



SUMMARY

Major change marked the 2015 season for the Grand Canyon National Park (GRCA) Fire Ecology Program. Complete turnover occurred at all positions except Lead Monitor, ushering in a new Fire Ecologist, Assistant Lead Monitor, and three fresh Fire Effects crewmembers. Responsibility for fire effects monitoring at Walnut Canyon National Monument (WACA) near Flagstaff was fully implemented, with new baseline data collection on all active plots through a collaborative relationship with the Southern Colorado Plateau Inventory and Monitoring Network (I&M). Cooperation with the I&M crew continued as both programs worked together to accomplish necessary reads of mixed conifer plots at GRCA. Support expanded for the Saguaro National Park (SAGU) Fire Ecology Program, incorporating field data collection on multiple plot types as well as database management expertise. Nonetheless, all scheduled work was completed while crewmembers participated in a wide variety of opportunities supporting incidents nationally and locally. With monitoring of 29 Fire Monitoring Handbook (FMH) plots, 40 Rapid Assessment Protocol (RAP) pilot sampling plots, 96 Composite Burn Index (CBI) burn severity plots, and 13 I&M plots at GRCA; 13 combination FMH-I&M plots at WACA; and 15 FMH plus 22 CBI plots at SAGU, it was a diverse, successful year.

The tradition of assisting other Fire Ecology programs continued and deepened, with the Lead, Assistant, and one crewmember independently accomplishing plot work for the Saguaro Fire Ecology Program in the Rincon Mountains District of Saguaro National Park in southern Arizona. On top of remeasuring 15 FMH plots, the GRCA Fire Effects Crew worked remotely with the SAGU Fire Ecologist to plan the first 22 CBI plots ever installed in the park. Support also expanded to data management later in the season as the Lead developed quality assurance-quality control (QAQC) queries for the SAGU database to help preparation for external analysis of their data. Additionally, further cooperation with the Kaibab National Forest resulted in installation of 13 CBI plots on the North Kaibab Ranger District (NKRd). The interagency North Zone fire management structure again provided opportunities for monitoring and other operational support on multiple fires.

A second full season of 100% tablet-based, electronic field data collection and office data management using FFI (FEAT/FIREMON Integrated) and FFI Lite software again enhanced efficiency. Based on GRCA's pioneering work in electronic data collection, the Lead was invited to the combined Intermountain (IMR)-Midwest (MWR) Regional National Park Service (NPS) fire ecology meeting to present on the subject, and subsequent remote assistance was provided to several other Fire Ecology programs wanting to incorporate tablet use. During the transition between Ecologists, queries for QAQC and Access-based datasheet replicates were created or modified by the Lead and Assistant for WACA and SAGU, expanding the suite of new data management products to other parks. Exclusive use of tablets for data collection again saved enough time compared to traditional data entry that all seasonal crewmembers were given the opportunity to learn advanced skills by performing query-based QAQC or standardized data analysis for this annual report.

Along with the accomplishment of plot-related work, the program supported a very busy national fire season, and crewmembers continued to expand both their skill sets and their variety of contributions to fire operations. This balance would not have been possible without sufficient staffing, the experience of existing crewmembers, and a new Assistant Lead with prior knowledge of the program. In some capacity, the crew worked on a total of 13 different incidents over 131 operational periods and attended 4 different NWCG training classes. Highlights of this experience included 4 assignments with the Saguaro, Apache Kid, and Abajo Wildland Fire Modules in California and Wyoming; and intra-Zone cooperation through a severity detail to Idaho on North Kaibab E-332. The crew also continued its role as the primary Fire Effects Monitors (FEMO) within Grand Canyon National Park and the neighboring North Kaibab Ranger District on both prescribed and wildfire events, amounting to a total of 42 operational periods of local fire assistance. Tablet computer and mobile device use continued to support FEMO duties, even with minimal local fire activity. These opportunities led to the completion of two fire qualifications (FEMO, FFT1) and work on many others (FEMO, FFT1, FAL3) to further increase the crew's ability to fulfill a variety of roles within fire.

Cross-training Fire Ecology crewmembers with other field disciplines in the fire management program continued to allow the crew to build myriad skills and increase overall staffing flexibility. Personal interest by the crew greatly facilitated this multi-disciplinary learning, be it assisting with saw work on prescribed burn prep or backfilling on the wildland engine. To spread the wealth of knowledge further, two other fire personnel (including the FMO), the deputy chief of Science and Resource Management, a visiting Australian parks employee, and over 10 individuals from vegetation management and volunteer crews were cross-trained in fire effects plot protocols.

The outgoing Ecologist spent the majority of time this year on planning and data management tasks for GRCA and the growing network of collaborations and regional assistance responsibilities, working remotely from May-September. In addition to the standard GRCA planning and data tasks, the Ecologist performed the following duties:

- Participated as a technical specialist for the 13-park Utah Parks FMP EA and worked with the Utah Parks Fire Effects Crew to compile plot protocols and identify and correct FFI database errors for the 3 parks with monitoring programs.
- Facilitated a meeting with Flagstaff Area National Monuments (FLAG), I&M, and GRCA Fire & Aviation staff to review past fire effects monitoring in the 3 FLAG Monuments and determine the future of monitoring activities in those monuments. The meeting and subsequent data analysis resulted in a formal report on the history and future of fire effects monitoring in FLAG.
- Contributed to GRCA Fire & Aviation's expanding work with volunteer groups by developing a new WUI thinning plot monitoring protocol specifically for use by volunteers and giving presentations on fire ecology and monitoring to five volunteer groups.

- Completed one NPS-funded research collaboration by co-authoring a publication in the journal *Canadian Journal of Forest Research* with researchers from Northern Arizona University and began work on one new NPS-funded research project with collaborators from The University of Montana FireCenter.
- Assisted with handoff of work duties, and transitioned with the new Ecologist during FY15 closeout.

