauna, with no access to soil resources occupy an unusually climate defined ecospace in tropical montane cloud forests due to intrinsic dependence on the atmosphere for moisture and nutrients. Due to their exceptional sensitivity to air quality and climate, changes in the epiphytic community may provide early indications of floristic response to climate change. This study intends to elucidate a topic never before explored in Hawaii by 1) investigating patterns of epiphyte abundance and species composition across an elevation and precipitation gradient on windward Hawaii Island, and

2) using physiological measurements to determine the relative importance of fog across these gradients. Preliminary data analysis shows across the precipitation gradient, higher epiphyte abundance in the "fog belt" and a shift in species composition along the elevation gradient. Further research and data collection are needed to comprehensively investigate this significance. Understanding dynamics of epiphytic communities will provide an early indication of climate change while justifying the need for local and global adaptation and mitigation to climate change worldwide.

Fellow Name: Amanda Kissel
University affiliation: Simon Fraser University
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Project Name: Exploring the biological consequences of climate change on high-elevation amphibian populations
National Park(s): Mount Rainier National Park/North Cascades National Park/Olympic National Park
Award Amount: $20,000.00

Brief project description:
U.S. National Parks are arguably among the most well preserved areas of land in the country. However, unlike other threats such as resource extraction and development, parks do not offer protection from anthropogenic climate change. Understanding species responses to climate change within protected areas, and developing tools to manage this threat is essential to continuing success of exiting protected areas. Amphibians, as a globally threatened taxonomic group represent a particular priority for mitigating the effects of changing climate. Climate change is expected to act synergistically with other primary threats to exacerbate declines in many areas including within National Parks. Some evidence suggests that for high-elevation amphibian species, warmer temperatures resulting in longer growing seasons will have net positive effects on these populations. Other studies show that acute adaptations to harsh environments will be de-coupled with increasing variability in the amount and form of precipitation that falls, resulting in a net negative effect on amphibians. I propose to link long-term demographic amphibian data with ongoing hydrologic and climate monitoring to forecast the effects of a suite of climate change scenarios on Cascades frogs in three Washington National Parks (Olympic, Mt. Rainier, and North Cascades). I will use a combination of field studies and quantitative modeling to assess stage specific (i.e. embryos, larvae, adults) sensitivity of Cascades frogs to climate change and explore the net effects on the populations in these three parks. My results will provide Park managers with the field-based scientific data to develop climate adaptation strategies for amphibians in the Pacific Northwest.

Fellow Name: Aaron Ramirez
University affiliation: University of California, Berkeley
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Project Name: Responses of chaparral shrubs to experimental drought
National Park(s): Santa Monica Mountains National Recreation Area
Award Amount: $19,884.00

Brief project description:

Future climate change predictions for southern California suggest warmer temperatures and more variable rainfall, both expected to contribute to an increase in global-change-type drought. Recent studies suggest that droughts are already contributing to large-scale vegetation dieback. Despite recent interest in the topic, debate still encircles mechanistic explanations of drought-induced plant mortality. Furthermore, diverse plant communities like the California chaparral are likely to display a diversity of responses and outcomes in the face of increasing drought, yet accurate models of these diverse responses are lacking. In addition, drought-induced shrub dieback is likely to interact with fuel characteristics and fire behavior but this link has not been well studied. One of the best tools for deciphering the physiological mechanisms and ecological implications of drought impacts on vegetation are manipulated field studies that experimentally induce drought treatments on native plant communities. Here we propose a field manipulation experiment to study the impacts of experimental drought on native chaparral shrubs. The goals of this research are to: (1) document the diverse responses of chaparral shrubs to experimental drought and identify species/functional types that are particularly sensitive; (2) evaluate the role of carbon starvation and hydraulic failure as potential mechanisms of drought-induced shrub mortality; (3) quantify the effects of drought on fuel characteristics and assess the potential implications for an interaction between fire and drought.

Fellow Name: Derek Young
University affiliation: University of California, Davis
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Project Name: Understanding Range Shifts by Chipmunks in Yosemite National Park: Interannual Variability in Habitat Use and Spatial Overlap
National Park(s): Yosemite National Park
Award Amount: $19,894.55

Brief project description:
Anthropogenic climate change is an imminent and pervasive threat to global biodiversity. In the Sierra Nevada Mountains of California, climate change is thought to have driven substantial shifts in elevational ranges of small mammals over the past century (Moritz et al. 2008). These responses to climate change, however, vary dramatically even among closely related species. My primary objective is to evaluate the roles of habitat variables and competitive interactions in determining patterns of range shifts by chipmunks in Yosemite National Park. The alpine chipmunk, Tamias alpinus, has undergone a marked upward contraction in elevational range over the past century, whereas the lodgepole chipmunk, Tamias speciosus, has shown effectively no change in its elevational range. My research examines ecological processes underlying this difference in response. Specifically, tracking of chipmunks via radiotelemetry and fine-scale measurements of temperature and habitat structure (e.g. vegetation cover, tree density) are being used to evaluate interspecific differences in habitat use and patterns of spatial overlap. Two seasons of data have already been gathered to address these topics; funding for a third season of radiotelemetry work is requested. This work will constitute a unique opportunity to examine how the effects of interannual changes in weather and vegetation over a three-year period compare with those observed over the past hundred years. My proposed study will therefore move beyond quantifying how species respond to determining why specific responses are observed. This information will prove critical in identifying vulnerable species and in developing sound future management plans for these taxa.