RxEffects

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Biotic and Abiotic Factors Contributing to New Mexico's Largest Wildfire: The Las Conchas Fire

Laura L. Trader, Fire Ecology Program Manager, Bandelier National Monument, National Park Service

INTRODUCTION

Many of the biotic and abiotic factors that contribute to fire magnitude couldn't have been more aligned in the days and months preceding the Las Conchas Fire, New Mexico's largest wildfire. The Las Conchas Fire ignited in the Jemez Mountains in north-central New Mexico (Figure 1) at approximately 1:00pm on June 26th, 2011, after an aspen tree fell on a power line. The fire ultimately burned 156,593 acres, with more than 14,000 acres consumed in the first 14 hours (USFS InciWeb), an unprecedented rate of fire spread and forest fuel consumption in this forest type and fire regime (predominantly frequent, low intensity, surface fires). We investigated some of the biotic and abiotic factors that contributed to the Las Conchas Fire magnitude, including weather conditions, fuel moisture, forest structure and composition, slope, aspect, and elevation.

METHODS

To investigate the abiotic factors (Figure 3) that contributed to the magnitude of the Las Conchas Fire, we gathered information regarding slope, aspect, and elevation and analyzed approximately 10 years of meteorological data, including temperature, relative humidity (RH), precipitation, wind speed, and wind direction. All weather data were gathered from a meteorological observation tower administered by the Los Alamos National Laboratory (The Weather Machine 2011). The tower is located at 7,045 feet on the Pajarito Plateau in an open meadow (Figure 1).

To examine several of the biotic factors (Figure 3), we analyzed fuel moisture

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Figure 2. Wind-driven spot fire. June 26, 2011.

Figure 9. Mixed conifer forest in the Jemez Mountains showing high fuel loading and dense forest.

Figure 10. Steep, south facing slopes in the Jemez Mountains.

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data collected by Bandelier's Engine Crew (Bandelier NM, *unpublished data*), and vegetation data collected by Bandelier's Fire Ecology Program (Bandelier NM, *unpublished data*). Twelve fuel moisture samples were collected on June 13th, 2011 on Cerro Grande and Scooter Peak in Bandelier National Monument, approximately 5 miles from the Las Conchas Fire ignition point (Figure 1). The data was used to estimate live and dead fuel moisture. The vegetation data was collected in 2008 in a mixed conifer forest (elevation ranging from 7,500 to 9,500 ft.) in Bandelier National Monument (Figure 1). The analysis produced estimates of tree species and densities, fuel type, and surface fuel loading.

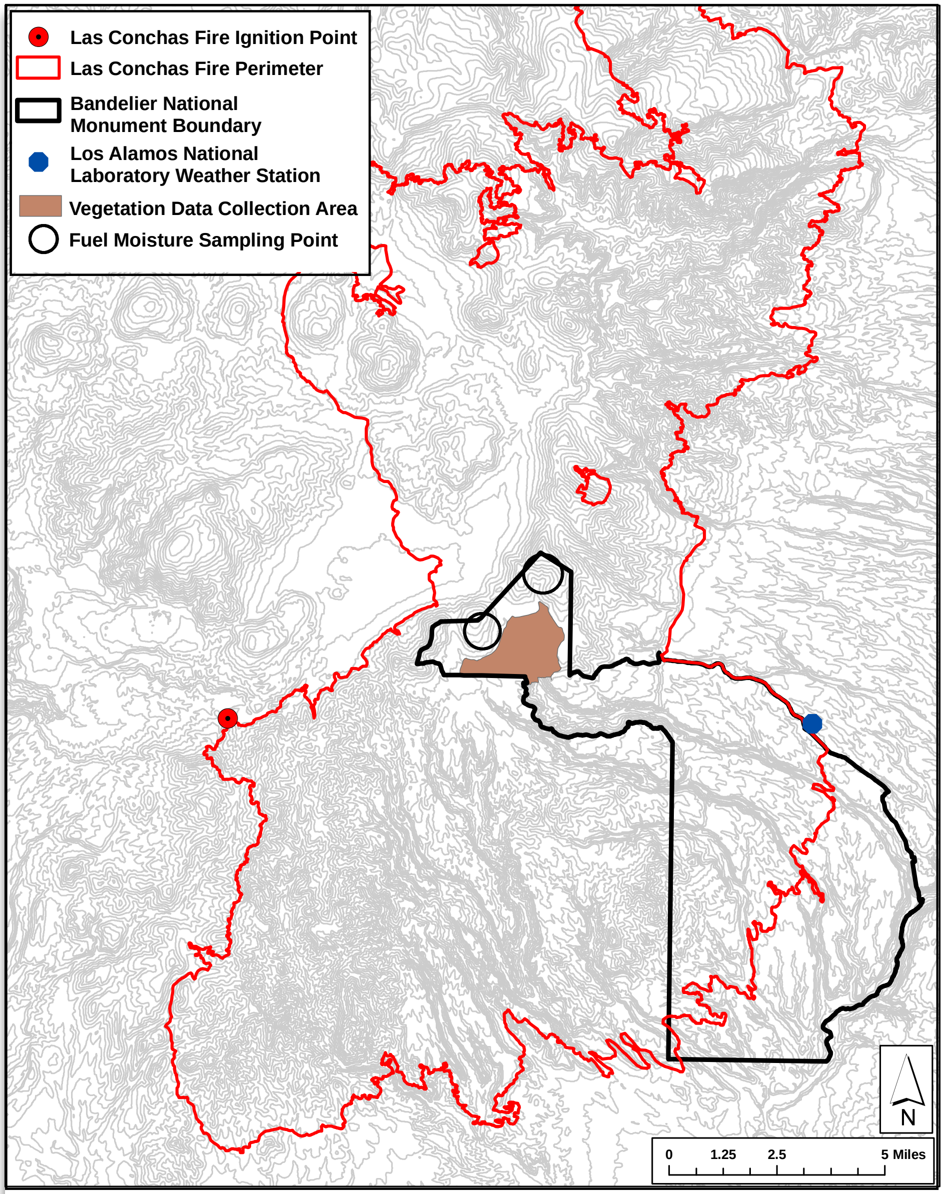

Figure 1. Area map

RESULTS AND DISCUSSION

Weather Conditions

We summarized the temperature, RH, and wind speed and direction for June 23rd – 29th, 2011, three days preceding the ignition of the Las Conchas Fire, the day of ignition (June 26th), and three days following ignition. We discuss precipitation for Water Year 2011 and compare it to average precipitation for the previous eleven year period (2000-2010).

Temperature

The maximum air temperatures in degrees Fahrenheit from June 23rd –June 29th, 2011, were 93.7, 92.3, 91.8, 89.2, 86.5, 88.9, and 90.7, respectively (Figure 7). For comparison, the average maximum temperature for June from 2000-2010, the previous eleven year period, was 82.7°F. The high air temperatures during the seven day period surrounding the ignition of the Las Conchas Fire had an influence on fire magnitude in two important ways.: 1) high air tem-

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peratures increased fuel temperatures, reducing the amount of heat required for ignition and the continuation of the combustion process. 2) high air temperatures reduced the RH and fuel moisture content.

Relative Humidity

The minimum RH, expressed in percent, from June 23rd – June 29th, 2011 was 4, 3, 4, 5, 9, 8, and 8, respectively (Figure 4). The average minimum RH for June from 2000-2010 was 12.5%. The amount of moisture in the air in the days surrounding the ignition of the Las Conchas Fire was critically low, thereby reducing fuel moisture content and increasing flammability of fuels.

Precipitation

Precipitation for the 2011 water year (October 1, 2010 – September 30, 2011) in the months leading up to the Las Conchas fire was well below the average for the same months of the previous eleven year period (2000-2010) (Figure 5). At the end of June, when the Las Conchas Fire ignited, total precipitation at that point in the water year was recorded at 3.69 inches, only 25% of the average (14.66 in.) for the 2000-2010 water years, with only three months remaining in the water year. The significant lack of precipitation leading up to the Las Conchas Fire had a direct and critical influence on fire magnitude by contributing to rising air temperatures, and causing low RH and low fuel moisture.

