

**Award Number:** P14AC00956

**Project Number**: PC-14

**CFDA #:** 15.945

**Park/NPS Unit: Dinosaur National Monument**

**Title of Project: Fire History Patterns and Climate Response in Pinyon-Juniper Woodlands, Dinosaur National Monument**

**Administered through the:**  Colorado Plateau Cooperative Ecosystem Studies Unit Cooperative Agreement Number H1200-09-0005

**CESU Partner: Prescott College**

**PROJECT CONTACTS:**

**Principal Investigator:** Lisa Floyd-Hanna, Ph.D. Prescott College, 220 Grove Ave, Prescott, Arizona 86301, Tel.: 928 350-2220, Fax: 928-776-5137, lfloyd-hanna@prescott.edu

**Co-Investigator :** William H. Romme, Ph.D. Colorado State University, Ft. Collins CO, Tel.: 970-692-9347, William.Romme@colostate.edu

**Researcher :** Dustin P. Hanna, Laboratory of Tree Ring Research, 1215 Lowell St, Tucson, AZ 85721, Tel.: 928-925-7917, dustinhanna@email.arizona.edu

**Partner Administrative Contact*:***Susan Harvey, Grants Coordinator/Business Office, Prescott College, 220 Grove Ave, Prescott, AZ 86301, Tel.: 928-350-4007, susan.harvey@prescott.edu

**NPS Certified ATR:** Tamara Naumann, Botanist, Dinosaur National Monument, 4545 E Highway 40, Dinosaur, CO 81610, Tel.: 970-374-3051, Fax: 970-374-3003, tamara\_naumann@nps.gov

**NPS Technical Expert:** Tamara Naumann, Botanist, Dinosaur National Monument, 4545 E Highway 40, Dinosaur, CO 81610, Tel.: 970-374-3051, Fax: 970-374-3003, tamara\_naumann@nps.gov

**FUNDING INFORMATION:**

**Amount Funded: $24,795**

**NPS Account Numbers (amounts in parentheses): PPIMDINOR1 PPMRSNR1Z.EM0000**

**Fund Source (e.g., ONPS, FLREA, CRPP, CESU, etc.): ONPS**

[x] NPS Funding

[ ]  Is this funded using a reimbursable account number? If yes, IMR contracting needs a copy of the Interagency Agreement.

**PROJECT DATES:**

**Start Date:** June 20, 2014

***NOTE: This Task Agreement will become effective on the date of final signature or the effective date of the Award document, whichever is later.***

**End Date:** June 30, 2016

**NPS Administrative Contacts**

**Interim CESU Coordinator (May 18 – September 13, 2014):** Todd Chaudhry, National Park Service/CPCESU, NAU P.O. Box 5765, Flagstaff, AZ 86011, 928-523-6638, Fax: 928-523-2014; todd\_chaudhry@nps.gov

**Intermountain Region Administrative Contact:** Kelly Adams, Grants and Agreements Specialist, National Park Service, 12795 West Alameda Pkwy, Lakewood, CO 80228. Phone: 303-969-2303 Fax: 303-969-2992 Email: Kelly\_adams@nps.gov

**FEDERAL FINANCIAL REPORTS:**

***Federal Financial Reports*** (Check as required for project based on spending plan, period of performance, risk, cooperator history, etc.)

{ } Quarterly { } Semi-annually { } Annually (**X)** Final (required)

**Project SCHEDULE AND TECHNICAL REPORT DEADLINES:**

List all technical reports and products in sequential order as required in the scope (more lines and milestones can be added as needed):

*Project Start Date* – June 20, 2014

*Technical progress reports –* { } Quarterly { X} Semi-annually { } Annually

(Check as needed from PI to monitor progress of specific project. Content should be addressed in the scope.)

