

New research proposal to Western National Parks Association

The information supplied should be limited to the space provided and submitted on these forms. A proposal received in any other format will be returned. Additional attachments are not permitted.

<p>Title of Project: Impacts of the Horseshoe Two megafire on the vegetation of Chiricahua National Monument</p>	<p>Park(s) in which research is to be conducted: Chiricahua National Monument, Arizona</p>
<p>Name, address and phone number of principal investigator(s): Dr. Andrew Barton, 173 High St, Department of Biology, University of Maine at Farmington, Farmington, ME 04938, 207-860-6347 Dr. Helen Poulos, 284 High Street, College of the Environment, Wesleyan University, Middletown, CT 06457, 860-685-4205</p>	<p>Payee information - individual name and address or institution's name and address required: Andrew M. Barton, 173 High St, Department of Biology, University of Maine at Farmington, Farmington, ME 04938, 207-860-6347</p>
<p>Is this a multi-year project? <input type="checkbox"/> YES NO <input checked="" type="checkbox"/> Total amount requested: This year \$ <u>7,500</u> If multi-year project, estimated amount: 2nd year \$ _____ 3rd year \$ _____</p>	<p>Desired start date: <u>March 1, 2017</u> Note: Not prior to October 1st</p>
<p>Project Duration: 12 months Project final completion date: <u>March 1, 2018</u> (see Research Guidelines) _____</p>	
<p>Name(s) of research participant(s) who will acquire advanced degree(s) as a result of working on this project, if any:</p>	<p>Product(s) of research (articles, theses, maps, checklists, etc.) in addition to final report to WNPA (see research guidelines): One or two publications in scientific journals; short brochure on fire ecology for the public' a more detailed booklet for current and future interpretive staff; a poster for the rotating display area in the visitor center; a presentation for staff.</p>

Abstract to be provided by PI(s). Do not exceed the half-page space provided below.

The 2011 Horseshoe Two fire is one of the most important environmental events in Chiricahua National Monument (CHIR) since the establishment of the park. The appearance of the park's vegetation today is shaped as much by that fire as by climate, topography, and soils. The impacts of the Horseshoe Two fire are likely to be very long lasting, and, in some sites, recovery has hardly begun in the five years since the fire. This fire and others like it in the region are the most prominent consequence of environmental change in the Sky Islands – a result of more than a century of fire exclusion and a hotter, drier climate. These conditions are very likely to become the “new normal” for the entire Southwest.

We propose to investigate the impacts wrought by the Horseshoe Two megafire on the structure and species composition of plant communities in CHIR by resampling a network of vegetation inventory plots that were established by Dr. Helen Poulos in 2000. We would also statistically analyze the extensive fire effects monitoring data set that has been collected at CHIR since 1988. The terrain of the monument is highly dissected, giving rise to steep gradients of topography, stacking of vegetation communities, and variable fire severity during the Horseshoe Two fire. A key aspect of our study, accordingly, will be to investigate the extent to which vegetation change resulting from the fire depends on the topographic setting, the type of vegetation, and the severity of the fire.

The proposed research will provide the scientific basis for understanding the impacts of the Horseshoe Two fire on woodlands and forests in CHIR. We propose to develop interpretive materials—a brochure, booklet, poster, and presentation—based on these results that would provide visitors with the knowledge and tools to interpret what they see as they drive and hike across the park, as well provide as a deeper understanding of vegetation dynamics in response environmental change in the Sky Islands and the Southwest as a whole.

(1) JUSTIFICATION (to be provided by submitting park): This section should specify the following: 1) Are NPS-appropriated funds available for the project (Yes/No)? 2) Where does this project rank in NPS and the submitting park's research priorities? 3) Was this proposal solicited by the park? 4) How will this research enrich visitors' understanding of the park? 5) What are the implications for resource management?