The new Ecologist assumed duties in September and was able to work with the Fire Effects Crew in the field a couple of times, although the majority of her time was spent on getting set up and organized. She was able to pursue professional development that included attending two conferences (SCPN Biennial Conference and AFE Conference) and completing ATR training, as well as participating in several networking opportunities with local and regional fire ecologists and researchers. She also continued to develop work for volunteer groups, as well as new ideas and plans for field trips. Additionally, a new JFSP proposal to extend recent work was submitted with the FireCenter and other collaborators, and a conference workshop for the IAWF Fire Behavior concert in the upcoming year was accepted and is currently being developed.

Finally, special tribute must be paid to outgoing Ecologist Windy Bunn and outgoing Assistant Lead Jasper Peach. Both began work in the GRCA Fire Ecology Program in 2008 and contributed extensively to promoting and enhancing the ecological side of fire management at the local, regional, and national levels. Be it through the development of educational programs for youth, creation of advanced software tools to increase efficiency and accuracy of data collection on both plots and fires, or going beyond the call of existing duties to oversee and improve Fire Ecology programs outside of GRCA, their impact has been felt far and wide over the last eight years. It is not an overstatement to say that fire ecology in this country has advanced because of their dedication and commitment. Windy and Jasper will be missed, but we are all better because of their service at Grand Canyon.

STAFF ACCOMPLISHMENTS & AREAS OF FOCUS

TABLE 1. Fire Ecology Staff for 2015 calendar year.

Employee	Starting Date	Ending Date	# Pay Periods	Training	NWGG Taskbooks
Windy Bunn, GS-11	1/01/15	10/03/15	20	S491	
Casey Teske, GS-11	09/06/15	12/31/2015	8	ATR	LTAN-t RXB2-t
Li Brannfors, GS-7	1/01/15 4/05/15	3/21/15 12/31/15	23 ¹	S491	LTAN-t
Dominic Ali, GS-6 ²	4/13/15 5/03/15	5/02/15 11/14/15	15.5 ³	S230 S231 A100 NPS SAR3	FEMO ICT5-t HECM-t
Greg Hamby, GS-6	5/03/15	10/31/15	12 ⁴	S212 A100	FEMO-t FAL3-t
P.J. Koehler, GS-5	5/03/15	10/17/15	12	S230 S231 NPS SAR3	FFT1 FEMO-t ICT5-t
Daniel Leach, GS-5	5/17/15	10/17/15	11		FFT1-t FAL3-t HECM-t READ-t
Jasper Peach, GS-6		5/02/15	0 ⁵		

¹ Time for Li Brannfors reflects part-time work during payperiods 2-5.

² Through 5/2/15 Dominic Ali was GS-5. After 5/3/15 he was officially term, GS-6 Assistant Lead

³ From 4/13-4/18/15, Dominic Ali was funded by a SAGU project account. After Oct. 4, he was funded by a GRCA project account.

⁴ After Oct. 17, time for Greg Hamby reflects part-time work.

⁵ Assistant Lead Jasper Peach was officially converted to a new position at Yosemite National Park while on furlough with GRCA.

TABLE 2. Base-hour Fire Effects Crew activities by percent and category.

Employee	FMH Plots	RAP Plots	CBI Plots	I&M Plots	Data Entry/Mgmt	Plot Office	Other Office	Monitoring (Rx or Wildfire)	Rx Fire Ops	Wildfire/ Incident Ops	Training Courses	Other
Li Brannfors, GS-7	13	4	3	3	14	12	23	1	2	0	3	22
Dominic Ali, GS-6	17	10	1	4	12	9	10	5	4	8	4	16
Greg Hamby, GS-5	16	11	1	3	13	10	6	5	1	19	2	13
P.J. Koehler, GS-5	13	7	1	3	10	9	8	3	3	25	6	12
Daniel Leach, GS-5	24	3	5	2	7	8	6	5	2	14	4	20

"Plot Office" includes miscellaneous plot data preparation and management time, plant ID, photo filing, etc.

"Rx Fire Ops" includes time spent on non-fire fuels projects and fuel sampling.

"Wildfire/Incident Ops" includes in-park details with GRCA Helitack, administrative leave associated with fire assignments.

"Other" includes PT, leave taken, official meetings, conferences, webinars, paid holidays off, non-fire duties, etc.

TABLE 3. Base-hour Fire Effects Crew Focus Areas/Accomplishments in 2015.