Wind

From June 23rd – 29th, 2011, maximum 40 ft. wind gusts (mph) were recorded at 35.6, 31.8, 35.1, 38.9, 37.6, 39.6, 35.6, respectively (Figure 6). Maximum 150 ft. wind gusts were 36.7, 41.4, 42.1, 47.6, 41.2, 52.1, 38.7 for the same time period (Figure 6). For comparison, the average maximum 40 ft. wind gust for June from 2000-2010 was 31.5 mph, and 35.6 mph for 150 ft. winds. All recorded maximum 40 ft. and 150 ft. gusts from June 23rd – 29th were higher than average. Winds were predominantly S-SW and had a strong effect on the Las Conchas Fire magnitude by increasing the supply of oxygen to the fire, reducing fuel moisture by increasing evaporation, causing preheating of fuels by pushing the flames closer to the fuel, increasing the rate of fire spread, and causing the fire to crown and spot ahead of the main fire (Figure 2).

Fuel Moisture

Fuel moisture samples showed an average live fuel moisture content of 101.9% in Ponderosa Pine (*Pinus ponderosa*) and 103.6% in Douglas Fir (*Psuedotsuga menzisii*). According to the Southwest Area Fuel Moisture Monitoring Program Guide, fuel moistures at this level will "exhibit high fire behavior leaving no material unburned" (SW Area Fuel moisture monitoring program, 2004). Dead 1000 hour fuel moistures

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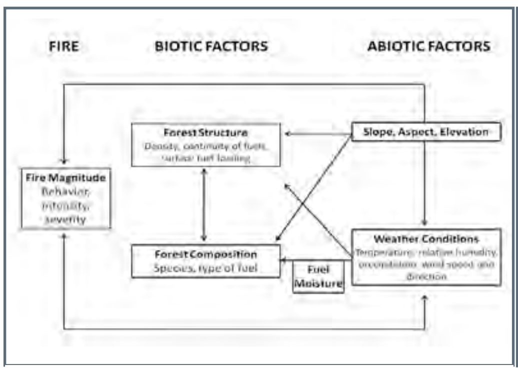

Figure 3. The relationship between the biotic and abiotic factors investigated in regard to the Las Conchas Fire magnitude.

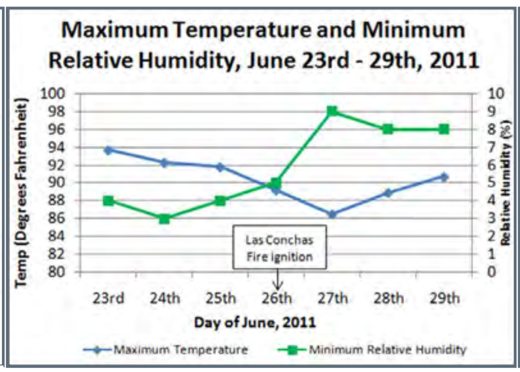

Figure 4. Maximum Temperature and Minimum RH.

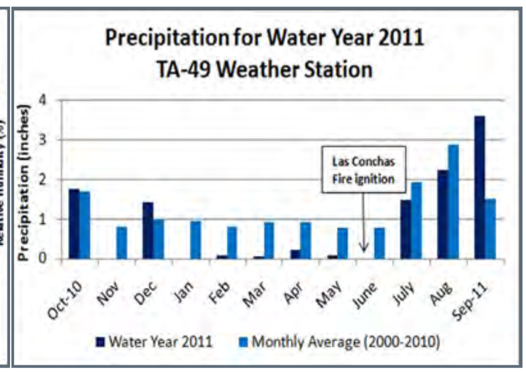

Figure 5. Precipitation for Water Year 2011.

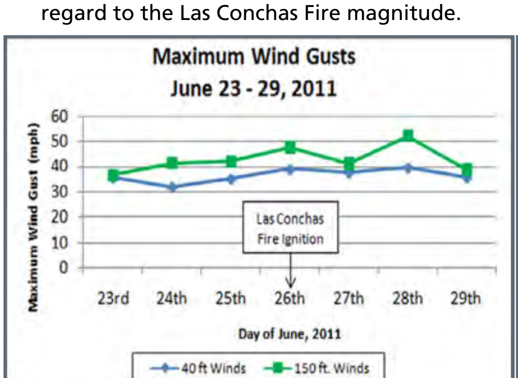

Figure 6. Maximum Wind Gusts

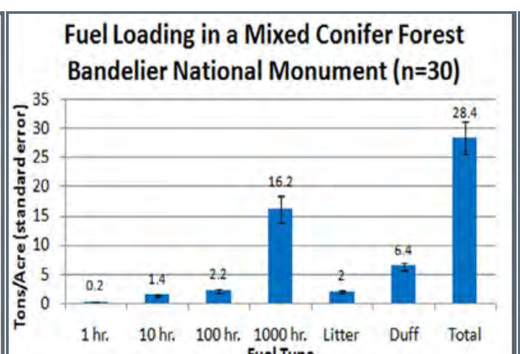

Figure 7. Fuel loading in a mixed conifer forest in Bandelier NM.

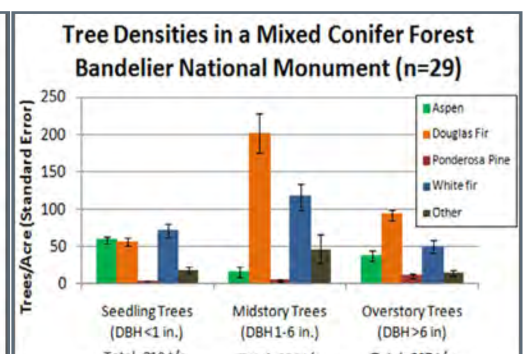

Figure 8. Tree densities in a mixed conifer forest in Bandelier NM.

Building Resilient Native Hawaiian Ecosystems in a Novel Fire Regime

Sierra McDaniel, Rhonda Loh and Mark Wasser, Hawai'i Volcanoes National Park

Wildfires, fueled by non-native grasses, are highly destructive to native ecosystems in the mid-elevation seasonal environment at Hawaiʻi Volcanoes National Park (HAVO). Following wildfires, native woody vegetation, especially the community dominants, ʻōhiʻa (*Metrosideros polymorpha*) and pukiawe (*Leptecophylla tameiameiae*) suffer high mortalities, and are unable to re-establish in competition with fast growing alien grasses. In contrast, fire-adapted non-native grasses recover vigorously and increase fine fuel loads up to three-fold greater than in adjacent unburned areas thereby increasing the risk for future wildfires in the area. Ultimately, repeated fires without active management efforts result in a conversion of open canopied woodland to alien grassland savannahs. Since the 1970's, approximately one half of seasonally dry ʻōhiʻa woodlands have been converted by fire to alien savannas in the park. Vegetation recovery following the Broomsedge fire in 2000 was expected to follow this pattern.

The 405 ha Broomsedge fire provided an opportunity for resource mangers at HAVO to apply results from small scale field and laboratory experiments to change this pattern and maintain native structure and diversity in an ʻōhia woodland invaded by non-native grasses. Trying to restore formerly dominant but fire-sensitive ʻōhiʻa and pūkiawe was impractical given the widespread abundance of alien grasses and inevitability of future wildfires. Instead managers adopted a rehabilitation approach by creating a replacement community of fire-tolerant native plants that could survive and ideally spread in the new grass/fire cycle. The potential for some native species to survive wildfire and colonize rapidly became apparent from fire effects studies and through several research burns conducted in the 1990s at HAVO. These species were identified by their ability to recover from fire by re-sprouting or to recruit prolifically from seeds applied before and after research burns. Many of these species were once common to the area but were eliminated by introduced feral goats that roamed the park over the last two centuries. Goats were eliminated in the mid-1970's, but lack of available source material limited natural recovery of many native plants.

Ko'oko'olau (*Bidens hawaiensis*) was one of 12 planted species that was reproductive 10 years following fire. Maturation of these fire tolerant plants is critical to establishment following future wildfires.

The BAER funded rehabilitation of the Broomsedge Fire was HAVO's first attempt at establishing fire-tolerant native species following wildfire. Over 2.5 million seeds of four species were broadcast and 14,000 nursery reared seedlings of 15 species were planted into 693 plots following the fire. Seeding was conducted within six months and planting was carried out over a 3 year period. The assumption, at the time of the rehabilitation effort, was that individuals would mature, reproduce, and eventually establish a soil seed bank for future proliferation with the next fire event. Based on recent fire history, the interval between fire events was anticipated somewhere between 10 to 25 years in the park's dry ʻōhiʻa woodlands. Consequently, monitoring the success of the revegetation effort ten years following the fire was critical for evaluating the success of the rehabilitation effort, providing information to managers that would improve future rehabilitation efforts, and providing a valuable baseline for comparing plant community response to the next wildfire that would occur in the area.