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1. There is no NPS funding available for this research project.
2. There are currently no Park projects ranked which would be equivalent to this proposal. However, understanding fire ecology and its past history at Chiricahua NM is critical to managing park resources in the future.
3. This proposal was not solicited by the Park, but is one that the Park wishes to support.
4. This project will enhance visitor understanding of the park through multiple ways:
 - A. a short brochure about fire ecology which explains what visitors will directly see as they tour the park or hike the trails,
 - B. a poster about fire ecology and the Horseshoe Two Fire for our rotating display space at the visitor center,
 - C. an in-depth booklet for current and future staff to explain fire ecology concepts and the specifics of what happened due to the Horseshoe Two Fire, and
 - D. a training presentation on fire ecology for all park staff by the research team with the opportunity for staff to seek additional information.Each of these options will help visitors understand the effects of fire on the landscape of Chiricahua NM which has very diverse terrain resulting in a wide variety of wildlife and complex ecosystems.
5. Information resulting from this project will aid in resource management planning activities as it will give more in-depth information about post fire restoration and habitat recovery.

(2) CONCISE STATEMENT OF RESEARCH OBJECTIVES, DESIGN, AND METHODOLOGY. This section should include the facilities and sites to be used. Note: Limit this section to the two pages provided.

RESEARCH OBJECTIVES

Frequent, low-intensity fire maintained forests of the American Southwest for millennia (Swetnam et al. 1999), but in recent decades the occurrence of large, high-severity fires has increased dramatically in response to mounting fuel loads from fire suppression and drought (Allen et al. 2002, Westerling et al. 2006, Dennison et al. 2014). For most ecosystems in the region, this altered fire regime is well outside the historical natural range of variation (Swetnam et al. 1999). Given continued high fuel loads and projections of increased aridity, the prevalence of high-severity fires is unlikely to abate (Seager et al. 2007, Williams et al. 2014). This new fire regime is causing major shifts in vegetation structure and species composition. Studies throughout the Southwest, for example, have documented fire-driven conversion of pine and pine-oak forests to persistent shrublands and grasslands (Savage and Mast 2005, Haire and McGarigal 2008, Shive et al. 2013). This issue has become a key forest management concern in the region, prompting a recent Southwest Fire Consortium panel discussion that addressed, "...the fear that uncharacteristic fires may convert large areas of pine forest to other vegetation such as oak brush" (Wolfson and Thode 2014).

The fire history of Chiricahua National Monument (CHIR) in the Sky Islands of the Arizona-Sonora borderlands closely parallels the regional pattern. Before Euro-American settlement, surface fires burned as frequently as every 5-10 years, a fire regime that discouraged shrub invasion of grasslands, maintained open woodlands, and promoted a balance of pines and oaks in mixed conifer forests (Kaib et al. 1996, Seklecki et al. 1996, Barton et al. 2001). Fire exclusion commenced by the late 19th century with the introduction of livestock grazing, followed by effective fire suppression in the 20th century. Reduced fire frequency led to increased tree density and extensive fuel build-up. A regional drought in the 1990s ushered in a new era of large crown fires throughout the Sky Islands and beyond (Barton 1999, 2002, Haire and McGarigal 2008, Williams et al. 2014).

The signature fire in the Chiricahua Mountains for this new megafire reality was the 2011 Horseshoe Two fire, which burned over 200,000 acres, nearly 1/3 of the mountain range. The fire burned through much of CHIR, affecting every topographic setting and vegetation type. The results of the fire can be observed from all trails and viewpoints in the park. The trail up Rhyolite Canyon experienced some of the most moderate impacts of the fire, with thinned forest stands and charred but surviving pines. On the drive from the Visitor Center to Massai Point, in contrast, visitors can see entire hillsides where nearly every single woody plant died above ground. Even at Massai Point, one of the park's highlights, dead snags of fire-killed old trees mix with spectacular standing rocks and canyons.

We propose to assess the impacts wrought by the Horseshoe Two fire on the structure and species composition of plant communities in CHIR by resampling a network of vegetation inventory plots that were established by Poulos in 2000, 11 years prior to the fire (see Poulos et al. 2007). The terrain of the monument is highly dissected, giving rise to steep gradients of topography, stacking of vegetation communities, and variable fire severity during the Horseshoe Two fire. A key aspect of our study, accordingly, will be to investigate the extent to which vegetation change resulting from the fire depends on the topographic setting, the type of vegetation, and the severity of the fire. Poulos et al. (2007) examined the association of topography and vegetation in general across the CHIR landscape in 2000. Our study will further evaluate the extent to which high-severity fire has altered those relationships. Answering these questions will provide managers and park visitors with a fine-grained view of how the Horseshoe Two fire influenced the natural communities of CHIR specifically and ecosystem-scale impacts of high-severity fire in the Sky Island forests generally.