Focus Area	Percent Time	Accomplishments and Activities
FMH Plots	16%*	29 remeasurements at GRCA 13 new baseline measurements in coordination with I&M at WACA (combo FMH-I&M plots) 15 remeasurements at SAGU by Lead, Assistant, & 1 crewmember
RAP Plots	7%	20 installs and 20 pre-burn re-reads across 2 Rx units
CBI Plots	2%*	96 plots across 3 fires at GRCA & 1 fire on Kaibab NF 22 plots across Deer Head Fire at SAGU
I&M Plots	3%*	13 remeasurements of fuel and tree data at GRCA 13 new baseline measurements in coordination with I&M at WACA (combo FMH-I&M plots)
Data Entry/ Management	11%*	<i>ALL 2015 plot data collected and checked electronically with tablet computers in the field; data entry and field checking is included in % time under each plot type</i> - QAQC queries completed for 2015 FMH & RAP data by Oct 7 - QAQC queries completed for 2015 WACA data by Nov 5 - QAQC queries completed for 2011-2015 I&M data by Dec 15 - Created FFI QAQC queries for WACA & SAGU - Includes FFI/FFI Lite electronic data prepping, merging, checking, & hardcopy datasheet creation for all plots at GRCA, WACA, & SAGU
Data Analysis	1%	- Annual Report analysis on all major variables in program - Seasonal Fire Ecology staff analyzed data for annual report
Plot Office	10%	Includes plot preparation, plant ID, photo filing, tree mapping, hardcopy data filing/organization, and plot-related projects
General Office/ Supervision/ Admin	12%	- Includes paperwork for travel, credit cards, non-plot related projects - Hiring, evaluations, and supervision by Lead & Assistant - Lead & Ecologist hired seasonal crew - Lead supervised 1 term Assistant & 3 seasonals
Fire Monitoring (Rx or Wildfire)	3%*	- Lead FEMO & FEMO-trainees on 1 Rx fire at GRCA and 1 Rx fire on Kaibab NF - Lead FEMO & FEMO-trainees on 2 wildfires on Kaibab NF - Trained members of Apache Kid Module as FEMOs in California
Fire Operations/ Assignments (Rx, Wildfire, Engine, Helitack, Non-fire Fuels Projects)	14%*	- Qualified personnel as FFT1 and FEMO - Assistant and 3 crewmembers detailed for a total of 13 weeks on multiple wildfires and prescribed fires with Saguaro, Apache Kid, and Abajo Modules to California & Wyoming 1 crewmember detailed for 2 weeks with North Kaibab Engine 332 for severity in Idaho - FFT1, FAL2, & FFT2 support on multiple North Zone fires - Cross-trained crewmembers with GRCA engines, mechanical fuel reduction projects, fuel sampling
Training	4%	- All attended annual fire refresher 1 completed S212 2 completed S230 2 completed S231 1 completed S491 2 completed A100 aviation safety online 3 completed NPS SAR3 1 completed Emergency Vehicle Operations certificate
Travel Away from Duty Station	—	Total of ~2¼ months spent on South Rim, camped out on Walla Valley unit, at Walnut Canyon, or assisting Saguaro Fire Ecology
Other	17%	5% of crew time spent on PT 5% of crew time spent on leave

*Approximately 1520 hours of overtime on both fire and plot duties, equaling 21% of total crew work time (base + OT), are not reflected.

TABLE 4a. Fire Ecologist Focus Areas/Accomplishments in 2015 for Windy Bunn.

Focus Area	Percent Time	Accomplishments and Activities
Planning	30%*	- GRCA Fire IDT – reviewed 2 burn plans and 3 thinning plans; planning meetings for Rx fires and thinning projects - Wrote fire monitoring history and future plans report for FLAG - Served as Technical Specialist for Utah Parks FMP EA - Compiled monitoring history and plot protocols for Utah Parks - Developed protocols for GRCA WUI thinning and Hwy 67 RAP plots - Worked on GRCA compliance tasks (Section 7, wilderness MRA) - Managed activities in NFPORS and participated in out-year planning
Presentations/ Education	2%	- Presented fire ecology information to 5 volunteer groups - Assisted SWFSC Fires of Change artists with science & art projects - Presented Wildland Fire Resource Update to GRCA Interpretation & Education and Concessionaire staff
NPS Meetings/ Task Groups	8%	- Fire and park staff and strategy meetings - I&M and FLAG collaboration meetings - Fire, Compliance, & Resource Management collaboration meetings - MSO habitat, climate change needs, and GGCLA meetings, reviews, and data sharing - Regional fuel and fire ecology conference calls and meeting
Interagency Work	1%	- Prepared Bonito Park FMH data for transfer to Coconino NF staff - SWFSC Incident of the Year award committee
Fire Assignments and Project Work	0%	None
Research	2%	- Submitted article to <i>Canadian Journal of Forest Research</i> with Northern Arizona University collaborators - Meetings for IMR Fire funded research project - Provided data, support, research ideas, and/or manuscript & proposal reviews for 4 other fire-related projects
Data Collection	<1%	Installed WUI thinning plots with volunteer groups
Data Entry & Management	16%*	- Identified and corrected FFI database errors for ZION and BRCA - Converted GRCA I&M data to FFI - Created electronic data printing queries and procedures for GRCA - Organized, updated, and archived FLAG FMH data
Data Analysis	4%	- Analyzed FMH, RAP, and I&M plot data, severity data, and weather and fuel data for burn plans and annual report - Analyzed data from FLAG for monitoring history report
Supervision/ Admin	12%	- Supervised Lead Monitor and advertised Fire Internship position - Worked with Lead Monitor to hire term Assistant Lead Monitor and seasonal crewmembers - Participated on hiring panel for Fire Ecologist - Managed fire monitoring and ecology budgets - Travel, time, and purchasing
Training & Conferences	7%	- S491; webinars on various topics - NPS required annual training; fire and aviation refreshers - PT (2%)
Other	17%	Leave, holidays, travel, etc

*Approximately 4.3 pay periods (22% of time) spent assisting the Utah Parks Group with planning and data management.

TABLE 4b. Fire Ecologist Focus Areas/Accomplishments in 2015 for Casey Teske.

Focus Area	Percent Time	Accomplishments and Activities
Planning	10%	- Managed activities in NFPORS and participated in out-year planning - Gained understanding of GRCA fire monitoring and fire management programs
Presentations/ Education	<1%	Developing training for fire behavior conference workshop
NPS Meetings/ Task Groups	2%	- Fire and park staff and strategy meetings - Park Leadership/Supervisory meeting - I&M collaboration meetings - Fire, Compliance, & Resource Management collaboration meetings - Regional fuel and fire ecology conference calls and meeting
Interagency Work	4%	- Participated in plot installation and plot data collection at WACA - Participated in CBI plot data collection on USFS KNF (N Zone)
Fire Assignments and Project Work	1%	Shoshone Rx Blackline burning and mapping
Research	<1%	- Meetings for IMR Fire funded research project - Submitted JFSP proposal for continuation of fire-related projects
Data Collection	1%	- Installed WUI thinning plots with volunteer groups - Tested new technology for mapping fire perimeters
Data Entry & Management	6%	Identified FFI database errors for GRCA, WACA, and SAGU
Data Analysis	3%	Analyzed FMH, RAP, and I&M plot data, severity data, and weather and fuel data for burn plans, field trips, and annual report
Supervision/ Admin	9%	- Supervised Lead Monitor - Advertising preparation for Fire Internship position - Worked with Lead Monitor to furlough term Assistant Lead Monitor and seasonal crewmembers - Managed fire monitoring and ecology budgets - Travel, time, and purchasing
Training & Conferences	17%	- ATR Training - Southern Colorado Plateau Conference - AFE Conference - NPS required annual training; fire and aviation refreshers - PT (3%)
Other	43%	- Install software on computer - Set up new office/move out of S/R office - Leave, holidays, travel, etc

FIRE EFFECTS PLOT WORKLOAD

The 2015 season produced a moderate but very consistent plot load for most of the year at Grand Canyon, with the installation of 20 new RAP plots on the North Rim and noticeable workload spread between all plot types. No immediate post-burn reads occurred due to a lack of fires.