Park staff measured re-vegetation success in fifty 20 x 30 m permanent plots. Forty plots were established in the burn, twenty inside augmented

Hawai'i continued on page 12

Changes in Forest Community Structure and Fuel Loading Following the American Elk Prescribed Fire

Dan Swanson, Northern Great Plains Fire Ecologist, National Park Service

The largest prescribed burn in the history of Wind Cave N.P. was completed October 20-21, 2010. The 3,450 acre American Elk unit was located primarily within forested communities of the park, but also included mixed-grass prairie, prairie dog towns, and ponderosa pine encroached meadows. The primary objective of the burn was to restore fire back into the project area since most of the unit hadn't experienced fire since the Park's creation in 1903. Additional resource objectives included reducing overstory, pole, and seedling densities.

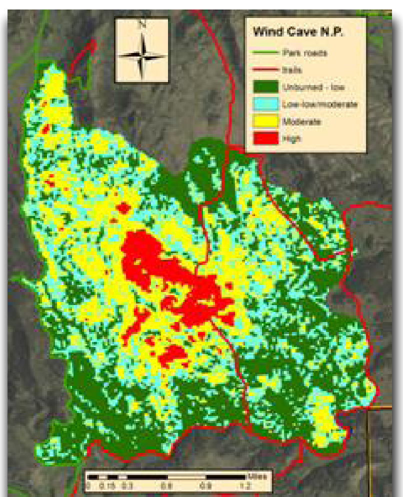

Figure 1. American Elk prescribed fire calibrated burn severity assessment map.

We also wanted to decrease the dead and down fuel loading within the forested communities and encroachment of ponderosa pine regeneration at the forest-prairie ecotone.

The first day of the burn consisted of two ignition teams blacklining approximately 12 miles of burn perimeter. Day two involved blacklining the final half-mile of burn perimeter and interior helicopter ignition. Approximately 39% of the unit was unburned to low, 29% low-low moderate, 26% moderate, and 6% high severity (Figure 1) based on the analysis of 48 CBI plots that were installed within the four burn severity classes.

This unit had seventy-five fire effects monitoring plots established in it which was the most for any unit and park within the Northern Great Plains park group. Fifty-seven of these plots were associated with a three-year invasive plant research project which was funded by research reserve funds. Since the research project's sampling design and plot layout were identical to most of the Northern Great Plains fire effects plots, I was able to analyze sixty of the fire effects plots together. All plots were read pre-burn between 2008 and 2010 and year 1 post-burn in 2011. Resource objectives included: 1) achieve 20-50% mortality in overstory ponderosa pine (>6" dbh), 2) achieve 50-70% mortality in pole-size ponderosa pine (1-6" dbh), 3) achieve 70-95% mortality in ponderosa pine seedlings, and 4)achieve > 40% reduction in 100 and 1000 hr fuel loading.

The paired fire effects data was analyzed for relative change using ratio of means (RoM) at an 80% confidence level. There was an average 29% mortality of overstory ponderosa pine trees with 80% confidence that it decreased between 23 and 37%. Pole-sized ponderosa pine decreased an average 64% with 80% confidence the mortality was between 55 and 72%. Ponderosa pine seedlings decreased an average 72% with 80% confidence the mortality was between 59 and 81%. 100 hr fuels decreased an average 61% with 80% confidence this fuel loading class decreased between 51 and 70%. 1000 hr fuels decreased by 36% with 80% confidence this fuel loading class decreased between 11 and 50%. Four of the five resource objectives were met and statistically significant with the fifth objective (1000 hr fuels) only slightly below target levels.

The several thousand acre unit allowed the prescribed fire to burn over multiple burn periods and weather conditions which replicates natural fire activity. The use of a helicopter provided for fire fighter safety by eliminating the need for interior hand ignition and enabled us to achieve a mosaic of burn severities across the landscape. Prescribed burns at Wind Cave N.P. are an integral tool for restoring these forests to their naturally diverse structure.

Figure 2. Passive tree torching shortly after helicopter ignition commenced on October 21.

A comparison of spring and summer fires in red and white pine stands at Voyageurs National Park

Scott Weyenberg, Great Lakes Ecoregion Fire Ecologist, National Park Service

INTRODUCTION

Prescribed fires in Northern Minnesota are typically conducted during a brief dry period in late spring. Historically however, naturally ignited fires typically took place in the summer when lightning occurred. Only one large naturally occurring fire has taken place in the park in recent history, which was in 2004. Summer prescribed fires have occurred in 2007 and 2009, with all other prescribed fire treatments occurring in the dormant season. These fires provided a unique opportunity to examine the differences in effects between spring (dormant season) and summer (growing season) fires. The focus of the analysis was to determine if **ground layer species composition differ significantly among the pre-fire, spring and summer burn treatments?**

Field observations of the sites revealed obvious differences in post-burn vegetation. Spring fires tend to propagate the same species that were present pre-burn, whereas summer fires tend to bring about a new suite of species though the germination of the seedbank.

METHODS

Since this was a retrospective study, there were some inconsistencies among the sampling methods. Some plots used point intercept transects while others used fixed radius plots to sample the ground layer. To rectify the situation, data were simplified to presence/absence per plot. Data were collected at regular intervals, pre-fire and 1, 2 & 5 years post-fire. Ten spring and four summer treatment sites were all red or white pine communities.

Analysis

Ordination techniques were used in all the analyses. These were found to be a very efficient tool to deal with the high numbers of “zeros” and individual species found in the dataset. Specifically, Non-metric Multidimensional Scaling (NMS), Multiple Response Permutation Procedures (MRPP), Two-way Cluster Analysis (cluster analysis) and Indicator Species Analysis (ISA) were all used to explore and analyze the data using PC ORD software (McCune and Mefford 2006). It is understood that the discrepancies in sampling procedure make valid statistical inferences more or less impossible. However, the purpose is to validate what is already obvious in the field and to tease out some specific details.

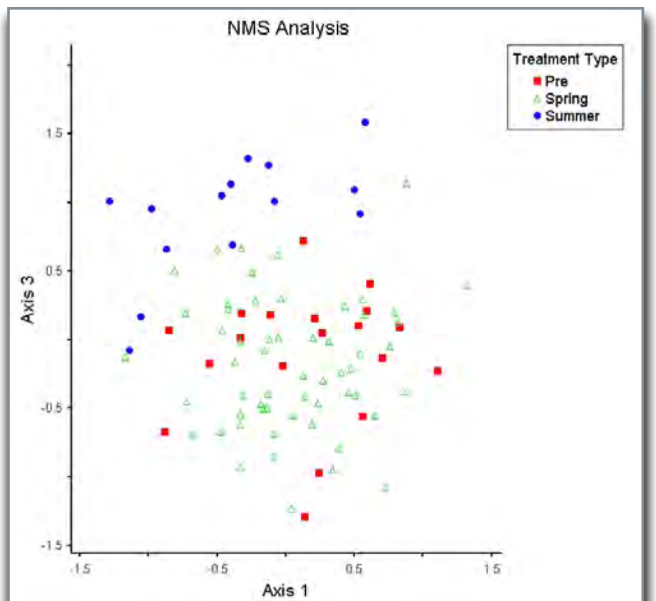

Figure 1. NMS ordination on the full dataset using summarized PLM plots. Model stress = 22.02. A Sorenson distance matrix and three axes were used.

RESULTS AND DISCUSSION

NMS

The NMS analysis produced noticeable clustering and separation of the summer dataset (Figure 1, blue). The pre-fire (red) and spring (green) dataset clusters occupied the same ordination space showing little difference in species composition.

MRPP

The MRPP analysis tested differences among the three treatment types (pre-, spring post- & summer post-fire) and among the years since fire by treatment (Pre, 1, 2 & 5 spring, and 1, 2 & 5 summer). The results showed significant differences between all treatment types although, the NMS showed significant overlap between the spring and pre-fire groups ($p < 0.0002$). This significance may be in part an artifact of the high number of plots and species used in the matrix, 90 plots by 61 species. Given the influence of the large dataset, contrary NMS results and comparisons with the summer group that yielded p-values of less than 10^{-8}, one can conclude the spring and pre-fire groups are not that different. This will be further explored in the cluster analysis.

The test for differences among year groups showed that years 1 and 2 post-fire (spring or summer) were not significantly different within a treatment ($p > 0.05$), which is no surprise. All other comparisons were significantly different ($p < 0.05$), i.e. pre vs. all post-fire years, spring year 1 vs. 5, and spring post-fire years vs. summer post-fire years. In short, the time since fire does not appear to play as large a role in accounting for

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Spring/Summer continued from page 6

differences in the dataset as do the treatments. However, by year 10, time will likely have a more noticeable effect.