(2) CONCISE STATEMENT OF RESEARCH OBJECTIVES, DESIGN, AND METHODOLOGY (Cont'd):

RESEARCH DESIGN AND METHODS

We propose to assess the impacts of the Horseshoe Two fire on the vegetation of CHIR in two ways. First, we will statistically analyze the extensive set of fire effects monitoring data gathered since 1988 at CHIR by park service staff. This research initiative is part of an NPS-wide program to assess the role of fire and other disturbances on vegetation. The sampling aims to quantify critical habitat characteristics before and after prescribed fire, as well as to follow long-term trends in environment and vegetation. Both Barton and Poulos have effectively used prescribed fire and fire effects plots in their past research at CHIR (Poulos 2000) and elsewhere. Perry Grissom, regional NPS fire ecologist, leads the fire effects monitoring program in CHIR and other parks in the region. He has generously offered to make the entire data set available by January 2017 for use in the research proposed here.

Our second and primary research effort will be to resample woodland and forest plots originally set-up and sampled by Poulos in CHIR in 2000. These sample sites were selected from the vegetation cover map developed by Kluber (2000), distributed among all major cover types. We will resample approximately 100 of the 200 plots in the original inventory that were dominated by tree species to examine the influence of high intensity wildfire on forest stand dynamics at CHIR.

In the original survey, sample points were placed in the center point of homogeneous cover type areas larger than 1,800 m² on Kluber's vegetation map due to the fact that random, or systematic sampling was impossible in such a dissected landscape. Vegetation at each point was sampled using a belt transect of 5–20 m in 5x5 m quadrants. Transect length varied depending on vegetation density, and was established parallel to the slope contour. At each point, the location (GPS), elevation, slope aspect and pitch, topographic position, slope configuration, soil type, and geologic substrate were recorded. In each quadrant, basal diameter of all shrubs and trees >10 cm in diameter was measured; seedlings, shrubs and cacti (stems <10 cm basal diameter) were counted; and percent cover was estimated for each woody species.

We will resample those plots using the same methods. In addition, for all dead stems >10 cm in basal diameter, we will record species identity, pre-fire basal diameter, whether the top-killed stem resprouted, and maximum height and number of sprouts for resprouting plants. Fire severity will be assessed with both remote sensing and ground-truthing using tree mortality and stem char height. Location and topography will be confirmed for each of the plots. Helping us with this fieldwork would be two college students, who would have the opportunity to gain experience both in research and in the use of research in the educational mission of the National Park Service.

Temporal changes in species composition and stand structure will be analyzed using ordination techniques (non-metric multidimensional scaling) and parametric mixed models analyses in R (R Development Core Team 2012). These models will include the fixed effects of topographic setting and fire severity, as well as the interaction between these two factors.

3) CONCISE STATEMENT OF HOW YOUR RESEARCH CAN ENHANCE THE INTERPRETIVE MISSION OF THE PARK. ALSO INCLUDE ONE PARAGRAPH DESCRIBING THE PLAN FOR AN INTERPRETATION-RELATED PRODUCT OF THE RESEARCH. Use this page only.

The Horseshoe Two fire is one of the most important environmental events in CHIR since the establishment of the park. The appearance of the park's vegetation today is shaped as much by that fire as by climate, topography, and soils. The impacts of the Horseshoe Two fire are likely to be very long lasting, and, in some sites, recovery has hardly begun in the five years since the fire. This fire and others like it in the region are the most prominent consequence of environmental change in the Sky Islands – a result of more than a century of fire exclusion and a hotter, drier climate. These conditions are very likely to become the “new normal” for the entire Southwest. Such a shift in vegetation structure and composition from a mosaic of early- to late-successional forest to a seral, oak-dominated shrubland will have cascading influences on key late-successional forest specialist wildlife species such as the Mexican Spotted Owl, which had multiple nesting sites in CHIR prior to, but not after the fire raged through the Monument.

The research proposed above will provide the scientific basis for understanding the impacts of the Horseshoe Two fire on woodlands and forests in CHIR and how these effects vary across gradients of topography, vegetation, and fire severity. Effective interpretive materials based on these results would provide visitors with the knowledge and tools to interpret what they see as they drive and hike across the park, as well provide as a deeper understanding of vegetation dynamics in response environmental change in the Sky Islands and the Southwest as a whole.