TABLE 5. Grand Canyon National Park Fire Effects Plot Workload for 2015.

Rim	Monitoring Unit	Plot Type	Install/ Pre- burn	Immed. Post- burn	Year 1	Year 2	Year 5	Year 10/ 20	Annual Total	Total Plots¹
South	Ponderosa Pine PIPO	FMH - Forest				3	2	8	13	41
South	Pinyon-Juniper Woodland— PIED²	FMH - Forest							0	17
South	Moqui Rx	RAP ³							0	5
South	Picnic Rx	RAP ³							0	10
South	Quarry Rx	RAP ³							0	10
North	Ponderosa Pine PIPN	FMH - Forest			11			4	15	30
North	Ponderosa Pine with White Fir Encroachment PIAB	FMH - Forest	1						1	27
North	Rocky Mountain Subalpine Conifer PIEN	FMH - Forest							0	17
North	Grassland Interior GRIN	FMH - Brush							0	10
North	Grassland Edge GRED	FMH - Forest							0	6
North	Galahad WF	CBI			26				26	-
North	Kanabownits WF	CBI			12				12	-
North	Slopes Rx	CBI			45				45	-
North	Quaking WF-NKRD	CBI			13				13	-
North	Fawn Spring Rx	RAP ³	20						20	20
North	Highway 67 Rx	RAP ³	20						20	20
North	Range Rx	RAP ³							0	20
North	Spring Canyon Rx	RAP ³							0	20
North	Thompson Rx	RAP ³							0	20
North	Tipover Rx-NKRD	RAP ³							0	40
North	Walla Valley Rx	RAP ³							0	6
North	Mixed Conifer	I&M ⁴	13						13	44
Total			54	0	107	3	2	12	178	363

¹ Total Plots includes all permanent plots (FMH , RAP, or I&M) installed to date within a monitoring unit/type

² PIED monitoring type reads were discontinued in 2000

³ Pilot sampling

⁴ Fuel and tree data collected to add to data collected by I&M crews

During 2015, fire effects monitoring plots within the three Flagstaff Area National Monuments were evaluated to determine their utility in providing feedback for fire management activities in the monuments. As a result of the evaluation, five monitoring types containing 33 total plots were discontinued and archived. The details of the evaluation and decision process are contained in the report “Fire Effects Monitoring for the Flagstaff Area National Monuments: Overview, Status, and Future Direction” (Bunn 2015; National Park Service Integrated Resource Management Applications Data Store Reference Code: 2223756). GRCA worked with the I&M program in 2015 to share data and repeat the pre-burn fuel, pole-sized tree, and overstory tree measurements in eleven FMH-established ponderosa pine (PIPO) plots and two I&M-established PIPO plots in Walnut Canyon National Monument. A copy of the FFI database containing the existing plot data is available on the NPS IRMA portal (Reference Code: 2194013).

TABLE 6. Flagstaff Area National Monuments Fire Effects Plot Workload for 2015.

Park	Monitoring Unit	Plot Type	Install/ Pre-burn	Immed. Post-burn	Year 1 - 20	Annual Total	Total Plots ¹
Sunset Crater NM	Montane Meadow BOGR	FMH - Grass				All Plots Discontinued ²	
Sunset Crater NM	Pine Encroachment of Montane Meadow PIPO	FMH - Brush				All Plots Discontinued ²	
Walnut Canyon NM	Pinyon-Juniper Woodland PIED	FMH - Forest				All Plots Discontinued ³	
Walnut Canyon NM	Ponderosa Pine Forest PIPO	FMH – Forest / I&M	13			13	13
Wupatki NM	Plains/Great Basin Grassland BOER	FMH - Grass				All Plots Discontinued ⁴	
Wupatki NM	Plains/Great Basin Grassland HIJA	FMH - Grass				All Plots Discontinued ⁴	
Total			13			13	13

¹ Total Plots includes all permanent plots (FMH or I&M) installed to date within a monitoring unit/type.

² Sunset Crater NM FFI database containing the plot data, including plot coordinates, is archived on the NPS Integrated Resource Management Applications (IRMA) portal (Reference Code: 2221713).

³ Walnut Canyon NM FFI database containing the PIED plot data, including plot coordinates, is archived on the NPS IRMA portal (Reference Code: 2222935).

⁴ Wupatki NM FFI database containing all plot data, including plot coordinates, is archived on the NPS IRMA portal (Reference Code: 2222001).

MONITORING OBJECTIVES & RESULTS

Fuel Loading & Tree Density – FMH plots

Grand Canyon National Park's Fire Ecology Program has installed 148 permanent FMH-style plots to date and 119 of these same plots have burned. This large body of data allows us the luxury of being able to report results to our desired level of statistical accuracy for many of our major management objectives. The PIEN and PIED monitoring types are not included in these tables because (1) these areas are thought to be within the natural fire regime and (2) prescribed fires are not the management focus in these areas. Of the 9 restoration objectives listed in Table 7, we can say with statistical confidence we are achieving 5 of them after first entry fire and 3 of them after second entry fire.