Cluster Analysis

The cluster analysis helped visualize how sample sites are grouped with respect to species composition and specifically how each treatment group differed. The analysis reveals a very distinct subset of species that are universally common to all the sites and all years (Figure 2, black outline). This subset or "core set" includes species such as large-leaved aster, bracken fern, blueberry, Canada mayflower and wild sarsaparilla. A secondary set of common species was also revealed (yellow), which includes raspberry, Canadian dogwood, beaked hazel and bush honeysuckle. A unique set of species was identified for the summer post-fire dataset (blue). Species in this set include, *Dicranum* mosses, common liverwort, Bicknell's geranium, black bindweed, *Epilobium* species and sedges.

The analyses grouped some of the pre-fire and spring-fire sites at relatively close levels confirming the NMS analysis and the assumption that the two groups share some similarities as stated in the MRPP discussion. The summer post-fire sites were placed into distinct groups with their pre-fire conditions being placed with the rest of the dataset illustrating the uniqueness of the post-fire effects. The spring post-fire and pre-fire plots are grouped in many different sets indicating a lack of significant difference in species composition between them. This will be explored further in the ISA below.

Indicator Species Analysis

The ISA provided some specifics to the previous findings by identifying species that set groups apart. Within the summer treatment group, 21 species were found to be significant identifiers (Monte Carlo test, $p < 0.05$). They consisted of mainly pioneer species and re-sprouting shrubs. The pre-fire group had five significant species, with four being lichens or mosses, while the spring group had no significant species.

The unique nature of summer group is clear and has to do with the presence of a large number of species that are either not present or are infrequent among the other two groups. The pre-fire group shows some unique character with the presence of a few species common mainly to older stands. The spring post-fire group does not show any particular uniqueness to it. It has species in common with both the pre-fire and summer

Spring/summer continued on page 16

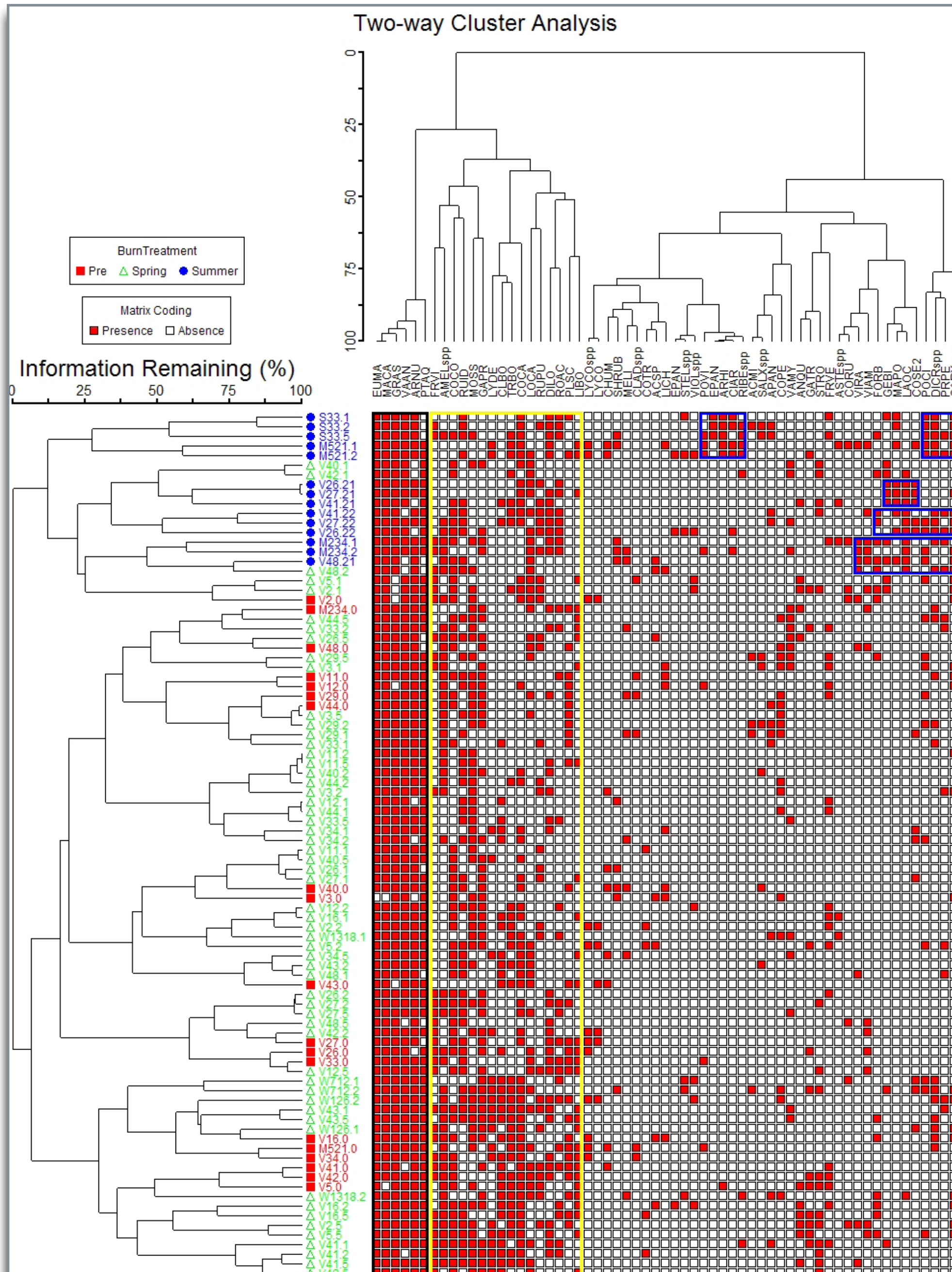

Figure 2. Two-way Cluster Analysis on pre-fire, post-fire spring and summer data. Data are grouped by fire treatments. The dendrogram tree was rearranged to consolidate the treatment groups as best possible; this does not change the results. Colored boxes: black - universally common species, yellow - secondary common species, blue - species mainly specific to summer fires. Distance measure = Euclidean; Linkage method = Ward's.

The Wildfire Ecology of Wetland Landscapes

Adam Watts, University of Florida

The ecological effects of fire often are difficult to ascertain in uplands, and wildfires in wetlands pose added challenges. The rare nature of fires in places like swamps, marshes, and bogs provides few opportunities to understand how fires influence these ecosystems. When wildfires do happen, it is often under conditions of severe drought, and difficulties of site access for research and monitoring are compounded when the return of normal hydrologic conditions places them under water. However, the habitat and ecosystem services provided by wetlands make understanding the role and impacts of fire in them a key goal from a natural-resources standpoint. Additionally, drought-condition fires that consume organic soils—peat or muck fires—are associated with high control costs, human safety impacts, and global implications due to massive carbon release. Two ongoing research collaborations with the University of Florida will help to shed light on wetland fire effects from the standpoint of forest structure as well as feedbacks to future fire events.

At Big Cypress National Preserve (BICY) in southern Florida, a patchwork of pinelands, prairies, and pondcypress (*Taxodium distichum* var. imbricarium) swamps extends across 750,000 acres from the peninsula's interior to its mangrove-fringed coast (Figure 1). With a subtropical climate and the National Park Service's most extensive prescribed-burn program, BICY has a year-round fire season that includes winter prescribed burns and abundant lightning ignitions from summer thunderstorms. With most of its rainfall occurring from June to October, the landscape also experiences hydrologic extremes. By the time summer rains begin, swamps may become so dry that fires from adjacent pinelands or prairies do not stop at their edges. During severe droughts, as have occurred in recent years, the peat-like soils of swamps may become so dry that they will ignite during wildfires. The 2009 Deep Fire burned over 30,000 acres including many small cypress swamps; and the NPS Fire Ecology Program supported research to investigate patterns of severity and tree mortality in these areas, called domes because of their characteristic shape (Figure 2).