*Investigator’s Annual Report (IAR)* – February 1, 2015 and February 1, 2016

*Field Work* – *2015*

*Database, Collections/Specimens, Archives, and Maps provided to the NPS ATR or Technical Expert* – June 30, 2016

*Draft Final Report* –April 1, 2016

*Final Report* – June 30, 2016

*Project End Date* – June 30, 2016 (project reports/deliverables are due)

*Final SF425 FFR* must be submitted within 90 days of project end date

**PAYMENTS**

**2 CFR PART 215.22*:*** Cash advance (drawdown) to recipient organization shall be limited to the minimum amounts needed and be timed to be in accordance with the actual immediate cash requirements of the recipient organization in carrying out the purpose of the approved program or project. The timing and amount of cash advances shall be as close as is administratively feasible to the actual disbursements by the recipient organization for direct program or project costs and the proportionate share of any allowable indirect costs.

**2 CFR PART 215.25 (8)(e)(1):** Incur pre-award costs 90 calendar days prior to award or more than 90 calendar days with the prior approval of the Federal awarding agency. All pre-award costs are incurred at the recipient’s risk. (i.e. the Federal awarding agency is under no obligation to reimburse such costs if for any reason the recipient does not receive an award or if the award is less than anticipated and inadequate to cover such costs.)

**CESU REQUIRED PRODUCTS (may be different from those products required by the ATR – See Statement of Work for Products required by the NPS unit):**

The Principal Investigator will prepare a brief report abstract suitable for public distribution and two hard copies and an electronic version (in PDF file format) of the final report and mail all toTodd Chaudhry, National Park Service, CPCESU, NAU P.O. Box 5765, Flagstaff, AZ 86011. Please be sure to include the project number (e.g.; NAU-###, UMT-###, UAZDS-###) and the P number on the cover page of the final report.

**PROJECT ABSTRACT:**

We recently completed a fire history and a study of age-related tree ring growth patterns in *Pinus edulis* populations, Dinosaur National Monument. This population on the northern extent of the extant woodland revealed surprising old, ancient stands and well-preserved downed wood, remnants of the earliest piñon populations of the region. Stand replacing fires were estimated with a fire rotation of 550 years, yet patch sizes and presence of charcoal in nearly one half of the stands suggest a heterogenous pattern of fires. In this study we propose completion of dendrochronology analysis of down wood collected during the previous study, adding new samples (down wood and cores from old, live trees) to this analysis, and further determining patterns of historical fire extent on the landscape. We will focus on the ancient stands to study the sensitivity and tree ring indices of the oldest piñons in the area. Coupled with completed work (Romme et al 2014) these analyses will provide a more thorough picture of the characteristics of fire and of the climate sensitivity of trees of various ages and will provide insight into the possible effects of changing climate on piñon populations.

**Scope of Work:**

A fire history study was recently completed in Dinosaur National Monument (Romme et al. 2014). Our purpose in estimating fire rotations in piñon-juniper woodlands was to compare the historical fire rotation with modern fire rotations in the same vegetation types to see if the fire regime has changed substantially. By “historical” we mean prior to the influences of Euro-American settlers, who arrived in the region in the late 19th century; this fire rotation was compared with the modern rotation (Arendt and Baker, 2013). One of the surprises in this study was our discovery of extremely old piñon trees in several areas. The oldest piñon dated to 1170 AD, however the 1200s and earlier were only minimally represented in the sampling. Only three of our 80 sampled sites were ancient stands—a product of the unbiased stratified random sampling method used to obtain cores from across the Yampa Bench landscape. We observed that the best-developed old-growth piñon stands in DINO are often surrounded by sandstone cliffs and other fire barriers. These fire-protected physiographic situations have allowed the development of very old, indeed ancient, piñon stands that are unique to these conditions and may be some of the oldest woodlands that exist on the landscape today (Jacobs 2008). Indeed, these are early descendants of the original piñons in the region which date to 1103 + 30 years BP (Sharpe 2002 and personal communication). In contrast to other piñon-juniper woodlands in which junipers are typically older than the piñon, these stands have 700+ year old piñons and few junipers. Characteristics that suggest very long intervals between fires are apparent in many of these very old stands; these include numerous standing dead trees and downed logs, minimal evidence of single-tree fires and, in a few locations a few single fire scars on living trees.