Targeted mean fuel loading values were achieved during first entry fires in the PIPO and PIPN monitoring types. In the PIAB monitoring type, mean fuel loading fell within the targeted range, but the confidence limits extend above the targeted range (too much fuel remaining). After second entry fires, mean fuel loading values in all monitoring types were within the targeted range, but the confidence limits extend above the targeted range (too much fuel remaining) in the PIPO and PIAB monitoring types.

In the PIPO and PIPN monitoring types we cannot realistically install and maintain the number of plots needed to overcome the variability in pole-sized tree density. In the PIPO monitoring type, mean pole-sized tree density fell within the targeted range after first entry fire, but the confidence limits extend above the targeted range (too many pole-sized trees). After the second entry in PIPO, the mean pole-sized tree density was above the targeted range, although the lower confidence limits fall within the targeted values. In the PIPN monitoring type, mean pole-sized tree density fell within the targeted range after both first and second entry fire. However, the confidence limits extend above the targeted range (too many pole-sized trees) after the first entry fires and below the targeted range (too few pole-sized trees) after the second entry fires. The PIAB monitoring type has the minimum number of plots required to overcome variability in pole-sized tree density. After first entry fires in the PIAB type, mean pole-sized tree density was within the targeted range; however, the confidence limits extend above the targeted range (too many pole-sized trees). After second entry fires in the PIAB type, mean pole-sized tree density was well below the targeted range.

For large tree density, minimum plot numbers have been reached for all monitoring types. Mean large tree density remained within the targeted range (and showed little change from pre-fire values) for first and second entry fires in the PIPO monitoring type. Mean large tree density decreased from pre-fire values in the PIPN monitoring type in both first and second entry fires, but mean values remained within the targeted range. In the PIAB monitoring type, mean large tree density decreased from pre-fire values, but remained within target values after first entry fire. However, after second entry fires mean large tree density fell below the desired range with confidence limits extending back into the targeted range (i.e. there is some uncertainty about whether tree density is at the low end of the target or below the target).

Table 7. Restoration Management Objectives and Monitoring Results for FMH plots in 2015. 1st entry and 2nd entry refer, respectively, to the first and second times an area has burned in any fire type (prescribed fire or wildfire).

Monitoring Unit	Restoration Management Objectives	Monitoring Results (n = # of plots)		Objectives Achieved?		Minimum Plot #s Achieved?
		1 st Entry	2 nd Entry	1 st Entry	2 nd Entry	
Ponderosa Pine (PIPO) South Rim	Reduce total fuel load to 0.2-9.3 tons/acre immediate post-burn	7.2 ± 0.8 tons/acre (-47%) (n=38)	7.9 ± 1.7 tons/acre (-48% due to fire 1 & 2) (-2% due to fire 2 only) (n=20)	YES	YES*	YES n=10
	Reduce poles (PIPO) with DBH of 1-6" to 16-81 trees/acre 2 years post-burn	77.0 ± 29.5 trees/acre (-24%) (n=39)	106.4 ± 42 trees/acre (-33% due to fire 1 & 2) (-8% due to fire 2 only) (n=20)	YES*	NO*	NO n=61
	Maintain overstory (PIPO) density with DBH ≥16" of >14 trees/acre 5 years post-burn	19.9 ± 2.5 trees/acre (-0.17%) (n=36)	19.4 ± 3.6 trees/acre (-2% due to fire 1 & 2) (-0% due to fire 2 only) (n=19)	YES	YES	YES n=14
Ponderosa Pine (PIP) North Rim	Reduce total fuel load to 0.2-15.7 tons/acre immediate post-burn	12.1 ± 1.6 tons/acre (-56%) (n=30)	9.8 ± 2.4 tons/acre (-62% due to fire 1 & 2) (-42% due to fire 2 only) (n=22)	YES	YES	YES n=11
	Reduce conifer poles with DBH of 1-6" to 16-81 trees/acre 2 years post-burn	70.1 ± 33.4 trees/acre (-58%) (n=30)	17.0 ± 6.4 trees/acre (-81% due to fire 1 & 2) (-25% due to fire 2 only) (n=20)	YES*	YES*	NO n=48
	Maintain overstory conifer density with DBH ≥16" of >17 trees/acre 5 years post-burn	41.0 ± 4.0 trees/acre (-10%) (n=29)	37.5 ± 12.1 trees/acre (-22% due to fire 1 & 2) (-12% due to fire 2 only) (n=8)	YES	YES	YES n=4
Ponderosa Pine w/ White Fir Encroachment (PIAB) North Rim	Reduce total fuel load to 1.7-19.0 tons/acre immediate post-burn	17.5 ± 3.3 tons/acre (-49%) (n=20)	17.6 ± 7.7 tons/acre (-59% due to fire 1 & 2) (-35% due to fire 2 only) (n=11)	YES*	YES*	YES n=5
	Reduce conifer poles with DBH of 1-6" to 16-100 trees/acre 2 years post-burn	85.9 ± 23.5 trees/acre (-64%) (n=21)	1.6 ± 1.5 trees/acre (-98% due to fire 1 & 2) (-63% due to fire 2 only) (n=10)	YES*	NO	YES n=9
	Maintain overstory conifer density with DBH ≥16" of >20 trees/acre 5 years post-burn	28.3 ± 2.6 trees/acre (-22%) (n=19)	18.0 ± 6.4 trees/acre (-38% due to fire 1 & 2) (-33% due to fire 2 only) (n=11)	YES	NO*	YES n=7

NOTE: Assessment of objective success and fulfillment of minimum plot requirements are based on 80% confidence intervals. Minimum plot calculations are based on pre-fire values, with R-value of 20 for overstory tree and fuel assessment and R-value of 25 for pole-sized tree assessment; variable fire conditions increase the minimum number of recommended plots for post-fire analysis.

YES* indicates that the mean value meets stated objectives but the confidence interval is outside the range of objective values.