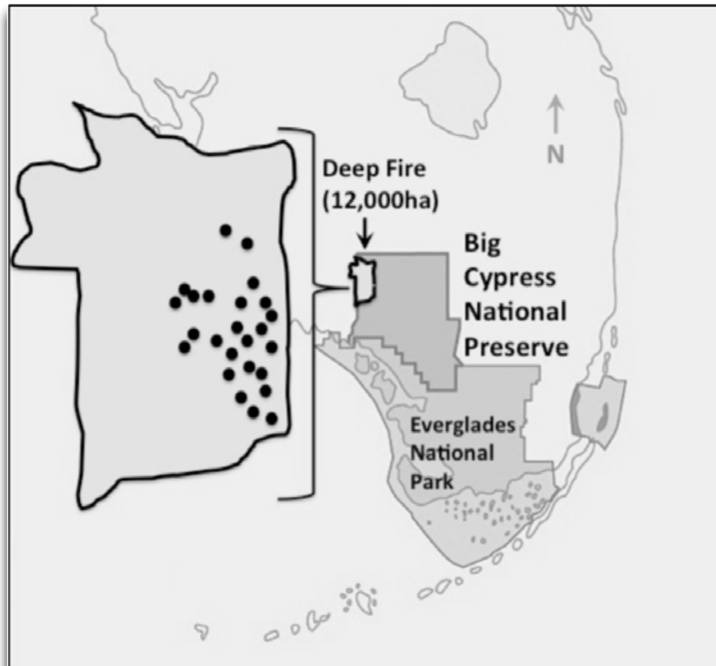

Figure 1. Big Cypress, adjacent to Everglades National Park in southern Florida, covers 750,000 acres. It was the site of the 30,000-acre Deep Fire in 2009, which provided opportunities to study fire effects on forest structure and microclimate. Black dots represent the locations of study sites in small pondcypress swamps called domes.

Expectations were that fire severity measures, assessed using the ground-truthing component of CBI, would be greatest at the edges of the cypress swamps and decrease toward their centers, where shadier conditions and shallow depressions in the soil make for cooler, moister conditions. These swamp patches vary considerably in size, and we also expected to see lower severities in the centers of larger domes. While we did see higher severities at the edges of swamps than in their centers, it appeared that the severe drought brought soil moisture values down so low that there was no protective effect of patch size on fire severity.

Fire-caused mortality of cypress yielded some interesting findings. Shortly after the fire, nearly all (99.5%) of the trees in the study plots put out new leaves. It was not until the year following the fire that mortality began to show, and an average of 23.5% of the cypress tress died. While we will continue to track mortality in the plots for an additional season, 2-year mortality surveys indicated only a handful of additional pondcypress trees (around 1% overall) had died during the second year. We learned that fire severity and cypress tree mortality are related—an intuitive expectation, and true in part because tree damage is incorporated into severity measures. However—and counter to what we expected—severity is not one of the major predictors of post-fire mortality among pondcypress. Instead, the

Wetlands continued on page 9

Figure 2. This small patch of pond cypress is locally called a dome due to its characteristic profile, with small tress at the outside and larger trees nearer the center. While it has long been known that this shape results partly from the influences of soil and hydrology, research supported by the NPS Fire Ecology program led to the discovery that fire plays an important role in shaping these landscape features.

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two most important factors are tree size (which is also obvious) and elevation (which is not). Trees growing in lower places are more likely to die following a severe fire, possibly because these areas have thicker organic soils (which are subject to combustion, damaging roots); also, longer inundation in these sites may produce greater flooding stress on trees damaged by fires.

A major surprise of this research was the discovery that fire is a major cause of the shapes of cypress domes. It is widely accepted that thicker soils and lower elevations (which lead to longer hydroperiods) at the centers of cypress domes lead to better growing conditions for trees there, resulting in their greater sizes than the stunted "hatrack" cypress trees at the edges of domes, which resemble large bonsai. This project revealed that fires during droughts tend to kill smaller trees in the centers of domes, possibly because their roots are not as well established in deep mineral soils that are unaffected by peat-consuming, severe fires. Meanwhile, the smaller trees at the edges of domes are topkilled, reducing their height. This stunting effect appears to be durable, as our surveys two years post-fire saw relatively little increase in height among these edge trees (as opposed to a rapid height-growth response one might see in other species). Thus, fire turns out to be a natural process that exaggerates the dome-shaped profile we see where these small swamps occur in fire-prone landscapes. The results of this study are published in the current issue of the journal Wetlands, and our next steps include preparing a document oriented toward fire and natural-resource managers.

A separate study conducted in the perimeter of the Deep Fire and in adjacent areas, is examining effects of fire, hydrology, and forest structure on microclimate. Specifically, we want to know whether changes caused by a severe, drought-condition wildfire in swamps can alter the effects of future fires there. Our initial expectations are that tree mortality will lead to increased large fuel loads, while reducing shade and evapotranspiration—thus leading to higher temperatures and lower humidity. If this is the case, then future scenarios of climate change (which predict conditions that would increase fire effects in wetlands) will include a positive feedback to fire effects, which could be devastating to small patches of wetlands that many wildlife species depend on for habitat and food.

Our approach involves installing sensors on trees in a number of locations in these patches (Figure 3) that record temperature and relative humidity at short time intervals. The end result is a detailed reading of the microclimate history from each sensor's location, from which we expect to determine whether feedbacks from climate to potential fire severity exist. If we find that this is the case, it could help managers design strategies to reduce current fire impacts to these important areas to better ensure their persistence on the landscape in the event that predicted scenarios of climate change do occur.

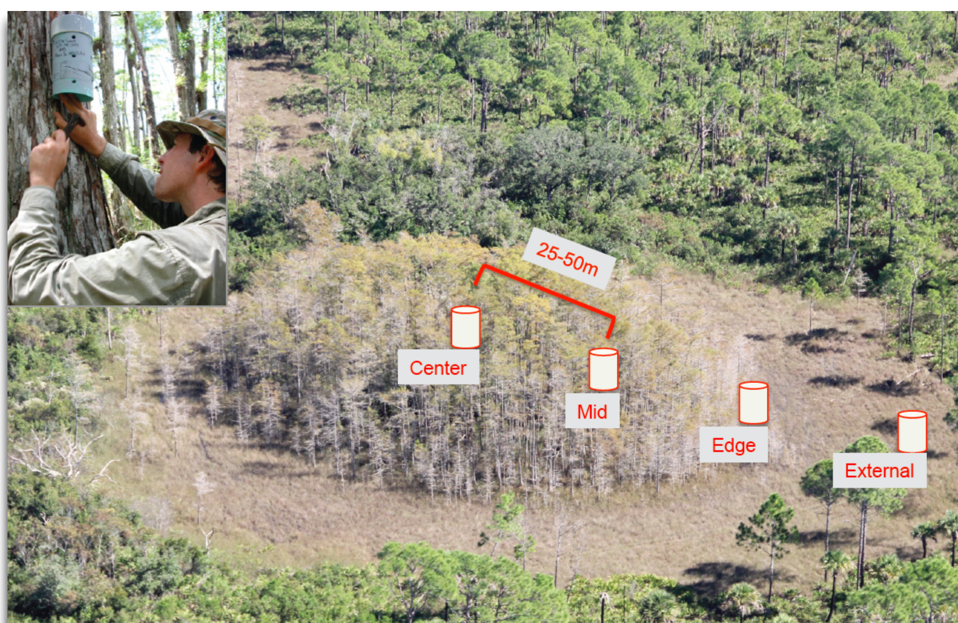

Figure 3. Installing sensors at various locations in these cypress swamp patches will help us to determine whether feedbacks exist that could threaten their persistence in a warming, more fire-prone climate.

Fire Fuels Research in the War on Buffelgrass

Perry Grissom, Fire Ecologist, Saguaro National Park

An unprecedented threat to the Sonoran Desert and the resources of Saguaro National Park has emerged. Buffelgrass (*Pennisetum ciliare*, syn. *Cenchrus ciliaris*), an invasive grass from Africa, has been introduced into the area and is spreading exponentially in undisturbed desert. It converts diverse desert plant communities into grassy monocultures. In 2008, it was estimated that Saguaro NP had about 2,000 acres of buffelgrass, and the adjacent Santa Catalina Ranger District of the Coronado National Forest was estimated to have about 5,000 acres. It is spreading across all government jurisdictions and private property--urban and wilderness alike. Research and monitoring data indicate an exponential rate of increase ranging from 10 to 35% annually, which means that it is capable of doubling in area every 2-7 years.

People are coming together to fight against this tide. The Southern Arizona Buffelgrass Coordination Center (see www.buffelgrass.org) was formed, and among other things, this interagency, multidisciplinary group has identified research needs. Some of the most pressing research needs have been funded through the NPS Fire Fuels Reserve Funds.