In the recently completed study we used 795 cores to date 70 stands throughout the Yampa Bench study area and approximated a 550 year fire rotation during the historical reference period 1500-1900 A.D, and nearly one half of our points had evidence of charcoal. In addition, approximately 60 samples were collected from old downed piñon logs from 50 sites throughout the Yampa Bench and on BLM land to the south of DINO; these old wood samples could illuminate an earlier generation of piñons not well represented by the living trees on the landscape and thus extend our knowledge of these stands back in time and shed additional light on disturbance history. For example, at sampling point 1130, the oldest live trees today were relatively young, dating to the 1800s, but down wood was much older and one section contained a fire scar from 1495. Also, spatial analyses in the 2014 study were challenging; it is very difficult to determine the extent of cover or historical fire patchiness from remote sensed imagery in this woodland type, hence our fire rotation depended on point sampling for fire dates and extrapolation to the landscape using Dinosaur’s vegetation map. Additional sampling of downed wood and mapping on the ground the spatial extent of historical fires (as we did in one pilot area in Romme et al. 2014) could verify the occurrence of fire at this time in history and “push back” our interpretation of the landscape, extending the reference period back in time and obtaining data on the range of patch sizes resulting from stand replacing fires in historical periods. The availability of the dendrochronology samples allowed a complementary study, carried out by Dustin Hanna at the Laboratory of Tree Ring Research (University of Arizona), in which the sensitivity of piñon to climatic fluctuations was explored. The mean sensitivity (a measure of the relative change in ring widths from one year to the next commonly used in dendrochronological analysis) was measured along with other standard indicators of climate sensitivity such as ring width variance and partial autocorrelations. Hanna tested, irrespective of time and across a span of tree ages up to 800 years, whether older trees showed greater mean sensitivity than did young (less than 200 yr) trees. His analysis suggests that young trees are relatively insensitive to climate perturbations, and that mean sensitivity and coefficient of variation jumps significantly after 200 years, reaching a consistent level in trees 400-600+ years and perhaps declining again in exceptionally old trees (subject to verification with additional ancient trees to be accomplished in this proposed study). In piñon populations near Flagstaff, Arizona, Ogle et al. (2000) found that dead piñons which had succumbed to drought-related insect mortality had 1.5 times greater variation in growth than live trees and that climate sensitivity declined with age in samples collected from dead trees. Trees less than 40 yrs were highly sensitive to climate change but this sensitivity was lost by 150-200 years. This study, however, only included piñons less than 200 years; in DINO we have the potential to expand to trees up to 800 years and perhaps older. Also, the 2002-2005 mortality event (a climate-related *Ips confusus* infestation) that killed a large percent of the piñons in northern Arizona and much of the southwest, did not affect the Dinosaur area to the same degree. (We have, however, observed a slight increase in piñon tree death due to insects in Dinosaur in the past year.)

This research will have management and conservation implications for Dinosaur’s piñon stands given projections of warmer, drier trends in the southwest in future decades. The analyses by Hanna are important in at least three ways. First they show a potential difference in the sensitivity of piñon relative to other trees, many of which show greater sensitivity at younger ages (e.g., spruce, juniper). This unique characteristic/adaptation may be one of the means by which piñon maintain their populations in habitats marginal for trees. Secondly, the extreme age of piñons at DINO allows such analyses to cover a much longer time span (many other studies of growth sensitivity to climate, for example, cover only 300 years, whereas this data set covers many more centuries). Finally, some of the long-dead piñons that we have not yet sampled may be even older than the 800-year old trees that we have already documented in Dinosaur; such ages could represent the first cohort to colonize this area after the Pleistocene--for comparison, the first colonization of piñon at Dutch Mountain in northeastern Utah had occurred by the mid-1200s, but spread was forestalled by severe drought in the late 1200s (Gray et al. 2006) and at Dinosaur the first piñons appear in the 900s (Sharpe, personal communication). In summary, Dinosaur National Monument is especially suited for this proposed study because: a) We have a working model for fire history: DINO has centuries-long fire intervals and evidence of a superimposed “patchwork” of smaller, stand-replacing patches. Further investigation of old wood and spatial patterns will allow us to more fully understand these patterns and improve our measures of fire rotation before 1200.b) We have >60 samples of downed wood in the lab that await analysis, but we have no funding to complete the dating. We also have located abundant old, down wood in the field that has not yet been sampled. c) Dinosaur’s piñons are very old (perhaps some of the oldest extant stands in the southwest today) and possibly exhibit unique sensitivity characteristics that could be verified with an adequate number of older samples.