NO* indicates that the mean value does not meet stated objectives but the confidence interval is inside the range of objective values.

Maintenance objectives help to refine long-term desired states for each monitoring type and are described briefly in Table 8. On the South Rim, maintenance burning will likely continue in the form of prescribed fires, while on the North Rim, the expectation is that wildfires will be managed to achieve maintenance objectives. These objectives are for the general state of the landscape and will help define return intervals for prescribed fires on the South Rim and initiate planning for prescribed fires on the North Rim if wildfires are regularly suppressed. Measurement periods currently correspond to those for restoration targets but can be adjusted based on management need.

Maintenance burning in the PIPO and PIPN monitoring types has resulted in achievement of the fuel loading objectives for each type. However, in these monitoring types we cannot realistically install and maintain the number of plots needed to overcome the variability in tree density. In the PIPO monitoring type, 2015 data forced mean tree density to fall outside the targeted range after maintenance burning, but the confidence limits extend within the targeted range of objective values. However, it should be noted that in this instance, the PIPO plot type does not currently have the minimum number of plots (current n=12; minimum n=43). Thus, each additional plot reading in the PIPO monitoring type will likely highly influence this result and any interpretation should take this into account. A similar caution should be extended in the PIPN type, where only two plots have data two years following third entry fire (minimum n=48), and they both burned two years after the second entry fire. The small plot number and anomalous burn interval in the PIPN type make the pole-sized tree results unreliable.

Table 8. Maintenance Management Objectives and Monitoring Results for FMH plots in 2015. 3rd entry refers to the third time an area has burned in any fire type (prescribed fire or wildfire).

Monitoring Unit	Maintenance Management Objectives	Monitoring Results 3 rd Entry (n = # of plots)	Objectives Achieved?	Minimum Plot #s Achieved?
Ponderosa Pine (PIPO) South Rim	Maintain total fuel load of 0.2-9.3 tons/acre immediate post-burn	6.4 ± 1.9 tons/acre (-59% due to fire 1, 2, & 3) (-25% due to fire 3 only) (n=16)	YES	YES n=10
	Maintain tree (PIPO) density with DBH ≥1" of 43-135 trees/acre 5 years post-burn	143.7 ± 43.3 trees/acre (-15% due to fire 1, 2, & 3) (-5% due to fire 3 only) (n=12)	NO*	NO n=43
Ponderosa Pine (PIP) North Rim	Maintain total fuel load of 0.2-15.7 tons/acre immediate post-burn	10.0 ± 4.6 tons/acre (-62% due to fire 1, 2, & 3) (-16% due to fire 3 only) (n=11)	YES	YES n=11
	Maintain conifer pole density with DBH of 1-6" of <81 trees/acre 2 years post-burn	16.2 ± 24.9 trees/acre (-82% due to fire 1, 2, & 3) (-25% due to fire 3 only) (n=2)	YES	NO n=48
Ponderosa Pine w/ White Fir Encroachment (PIAB) North Rim	Maintain total fuel load of 1.7-19.0 tons/acre immediate post-burn	Not analyzed (n=0)	N/A	NO n=5
	Maintain conifer pole density with DBH of 1-6" of <100 trees/acre 2 years post-burn	Not analyzed (n=0)	N/A	NO n=9

NOTE: Assessment of objective success and fulfillment of minimum plot requirements are based on 80% confidence intervals. Minimum plot calculations are based on pre-fire values, with R-value of 20 for overstory tree and fuel assessment and R-value of 25 for pole-sized tree assessment; variable fire conditions increase the minimum number of recommended plots for post-fire analysis.

NO* indicates that the mean value does not meet stated objectives but the confidence interval is inside the range of objective values.

Year 1 Burn Severity –MTBS data and CBI plots

As part of the Monitoring Trends in Burn Severity (MTBS) program, Composite Burn Index (CBI) burn severity assessments have been occurring annually at Grand Canyon since 2001. Between 2001 and 2015, 1,414 post-fire year 1 CBI-style plots have been measured, providing Normalized Burn Ratio satellite-derived severity data on 59 fires for 138,768 total acres. This process is designed for field data and satellite imagery gathered one year following a fire; hence, 2015 work was performed on fires which burned in 2014. A total of 96 CBI plots were installed in 2015 (13 on the Kaibab National Forest and 83 in Grand Canyon National Park) across 9,141 acres in the Quaking (NKRD), Galahad and Kanabownits wildfires, as well as the Slopes Prescribed Fire. Additionally, the GRCA Fire Effects Crew installed the first-ever CBI plots at Saguaro National Park, providing 22 plots to allow SAGU Fire Ecologist Perry Grissom to better assess burn severity on the 1,130 acre 2014 Deer Head Fire.

Within all fire perimeters, there was a combined total of 1,392 unburned acres (15.2% of the total fire area), 6370 acres burned with low severity effects (70.0% of the total fire area), 593 acres burned with moderate/low severity effects (6.5% of the total fire area), and 785 acres burned with moderate/high to high severity effects (8.6% of the fire area). The majority of the acres burned occurred in the Galahad fire (6,137 acres), of which 628 acres (10% of the Galahad fire area) had moderate/high and high severity effects (Figure 1). These 628 acres account for 80% of the area classified as moderate/high and high severity over all fires for 2014.