The first funded project involved determining the proper fuel model for buffelgrass. Under Dr. Guy McPherson, University of Arizona, PhD candidate Chris McDonald measured fuel loading in Saguaro NP and on private land belonging to Tucson Water. The Tucson Water property was subjected to a prescribed burn, and fire behavior measurements were collected. They found buffelgrass stands in the park with fuel loads varying from 1.1 to 3.9 tons per acre. Fire behavior observed on private land (with fuel loads of 3 to 5.4 tons per acre), coupled with the fuel load data, indicates that fuel model GR4 (Moderate Load, Dry Climate Grass) is the best single fuel model for most buffelgrass stands within Saguaro NP. Fire temperatures recorded during the burn were mainly 1,300-1,600F, significantly higher than ever recorded for fires in the Sonoran Desert. Flame lengths under moderate conditions were 12-18 feet. In addition to clipping, Chris and his assistants measured plant species composition in buffelgrass stands. Native plant cover and richness both declined as buffelgrass cover increased.

The purpose of a study done by Dr. Molly Hunter, Northern Arizona University, was to evaluate effectiveness of treatment techniques for buffelgrass, as well as environmental factors that determine success or failure of buffelgrass control efforts. This information will help determine location of future treatments, and may give insight into site invasibility. The focus of the project was past treatments in Saguaro National Park and Organ Pipe Cactus National Monument. Buffelgrass control treatments were less effective on south-facing aspects and on steeper slopes. Treatments were more effective in seasons with higher rainfall. Buffelgrass was effectively controlled when multiple treatments occurred in consecutive seasons and when both manual and chemical treatments were used. Because buffelgrass

Experimental prescribed burn of buffelgrass conducted on Tucson Water property to observe fire behavior and determine the appropriate fuel model (NPS Photo).

Buffelgrass continued on page 11

Buffelgrass continued from page 10

cover, density, and patch size all decrease with treatment, monitoring can be difficult. Dr. Hunter recommended establishing fixed area plots within buffelgrass patches in which density and cover could be measured.

A different study with the objective of finding a more selective herbicide by studying the effects of herbicides on buffelgrass and non-target native species was partially funded by fire funds. The work was done under the direction of Dr. Mitch McClaran, University of Arizona, by Drs. Grant Casady and Travis Beane. Unfortunately, the two grass-specific herbicides that were tested were minimally effective on buffelgrass. The good news is that glyphosate, currently the main tool against buffelgrass, had little effect on saguaro cacti (*Carnegiea gigantea*) and little leaf paloverde (*Parkinsonia microphylla*) after one year.

The most recently funded project will attempt to determine weather factors that control buffelgrass green-up. The research will also involve developing a model for basin-wide green-up prediction. This will allow herbicide treatments to be better planned in order to take advantage of the sometimes very narrow windows of opportunity.

These research results are being used to inform treatment decisions in the park and for our collaborators. This includes providing input into a decision support model being developed by the US Geological Survey and ESSA Technologies. As an added benefit, data, photos, and video from these studies is widely used by the NPS and our partners in firefighter safety training and public education and outreach efforts.

A young saguaro cactus, one year after experimental treatment with the herbicides glyphosate and imazapic, showing no ill effects (UA photo)

Buffelgrass fuel loads in Saguaro National Park. In the background is a stand of 3.9 tons per acre of live, dormant buffelgrass. The foreground was treated three years previously and followed up to prevent reinvasion. Decomposition of the dead plants has lowered fuel load there to 1.2 tons per acre and broke up fuel continuity, which is likely to prevent fire spread (NPS photo).

The park has been involved in several other research projects that have been paid for by other fund sources and done in conjunction with other agencies. These include testing additional herbicides for selectivity, investigating the use of aerial application of herbicides, developing restoration techniques for treated areas and burned areas, remote-sensing of buffelgrass, and investigating the effects of buffelgrass on Sonoran Desert tortoise. These fire-funded research projects are all part of the larger effort to control buffelgrass, thereby protecting public safety and the plants and animals that make Saguaro NP and the Sonoran Desert so unique.

Hawai'i continued from page 4

(planting/seeding) plots and twenty non-augmented (no planting/no seeding) plots to compare vegetation changes following fire and management. Ten additional control plots were established in adjacent unburned 'ōhi'a woodlands. Inside the plots, vegetation abundance (% cover), the number of species (species richness), and density of shrub and tree seedlings were recorded, following modified protocols described in the Fire Monitoring Handbook (FMH). Modifications to the FMH protocols included a reduction of plot size to 20 x 30 m, and trees categorized by basal diameter rather than DBH. Monitoring was conducted in summer 2001, 2003, and 2010. Vegetation differences between augmented, non-augmented, and unburned control plots were evaluated using a one-way ANOVA and Tukey's multiple comparisons (Minitab v. 15). Non-parametric equivalents were used when the data did not meet the assumptions of the statistical model. Planted seedling survival and reproduction was determined by counting the number of individuals in plots, and was measured in 2004 and 2010. Survivorship of planted species was summarized as the percent of live individuals among the total number of individuals that were monitored across all sample plots.

Overall, planting of fire-tolerant native species was successful. Planted individual survival was high in the five years following the burn (72%). By year ten, 12 of the 15 species had reached maturity and six species had recruited seedlings. Ten year survivorship ranged from 59% for 'iliahi (*Santalum paniculatum*), to 0% for three species pua kala (*Argmone glauca*), 'emoloa (*Eragrostis variablis*), and hō'awa (*Pittosporum confertiflorum*). Due to abundant seedling recruitment in planted plots, individual plant survival could not be determined for koa (*Acacia koa*) and na'ena'e (*Dubautia cilolata*). Each of these species had relatively high survival rates (58-96%) in 2004 and were observed reproducing and recruiting in 2010.

The number of native species, percent cover of native species, and native tree density was significantly higher in the planting/seeding plots compared with the non-augmented plots in the burn. The number of native plant species and tree density in planting/seeding plots was equal to the unburned area, but percent cover of native woody species was still well below values in the unburned plots.

Rehabilitation of native species in the Broomsedge Burn serves as a model for restoration in other fire-affected dry 'ōhi'a woodlands at HAVO. Evidence of seedling recruitment and reproductive maturation of fire tolerant plants established in the burn was important as they implied the availability of seeds in the soil for plant establishment following future wildfires in the area. Since the Broomsedge Burn, three wildfires (Kupukupu (2002), Panau Iki (2003), Kipuka Pepeiao (2004)) have affected over 1,200 hectares of dry or transitionally dry 'ōhi'a woodland. Similar efforts to build resilient native plant communities in the new fire regime have been conducted in portions of the Kupukupu and Pepeiao burns. The full impacts of HAVO's rehabilitation efforts will be realized over time, future fires, and continued monitoring.

Fire Consortia Get Rolling Nation-wide

Sherry Leis, HTLN Fire Ecologist, National Park Service

The Joint Fire Science Program (JFSP) is an interagency program that funds the development of fire science. JFSP has been in existence for more than a decade and has funded over 450 projects in the areas of software system integration, smoke and emissions, fuel treatment effectiveness and effects. Some of this work has included syntheses and short briefs of the research projects. More recently, they have seen the need to expand their outreach efforts. Regional fire consortia have been proposed and developed across the country. Eight consortia were approved last year and the remaining consortia were approved in January 2012 (Figure 1).

These new regional consortia are tasked with finding ways to disseminate fire science to managers and practitioners, but also to develop a feedback mechanism so that researchers and funders better understand the information needs of the field. To do this, each consortium will develop a website, reach out by social media, and develop innovative approaches to sharing fire science. Other outcomes of this effort can include more cohesive fire communities and encouraging new members to the field. You can reach the consortia through JFSPs web portal: http://www.firescience.gov/JFSP_consortia.cfm.

The consortia are funded in two year intervals. The program is intended to be funded for the long term, so careful development at the outset is important. Each consortium has a governing board

Consortia continued on page 13

Consortia continued from page 12

Figure 1. Regional knowledge exchange consortia sponsored by the Joint Fire Science Program.

to oversee the work. Each consortia has a coordinator, but relies on volunteers to help carry out the mission.

Fire ecologists interface with both fire science and operations on a regular basis making them ideal candidates for working with the consortia. Fire Ecologists are in an ideal position to support the work of fire consortia in several ways. 1. Spread the word to your own network. 2. Volunteer to share fire science by writing a brief or synthesis. 3. Give a webinar, workshop, or host a field tour. 4. Share research needs with the coordinator. 5. Send in information about meetings and events. 6. Lend your expertise to answer questions submitted to "ask an expert" forums. Lastly, the consortia will be evaluated using feedback from their network through surveys, so *please* make time to answer the surveys that come to your inbox! Even though there are many opportunities to contribute to the consortia, fire ecologist can also benefit through these strengthened fire communities.

FFI – What can the new version do for you?