We plan to work closely with the staff at the Southeastern Arizona Parks (SEAZ) group to develop materials that meet the needs of visitors and interpretative staff. After consultation with Libby Schaaf, the new Director of Interpretation at SEAZ, we propose to develop a short brochure on fire ecology for the public, a more detailed booklet for current and future interpretive staff, a poster for the rotating display area in the visitor center, and a presentation for staff. We would also enjoy giving a talk to park visitors, if CHIR staff think that would be appropriate. Finally, we would be capable of creating Spanish versions of any of these materials.

Our plan for the short public brochure illustrates the principles and creative ideas that would guide the development of all of the interpretative products proposed here. Using non-technical language, this brochure would focus on the most important concepts underlying the scientific understanding of fire in nature: how fire occurs, plant adaptations to fire, and the role of fire in maintaining plant communities. It would highlight the major environmental changes over the past two centuries in CHIR, the Sky Islands, and the Southwest in general -- alterations that have led to the new era of megafires. It would use CHIR to describe the impacts of these changes, based in part on our research proposed here. The brochure would have clear, evocative images that would illustrate these concepts and changes. Park visitors would have the option of simply reading the brochure at their leisure (at the visitor center, campground, picnic table, etc.) or actively exploring the impact of the Horseshoe Two fire at park viewpoints, along roads, and on trails with short tours that we would provide in the second half of the brochure. If appropriate, we could explore the possibility of developing a more interactive, device-accessible version, with maps, photographs, and text. We would embed throughout the brochure not just what scientists know, but how we know it. Accordingly, we would highlight the scientists and the actual research in the park that led us to our present understanding of the changing role of fire in Chiricahua National Monument and the Sky Islands.

(4) QUALIFICATIONS OF THE PRINCIPAL INVESTIGATOR(S) CONDUCTING THE RESEARCH. Use this page only. List only those qualifications directly related to this grant request. Include a list of other WNPA-funded research conducted by this PI.

Andrew Barton has carried out research on the fire ecology of the Sky Islands for nearly 30 years. With a focus on the ecology of Madrean pine-oak forests, his research has spanned the transition from the relatively moist 1980s, during which fire exclusion held sway, to the new era of megafires. He is the author of many journal articles and reports on the Sky Islands, as well as on forest ecology research in Pennsylvania, Kentucky, Maine, and Costa Rica. Grants have generously supported a variety of forest research projects over the past three decades, including two Southwest Parks and Monuments Association grants in the early 1990s for work on the fire ecology of Madrean pine-oak forests in Chiricahua National Monument. His current Sky Island fire ecology research is supported until 2017 by a Joint Fire Science Program grant with Helen Poulos. Dr. Barton was the co-coordinator of the Chiricahua Mountains Research Symposium and co-editor of the proceedings, and is co-convenor with Dr. Helen Poulos of a special session on high-severity fires in the Southwest at the upcoming Association for Fire Science conference in Tucson. Barton also has an extensive record of publishing and presenting for general audiences in magazines, educational reports, and presentations. He is the author of *The Changing Nature of the Maine Woods* (University Press of New England, 2012), a Maine Literary Award winner, and the upcoming *Old-growth Forests in the East: Principles for the Anthropocene* (Island Press). Dr. Barton has degrees from Brown University (B.A. Biology), University of Florida (M.S. Zoology), and the University of Michigan (Ph.D. Biology), and is Professor of Biology at the University of Maine at Farmington.

Helen Poulos has worked in Sky Island systems of the desert southwestern United States and northern Mexico for over 15 years. Her research focuses on understanding the interactions among vegetation, fire, and topography at local-, landscape-, and regional-scales. Poulos has published over 30 peer-reviewed journal articles and popular publications, and she has performed both rapid assessments and long-term vegetation monitoring in over 10 Sky Island forests on both sides of the US-Mexico border. Her work in southwestern North America has been funded by a variety of institutions including the National Park Service, Joint Fire Sciences Program, The Nature Conservancy, and the Commission for Environmental Cooperation. Poulos, in collaboration with Dr. Andrew Barton, is currently supported by the Joint Fire Sciences Program to examine the effects of the 1994 Rattlesnake and 2011 Horseshoe Two fires on the eastern side of the Chiricahua Mountains through 2017. Poulos has an undergraduate degree in Biology and Spanish from Pepperdine University (1997), masters from Penn State University (Geography, 2000) and Yale University (Forestry and Environmental Studies, 2002), and a Ph.D. from the Yale School of Forestry and Environmental Studies (2007).