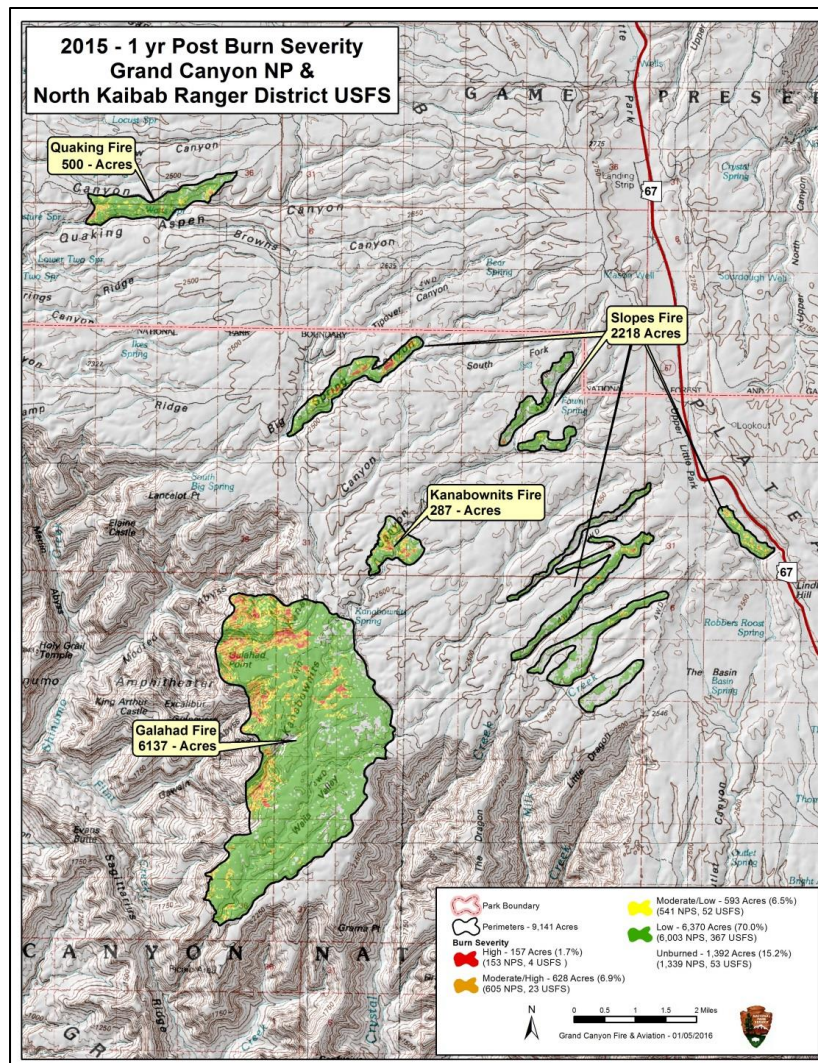


Figure 1. Burn severity data collected one year post-fire on the North Rim, Grand Canyon National Park and the North Kaibab Ranger District, Kaibab National Forest.

Cumulative Burn Severity –MTBS data and CBI plots

Landscape-scale severity objectives apply to the three monitoring types in which high severity fire was historically infrequent (PIPO, PIPN, and PIAB) and to the mixed conifer forest type (currently not an FMH monitoring type). The following table provides information on the extent of moderate/high and high severity fire in each monitoring type.

In all monitoring/forest types, the percentage of moderate/high and high severity fire on the landscape falls within the objective range. Some patches of moderate/high and high severity fire exceed the objective size in the PIPO, PIPN, and PIAB monitoring types.

Table 9. Management Objectives and Monitoring Results for fire severity.

Monitoring Unit	Management Objectives	Monitoring Results (all patches >0.1 acres)	Objectives Achieved?
Ponderosa Pine (PIPO) South Rim	Limit high severity fire to patches <5 acres across ≤5 % of monitoring type 10 year period fires from 2005 to 2014	1% moderate/high and high severity 6 patches >5 acres largest patch: 7 acres	YES - percent NO - size
Ponderosa Pine (PIP) North Rim	Limit high severity fire to patches <5 acres across ≤5 % of monitoring type 10 year period fires from 2005 to 2014	3% moderate/high and high severity 18 patches >5 acres largest patch: 52 acres	YES - percent NO - size
Ponderosa Pine w/ White Fir Encroachment (PIAB) North Rim	Limit high severity fire to patches <10 acres across ≤15 % of monitoring type 10 year period fires from 2005 to 2014	9% moderate/high and high severity 37 patches >10 acres largest patch: 288 acres	YES - percent NO - size
Rocky Mountain Montane Conifer (Mixed Conifer) North Rim	Limit high severity fire to ≤30 % of monitoring type fires from 2000 to Present	16% moderate/high and high severity ¹	YES

¹Updated mapping during 2013 altered the percentage of moderate/high and high severity fire in mixed conifer forests compared with previous years.

ADDITIONAL PROGRAM INFORMATION

TABLE 10. Additional Program Information for 2015.

Program Category	Measurement	Grand Canyon National Park	Flagstaff Area National Monuments
Planning	Does park have written Desired Future Conditions (DFCs)?	Yes	Yes
Planning	Date park-level monitoring plan completed (or revised)	2010	Not Completed
Planning	Total # project- or community-level monitoring plans	0	0
Planning	Assisted with how many Burned Area Emergency Rehabilitation (BAER) plans in 2015?	0	0
Monitoring	% 2015 data entered	100	100
Monitoring	% 2015 data quality checked	100	100
Monitoring	# 2015 prescribed fires monitored (# total prescribed fires monitored) ¹	0 (7)	0 (4)
Monitoring	# non-fire fuels treatments monitored	0	0
Monitoring	# 2015 wildfires monitored (# total wildfires monitored) ¹	0 (3)	0 (0)
Monitoring	# BAER treatments monitored	0	0
Communication	# project monitoring reports completed in 2015 ²	0	0
Communication	# annual meeting(s) with park staff	2	1
Communication	# formal presentations of results	4	0
Communication	Do you use Minitab?	Yes	
Research	Are research needs identified in Fire Management Plan (FMP) or monitoring plan?	Yes	Yes
Research	# proposals submitted in 2015	1	0
Research	# proposals funded in 2015	1	0
Research	# research projects supported in 2015 ³	6	0
Research	Additional Comments		

¹Number of fires/treatments completed in 2015 with fire/treatment effects monitoring conducted. Includes pre- and post-fire/treatment monitoring, but not on-site fire behavior monitoring. Number in parentheses represents 2015 post-fire/treatment monitoring of fires/treatments that occurred prior to 2015.