MaryBeth Keifer, Fire Management Program Center, National Park Service

The next version of FFI (1.04.02) is soon be ready for release. User-requested updates designed to improve the FFI experience in this version include the ability to save queries to improve the efficiency of the Query Tool. Saved queries are created at the Administrative Unit level, saved on the local machine and accessible by any user who can log on to the local machine. This feature will save time when users want to repeat certain queries/calculations multiple times. There is no limit to the number of queries that can be saved.

A long-awaited update for Reports and Analysis is a new Custom Report which lets users create reports with customized Seedling, Sapling and Individual Tree size classes. Also the FVS export files are now updated to use the latest database format for FVS and we fixed some issues with calculating the number of plots used in averages when protocols were not visited for a sample event.

FFI v1.04.02 also includes an export utility to provide FuelCalc files directly from the FFI database. FuelCalc is a new software tool for calculating crown and canopy fuel characteristics and predicting canopy and fuelbed changes for user-selected thinning, pruning, piling and burning activities. The FuelCalc tool, developed by the USFS, Missoula Fire Sciences Lab and the National Interagency Fuels, Fire, and Vegetation Technology Transfer Team, is due out by the fall of 2012.

FFI Ecological Monitoring Utilities

Visit the FFI Website hosted on FRAMES: frames.nbii.gov/ffi

Future Outlook for FFI

Currently under development, "FFI-Lite" is an option that will be available for users sometime in the next year. FFI-Lite will use SQL-CE, which is easier to install and use than SQL Express and is designed to simplify installation of FFI where networking capability is not needed. Users may choose to use FFI-Lite as a stand-alone application for areas with less complex monitoring programs, limited IT support and/or limited computer equipment. FFI-Lite can also be used on tablet computers instead of current PDAs in conjunction with the full FFI application to increase the efficiency of electronic field data collection. The specific functionality of FFI-Lite is still under development but will emphasize supporting electronic field data collection and ease of installation.

FFI development has seen solid funding over the past few years, but as we all know, future budgets will likely be less consistent. Funding for FY12 is adequate, and we expect FFI development will proceed on track through

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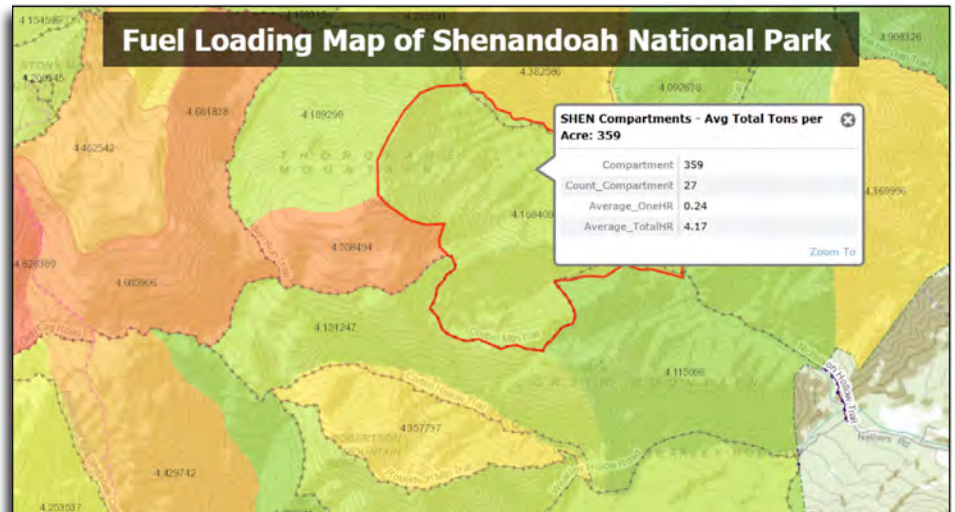
New Fuels Map for Shenandoah National Park

Heather Dammeyer, Shenandoah National Park

After Shenandoah National Park was created in 1935, “natural fires” were no longer allowed to roll across the landscape, resulting in increased-fuel accumulation and changes to canopy structure. Eighty years of aggressive fire suppression along with ice storms, wind storms and attacks by non-native insects have contributed to an increase in surface and ladder fuels. Fires in the park now have the potential to burn with greater intensity and risk to human infrastructure and protected resources.



The web application version of Shenandoah National Park’s fuel loading map.

With this in mind, fire and natural resource managers at Shenandoah National Park contracted with North Carolina State University to create a surface fuels map of the park. Surface fuels data used for this project came from 300 long-term vegetation monitoring and vegetation mapping project plots visited from 2001 to 2010. To create the fuel model map, an estimate of the average fuel load (tons/acre) was calculated for each sample location, using fine fuels data (1, 10, and 100 hour fuels) and Brown’s transect calculations (using 1, 10, 100, and 1000 hour fuels). If a plot had multiple visits, the average fuel load was used. Next, these values were spatially joined to corresponding vegetation class polygons in ESRI’s ArcMap. The dataset was then further segmented by overlaying Fire Management Units, planned burn blocks and areas classified as experiencing ‘severe’ wildland fires within the past eight years. This segmentation of the fuels data allows for quantitative comparison between units and lends to the development of a priority list of burn units.

This updated fuels map allows fire and natural resource managers to examine potential fire behavior characteristics and make more informed decisions. In particular, this park-specific fuels map will provide validation for managing wildfires that meet Shenandoah National Park’s natural resource objectives. In addition, it will help determine areas where fuel modification would be most appropriate along the 360 miles of wildland urban interface that exists at the park’s boundary. It has also been used to help develop the five year fuel treatment plan to help identify future target areas for treatment.

A web application, using ArcGIS.com, was also developed from the fuels data to disseminate this spatial data to the public. This web map allows non-GIS users to click on sampling locations and view the fuel load at each location, as well as the fuel loading trends over time. Check it out at: http://www.arcgis.com/home/item.html?id=63585e3a46e04eaa9eb1b6d188bb1d31.

FFI continued from page 13

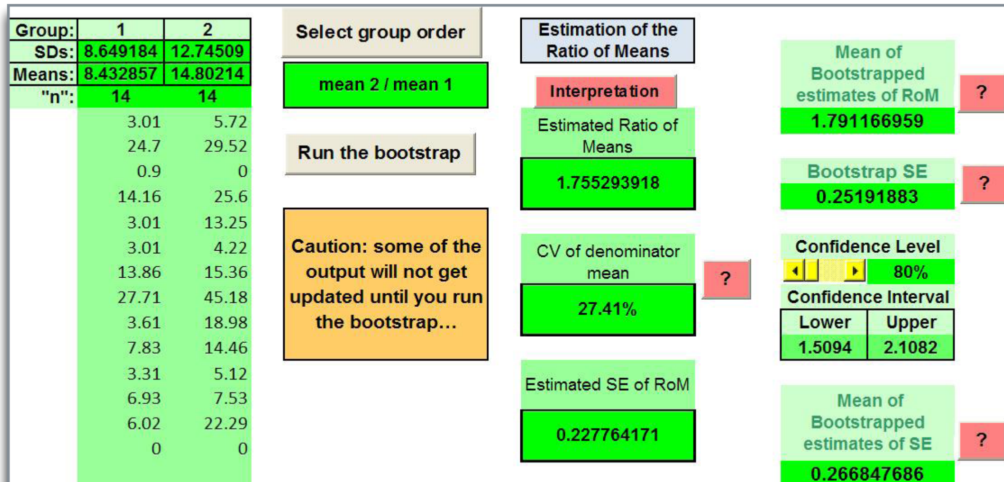
FY12. We anticipate funding amounts will decrease after this year, so we are working to ensure the longevity of FFI even with reduced funding. This strategy means that, for the time being, we may need to concentrate on installation, configuration, and database improvements rather than proceed with suggestions for changes from the field.

Training announcements, software, user guides, training materials and more are available on the FFI FRAMES Web site (http://www.frames.gov/ffi). As always, the FFI development team is interested in hearing your comments about our development plans and your suggestions for system improvements. You can post suggestions on the FFI discussion group at http://groups.google.com/group/ffiemu or contact Duncan Lutes (dlutes@fs.fed.us) or MaryBeth Keifer (marybeth_keifer@nps.gov).