 Work Program:

 A) Complete dating of old, down wood that has already been collected. *This work will be completed by Researcher Dustin Hanna.*

B) Where indicated by particularly old samples and/or fire scars, re-sample 10-15 sites from our original sampling points and collect old, down piñon. Date the origin of these trees and map the spatial extent of the historical fire***.*** *Students from Prescott College will participate in field sampling, which will be supervised by PI Lisa Floyd-Hanna.*

C) An extensive ancient stand known to us as “Ridge of the Giants” will be thoroughly sampled in 6 plots. We will construct stand (age) structures and thoroughly sample collect down wood from the six plots. Fire scars, if present will be dated. *Students from Prescott College will participate in this field sampling and analysis, which will be supervised by PI Lisa Floyd-Hanna.*

D) At “Ridge of Giants” and other ancient stands: collect additional cores of oldest age classes for sensitivity analyses. *Students from Prescott College will participate in field sampling, which will be supervised by PI Lisa Floyd-Hanna. Analysis will be conducted by Researcher Dustin Hanna.*

Reference

 Arendt, P. and W. Baker.2013. Land surveys across ~300,000 ha show piñon-juniper woodland decline over the past century". Ecosphere ES13-00081.

Gray S.T., J. L. Betancourt, S.T. Jackson and R.G. Eddy. 2006. Role of multidecadal climate variability in a range extension of pinyon pine. Ecology, 87:1124–1130.

### Jacobs, B.F., W.H. Romme and C.D. Allen. 2008. [Mapping “old” vs.“young” piñon-juniper stands with a predictive topo-climatic model](http://www.esajournals.org/doi/abs/10.1890/07-0847.1). Ecological Applications 18:1627–1641.

Ogle, K. T. G. Whitham, N.S. Cobb. Tree-ring variation in pinyon predicts likelihood of death following severe drought. Ecology 81(11)3237-3243.

Romme, W.H.M. Lisa Floyd, W. Baker. April 18, 2014. Report to NPS, Dinosaur National Monument “Landscape Condition Analysis, Dinosaur National Monument”NPS-IMR Cooperative Agreement Number: H1200040004 (IMR).

Sharpe, Saxon. 2002. Constructing seasonal climograph overlap envelopes from Holocent packrat middent contents, Dinosaur National Monument. CO. Quarternary Research 57:306-313.

Williams, A.P. , Craig D. Allen, C. I. Millar, T. W. Swetnam, J. Michaelsena, C J. Still, and S. W. Leavitt. 2010. Forest responses to increasing aridity and warmth in the southwestern United States, PNAS. 107: 21289–21294.

**COOPERATIVE AGREEMENTS OR TASK AGREEMENTS INVOLVING COOPERATORS WORKING ON-SITE**

**Background**

In cooperative agreements or task agreements with universities where the university utilizes interns, student employees, research associates (RAs) or cooperators on-site (hereafter called “cooperator personnel”), these cooperator personnel sometimes work on government sites in close proximity to federal employees. It is illegal (without specific statutory authority) for federal employees to directly supervise the cooperator personnel or any university employees or for the students or other university employees to supervise federal employees. When cooperator personnel are working on an NPS site, it is important that there is a clear distinction between students and federal employees.

**Office Environment and Vehicles**

* The office space of the cooperator personnel and NPS personnel should be clearly labeled (Name and NPS or University affiliation on office or cubicle space).
* Cooperator personnel should be listed separately from NPS personnel in telephone lists, other identification or organizational rosters, and publication credits.
* Cooperator personnel should not receive “all-employee” e-mail or other communications intended for NPS personnel (unless it relates directly to the work the cooperator is doing for the NPS). When the e-mail does relate to the work being done, a copy of the same e-mail message should be sent to the University or cooperator’s supervisor.
* Cooperator personnel may use NPS e-mail systems when the communication relates directly to the work the cooperator is doing for the NPS. The e-mail addresses of the cooperator personnel must include a label associated with their NPS e-mail address that identifies the cooperator’s status (i.e., “Linda Webb, Cooperator” would be the label associated with the e-mail address, linda\_webb@contractor.nps.gov). Doing so clearly identifies this individual each time they send an e-mail message using the NPS system, and it identifies their status as a research associate, student intern or student employee in the e-mail directory.
* Unless stipulated in the agreement, cooperator personnel should not drive government vehicles.
* Unless stipulated in the agreement, cooperator personnel should not ride as a passenger in a government vehicle. When this is planned as part of the agreement, an appropriate amount of liability insurance should be negotiated.
* Prior written approval by the Park Superintendent or Center Manager must be obtained in order for a task to allow cooperator personnel to drive or ride in government vehicles.