COSTS (Cont'd). Note: Be sure to explain here the duties that will be performed by any funded individual.

Dr. Andrew Barton: four weeks of work

- Two weeks of field work at Chiricahua National Monument
- Two weeks of data analysis, publication writing, development of interpretive materials
- In-kind contribution = 4 weeks x \$2004 per week = \$8,016

Dr. Helen Poulos: three weeks of work

- One week of field work at Chiricahua National Monument
- Two weeks of data analysis, publication writing, development of interpretive materials
- In-kind contribution = 3 weeks x \$1760 per week = \$5,280

Two field assistants (\$2,592): three weeks each of field work at Chiricahua National Monument

Chiricahua National Monument In-kind: 21 days of camping x \$12 per day = \$252

Travel and Subsistence (\$4,508):

- 4 round trip plane tickets @ \$600 per ticket = \$2,400
- Food for 4 people – 63 person days * \$20 per person = \$1,260
- Car Rental for 3 weeks @ \$250 per week = \$750
- Gas = \$98

Equipment (\$200): camping equipment, DBH tapes, look-through campus, transit poles

Supplies (\$200): shipping of two boxes of equipment to and from Arizona, production of interpretive materials, pens, data note books

A special note for researchers and the park superintendent:

WNPA is the funder of this grant on behalf of NPS, and WNPA handles selection, monitors progress, administers the payment schedule, and determines successful completion or default. WNPA also posts the final research report on its website, WNPA.org.

All other decisions regarding the conduct of this research grant (e.g., park access, laws, safety, protocols, etc.) and uses of the research, data, and its products (e.g., release of information, publication, intellectual property, etc.) rest in the hands of NPS and are the responsibility of NPS. Researchers and NPS should clarify any questions or assumptions before accepting the grant.

Due to several factors, ALL WNPA grants are for ONE YEAR ONLY (1 year only); however, we welcome and will carefully consider applications for second or third years following a successful first year.

Best wishes and hopes for a successful project. Thank you from WNPA.

I have read and agree to abide by the research guidelines in effect at the time of this application.

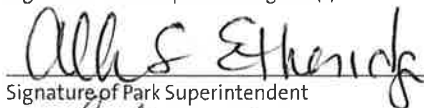
Andrew Barton

Digitally signed by Andrew Barton
DN: cn=Andrew Barton, o=University of Maine at Farmington, ou=Division of Natural Sciences, email=Barton@maine.edu, c=US
Date: 2016.08.05 14:23:00 -0700

August 5, 2016

Signature of Principal Investigator(s)

Date



8/10/16

Signature of Park Superintendent

Date



8/16/16

Signature of Chief of Interpretation

Date

For WNPA Use Only

WNPA Research Committee Review: Action and Date:

Amount Granted:

Budget for New Research Proposal

Project title and submitting park: Impacts of the Horseshoe Two megafire on the vegetation of Chiricahua National Monument
Chiricahua National Monument, Arizona

Personnel

Principal investigator(s)	Funds requested from WNPA	Cash or in-kind contribution (Please specify which and source.)
1 Dr. Andrew Barton	\$0	In-kind: \$8,016
2 Dr. Helen Poulos	\$0	In-kind: \$5,280
3		

Other personnel (Specify number in brackets. Specify duties to be performed to earn funds on next page.)	Funds requested from WNPA	Cash or in-kind contribution (Please specify which and source.)
1 Field Research Assistants (2)	\$2,592	
2		
3		
4		
5		

Total Personnel Costs \$2,592 \$13,296

EQUIPMENT COSTS (List item and dollar amounts for those items costing more than \$100 each on next page.) \$200

TRAVEL AND SUBSISTENCE (Itemize on next page.) \$4,508 \$252

Other costs

1 Supplies and material	\$200	
2 Consulting services		
3 Computer services		
4 Subcontracts (Itemize on next page.)		

Total Personnel Costs \$200 \$13,296

Total Personnel Costs \$7,500 \$13,548
 If multiyear project, summarize estimated subsequent year(s) budget(s) on next page.