Easy to Use Interactive Excel Tool Available to Analyze Paired Data

Dan Swanson, Northern Great Plains Fire Ecologist, National Park Service

In mid-February, Ken Gerow, professor and head of Statistics, and director of the Statistical Consulting Center at the University of Wyoming came out with a really cool interactive Excel tool for analyzing paired data sets. The tool will analyze your data if interested in incremental changes (classic paired-t test) but also in relative effects. The program's flexible in that you can customize the confidence level to meet your monitoring objectives. It's also very easy to use as you just copy and paste your pre- and post-burn data into the program and then click a button to run the analysis. There are also several "built-in" information and interpretation buttons to help the user. The way the burn objectives are stated will help determine which method to use. I personally prefer assessing relative change for most fire effects variables including vegetative cover, species richness, tree density, and fuel loading since it typically better assesses changes on the landscape. Ultimately it's up to the user to decide whether or not absolute or relative change best tells the story. Ken's Excel tool has two options for assessing relative changes pre to post-burn which are mean of ratios (MoR) and ratio of means (RoM). In a nutshell, use the MoR if you are interested in effects on individual plots and the RoM where change in the whole landscape is the parameter of interest. The document "Inference for Means from Paired Data" is helpful to read prior to using the Excel tool so that you have some background information. The interactive Excel tool and supporting documentation can be found within the Statistics folder on the NPS Fire Ecology Sharepoint site. http://npsfamshare.nps.doi.net/wildlandfire/firescience/fireecology/default.aspx Don't delay…go see for yourself how easy it can be to analyze your paired fire effects data!



Screen shot of the Excel paired data analysis tool.

Las Conchas continued from page 3

from the same locations were an average of 7.9%. Low moisture content of fuels had a significant effect on the Las Conchas Fire magnitude by increasing the ease of ignition, making fuels more available and more likely to be consumed in the combustion process, and increasing the rate of energy released during the fire.

Forest Structure and Composition

Historically, frequent, low intensity surface fires burned throughout the Jemez Mountains. These fires ceased in the late 1800's and early 1900's (Allen 1989). With more than one hundred years of fire absence, the forests have become over-crowded with trees and forest fuels have increased. Forest structure data, such as fuel loading, tree species, density, and size class were recorded in a mixed conifer forest close to the ignition point of the Las Conchas Fire (Figure 1). Total fuel load was recorded at 28.4 tons/acre, and consisted mostly of 1000 hour fuels (fuels with a diameter greater than 3 inches) (Figure 7). The density of seedling trees, trees with a diameter at breast height (DBH) of less than 1 inch, was 210 trees/acre (Figure 8). Midstory tree (DBH 1-6 in.) density was 386 trees/acre and consisted primarily of white and Douglas fir, two relatively flammable species when immature. Overstory tree (DBH>6 in.) density was 207 trees/acre. The total density of all size classes was 803 trees/acre. These estimates of fuel loading and tree densities (Figure 9) are well beyond historical levels, and contributed significantly to the magnitude of the Las Conchas Fire.

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Las Conchas continued from page 15

Slope, Aspect, and Elevation

The Jemez Mountains are characterized by steep canyons, southerly exposures, and high elevations (the highest peak is approximately 11, 500 ft.) (Figure 10). These topographic features contributed to the magnitude of the Las Conchas Fire in several significant ways: 1) as the fire moved up the steep slopes, it dried the fuels ahead of its flaming front, allowing for faster fuel consumption and greater fire spread, 2) the southerly exposures caused heating and drying of the fuels, contributing to the ease of ignition, and 3) the valleys and canyons concentrated the winds and increased the fire intensity and spread.

CONCLUSIONS

The biotic and abiotic factors that contributed to the magnitude of the Las Conchas Fire couldn't have been more aligned in the days and months preceding the fire. On the day of ignition, the maximum temperature was 89.2, minimum relative humidity was 5% (Figure 4), precipitation was only at 25% of average for the Water Year (Figure 5), and maximum 40 ft. and 150 ft. winds gusts were 38.9 and 47.6, respectively (Figure 6). Live and dead fuel moistures were also extremely low. Steep canyons, southerly exposures, high tree densities (803 trees/acre), and high fuel loading (28.4 tons/acre) all played a significant role (Figures 7 and 8). On a longer temporal scale, we also consider that climate change, resulting in higher temperatures, increased drought frequency, and more intense El Nino/La Nina Southern Oscillation events, as well as a land use history in the Jemez Mountains that includes extensive livestock grazing, logging, and effective fire suppression, has resulted in increased sensitivity of this landscape to fires of this magnitude.

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Photos: Front page banner & Figure 2: Brian Kliesen USFS, Figure 9 & 10: Laura Trader, NPS.

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post-fire groups but there is no consistency or pattern that sets it apart from either.

CONCLUSION

Summer-burned Sites

All analyses showed a clear difference between the summer group, and spring and pre-fire treatment groups. The summer group had a unique set of species that were nearly absent from the other two groups. The main changes that can be attributed to this season of burning include: a reduction in the abundance and frequency most of the common species, the addition of several pioneer (seedbank) species, which dominate the site for the first 3 to 5 years, and the elimination of most species associated with older stands such as several species of mosses and lichens ("old stand" species).

The germination of the seedbank species is certainly the result of differences in the depth of burn or soil heat penetration between the two seasons of burn. Though the sites are all burned under the same range of prescription parameters, regardless of the season, the soil and fuel moistures tend to be very different. Soil and duff moistures tend to be high in the spring and low in the summer, leading to greater duff consumption soil heat penetration in the summer. This leads to germination of the seed bank.

Spring-burned Sites

The types of changes seen after a spring fire are similar to that of a summer fire but orders of magnitude less and very short lived. The changes include the absence of a few "old stand" species and the addition of a few pioneer species. The common species merely experience a short term reduction in cover. The seedbank species are essentially untouched, resulting in very little change in species composition and no rejuvenation of the seedbank.

All Treatments

All treatments and plots contained a set of very common species. Differences in these species among treatment groups were mainly in terms of abundance. The main core group consisted of about six generalist species, while a secondary core group consisted of about 10 to 15 species.

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Sherry Leis Receives Outstanding Young Range Professional Award

Congratulations to Sherry Leis for receiving Outstanding Young Range Professional Award in early April. The Outstanding Young Range Professional Award is presented by the Society for Rangeland Management to an individual member who has demonstrated extraordinary potential and promise as a range management professional. This award is presented as an encouragement for outstanding performance by young men and women entering the profession of range management.

Excerpt from award entry

Sherry A. Leis has demonstrated extraordinary potential and promise as a range management professional and a future leader in the range profession. She has established herself as a capable leader in SRM by building collaborations among people from a variety of agencies and locations around a common rangeland interest, such as the Patch Burn Grazing Working Group, to address issues at the regional scale or greater. Sherry's journey to range management began with Peace Corps service in Africa. In Africa, she was introduced

to concepts like the effect of the interaction of fire and grazing on plant communities that formed the foundation of her professional expertise. At Oklahoma State University, she became a professional in range management by using an interdisciplinary approach to understanding the effects of military disturbance on rangeland.

Collaboration, perhaps her greatest strength, comes naturally to Sherry. Her whole journey has involved collaboration in different forms. She connects people who otherwise have barriers to communication. As one of her support letters states, Sherry "brings together all parties involved in the development of projects, encouraging the open communication of ideas and information, culminating in a proposed course of action." Yet another describes her "unfailing commitment to integrating information, ideas and observations in ways that expand our understanding of grasslands and her ability to transmit that understanding to land managers, enabling them to become better at what they do." She enjoys bringing new people into the profession by mentoring employees who are interested in fire and rangeland ecology.

RxFx Subscription and Submission Information

Rx Effects is the newsletter of the Fire Ecology Program in the National Park Service. It is an outlet for information on Fire Effects Monitoring, FMH, fire research and other types of wildland fire monitoring. The newsletter is produced annually for the National Park Service but we encourage anyone with an interest in fire ecology to submit information about their program or research. Examples of submissions include: contact information for your program, summaries of your program's goals, objectives and achievements, monitoring successes and failures, modifications to plot protocols that work for your park, hints for streamlining collection of data, data entry and analysis, and event schedules. Submissions are accepted in any format (e.g., hard copy through the mail or electronic files through e-mail). Please see our website for author instructions. The goal of the newsletter is to let the Fire Effects Monitoring community know about you and your program.

Rx Effects is issued each year in the spring. The deadline for submissions is the last Friday in February. If you would like a subscription or more information please see our website http://www.nps.gov/fire/wildland-fire/what-we-do/science-ecology-and-research/rx-effects-newsletter.cfm or contact:

Missy Forder
3655 US Highway 211 East
Luray VA, 22835
(540) 999-3500 ext. 3323
melissa_forder@nps.gov

Thanks to all who submitted articles for this issue, including Sherry Leis, Scott Weyenberg, Adam Watts, Cody Weink, Laura Trader, Sierra McDaniel, Dan Swanson, Perry Grissom, Justin Shedd, MaryBeth Keifer for their submissions. Submissions not included in this issue will be saved for future editions.