**Supervision and Scheduling**

* Each task must specify the university’s/cooperator’s supervisor for the cooperator personnel.
* Unless stipulated in the agreement, NPS staff should not set hours for cooperator personnel, specify where the work should be done, or conduct performance appraisals. National Park Service staff may give performance feedback to the cooperator personnel supervisor.
* Cooperator personnel should report leave, scheduling, and other related issues to the university or cooperator’s supervisor, not to NPS employees. The supervisor of the cooperator personnel should then communicate with the NPS. National Park Service employees cannot directly supervise cooperator personnel on a day-to-day basis. Work should be given to the cooperator personnel (via the cooperator’s supervisor) on a “task basis.” Cooperators should work without NPS supervision to accomplish each task, although technical consultations and cooperation is permissible.
* The Cooperator will be responsible for any disciplinary action needed to correct student employee conduct or performance problems. The NPS agreements technical representative will inform the university/cooperator’s supervisor of any conduct or performance problems.
* The Cooperator will remove student employees from their positions if they fail to improve performance or address conduct issues.
* The NPS will review and provide feedback to students or interns regarding work assignments.
* The NPS will inform the cooperator of conduct or performance problems with cooperator personnel so that the university can counsel employees and correct the performance problems.
* The NPS will recommend to the cooperator dismissal of cooperator personnel based on conduct or performance issues.
* The Cooperator will hire students, interns or RAs to work on NPS tasks identified in the agreement. Hiring will be conducted in consultation with the NPS Agreements Technical Representative (ATR).
* The Cooperator will: pay students, interns or RAs for hours they have worked in support of the agreement.

**Representation and Communication**

* Cooperator personnel cannot in any way represent themselves to the public as NPS employees.
* Cooperator personnel are required to wear visible identification at all times.

**Other Issues**

* Cooperator personnel should not list an NPS affiliation on publications, but rather should list the cooperative agreement under which the work was performed.
* Cooperator personnel should not be invited to official NPS “social” events.
* Cooperator personnel will follow the local policy of the facility when federal facilities are closed due to early release for holidays, snow days, etc.

**PRODUCTS:**

* Progress report, IAR, draft report, and final report.
* Voucher specimens and curatorial data, if any.
* Digital and tabular data, including GIS files.

**BUDGET:***(You may create your budget in a spreadsheet and attach it as a separate document when you submit your project coversheet and Justification for Use of Financial Assistance.)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Item** | **Rate** | **Unit** | **Number of Units** | **Total** |
| **Salaries** |  |  |  |  |
| **Lead field research** | **$750** | **week** | **3** | **$ 2,250** |
| **Field Assistant** | **$500** | **week** | **3** | **$ 1500** |
| **Dendrochronologist** | **$800** | **week** | **16** | **$ 12,800** |
| **Statistics, writing personnel** | **$800** | **week** | **2** | **$ 1,600** |
|  |  |  |  |  |
| **Benefits (.08 of salaries)** |  |  |  | **$ 1,452** |
|  |  |  |  |  |
| **Travel** |  |  |  |  |
| **Field sites, NPS meetings** |  |  |  | **$ 1,500** |
|  |  |  |  |  |
| **Equipment** |  |  |  | **0** |
|  |  |  |  |  |
|  |  |  |  |  |
| **Supplies** |  |  |  | **0** |
|  |  |  |  |  |
|  |  |  |  |  |
| **Total Direct Costs** |  |  |  | **$ 21,102** |
| **Total Indirect Costs (17.5%)** |  |  |  | **$ 3,693** |
| **GRAND TOTAL** |  |  |  | **$ 24,795** |