²Existing GRCA protocol burn-day monitoring reports are not included in this number. Project monitoring results for 0 projects included as part of this annual report

³Number of research projects supported including logistical info or support, staffing, data sharing, product reviews, etc.

NPS FIRE FUNDED RESEARCH UPDATE

Spatial analysis of the influence of fire severity on forest structure on the North Rim of Grand Canyon National Park using LiDAR and CBI corrected MTBS data (Valentijn Hoff, Eric Rowell, and LLOYD Queen, The University of Montana)

This research project was funded by the NPS Intermountain Region in January 2015 and a cooperative agreement through the Rocky Mountains CESU was completed. University of Montana researchers traveled to GRCA and met with fire management staff in June to finalize project objectives and work plan. A progress meeting was held in October, and UM researchers presented their findings thus far; these include structure metrics such as canopy cover (%), canopy bulk density, and canopy base height, among others. Findings thus far visually make sense in terms of what LiDAR is showing vs. what CBI-corrected MTBS data are showing. A trip to the field will be considered for Spring 2016.

The research project is expected to be completed by June 30, 2016. Project deliverables include:

- Electronic and/or hard copies of datasets with Federal Geographic Data Committee (FGDC) compliant metadata, this includes the severity / structure relationships and all geospatial data and maps indicating the allocation of structure / severity classes on the landscape
- Presentation to Grand Canyon fire managers
- Presentation at a national scientific conference
- Article submitted to peer-reviewed publication

RESERVE FUND RESEARCH UPDATE

Comparing modern and historical high-elevation fire regimes at Grand Canyon (Peter Z. Fulé and Larissa L. Yocom, Northern Arizona University)

This research project was funded by the Reserve Fund and NPS Intermountain Region in January 2012. The research project was completed in May of 2014 with a presentation of results to the park Fire & Aviation and Science & Resource Management staff and copies of all data were provided to the park. In the summer of 2012, tree cores were collected from 911 trees in 72 plots on the North Rim. The tree cores were dated and analyzed at the NAU School of Forestry during the 2012-2013 school year and presentations on initial results were given at the AmeriDendro and Colorado Plateau conferences in 2013, and final results at the Colorado Plateau and Association of Fire Ecology conferences in 2015.

A research article detailing the results was just published in the Canadian Journal of Forest Resources, a peer reviewed journal. The citation (with Park staff in **bold**) is:

Yocom-Kent, L.L., P.Z. Fule, **W.A. Bunn**, and **E.G. Gdula**. 2015. Historical high-severity fire patches in mixed-conifer forests. Can. J. For. Res. 45:1587-1596.

ON-GOING RESEARCH COLLABORATIONS

GRCA Fire Ecology staff members fulfill data requests from numerous federal and university researchers each year. In addition to the projects described above, the following list illustrates the diversity of collaborators and the types of research to which GRCA Fire Ecology staff (shown in **bold**) made substantial contributions in 2015.

How Does Climatic Stress at Intermediate Timescales Influence Fire Severity? PI: Phillip van Mantgem (USGS); Co-PIs: Emma Williams (U of AZ), Don Falk (U of AZ), Adrian Das (USGS), Jeffrey Kane (Humboldt State University), Mary Beth Keifer (NPS), Jonathan Nesmith (NPS), Nathan Stephenson (USGS). Western Ecological Research Center (WERC). USGS funded. **Windy Bunn** and **Li Brannfors** assisted with providing field data as well as some field data collection and plot access.

Landscape Impacts of Fire and Climate Change in the Southwest: A Science-Management Partnership. Submitted to JFSP. PI: Andrea Thode (NAU), Co-PIs: 14 researchers and managers including **Windy Bunn** (GRCA Fire).

Identifying nest-roost habitat for Mexican spotted owl on the North Rim of Grand Canyon National Park. Co-PIs: Kurtis Nelson (USGS), Birgit Peterson (USGS Contractor). Funded by USGS EROS Data Center. **Eric Gdula, Windy Bunn** and **Li Brannfors** provided data and assisted with field validation.

Building a new automated fire detection system with Landsat data. PI: Michael Coan & Stephen Howard (USGS). Funded by NASA. **Eric Gdula** provided data and tested research products.

FUTURE PROGRAM DIRECTION

One of the top priorities for the future is to maintain the integrity of our long-term datasets by continuing to hire a full field crew at GRCA, including returning the Assistant Lead position to permanent status. In addition, a long-term monitoring strategy for Walnut Canyon is recommended, with future plot measurements and data management being coordinated between the GRCA Fire Ecology Program and the Southern Colorado Plateau Network I&M Program. The ability of the GRCA Fire Ecology Program to continue to assist in ecology, monitoring, and data management efforts for other parks and the regional and national offices is entirely dependent on maintaining full staffing and continuity within our program.

Fire-related measurements have been added to all unburned mixed conifer plots installed by the I&M program, and the past data were converted into a workable FFI database. Future collaboration efforts will focus on ensuring that the data management and plot visit protocols will work for both groups. The CBI plot workload will be minimal due to lack of fire activity at Grand Canyon during 2015, but the continued struggle with multiple entry fire will persist into the future. RAP plots will, personnel allowing, be re-measured and installed in imminently pending burn units to provide data for burn plans. As usual, the North Rim will presently be the site of most 2016 GRCA field work, hosting ~50% of FMH plot and 100% of RAP, I&M, and CBI plot reads.

Building on our multiple years of testing and implementation with FFI Lite, fire monitoring software, and tablet hardware platforms, we would like to continue providing insight into the refinement of applications and protocols for mobile device-based data collection on both plots and active fires. Moving from paper datasheets to mobile applications has been realized and maintained within our program, and we hope to stay heavily involved in the development and implementation of future products. We will be asking the IMR to support the Lead in terms of travel to other parks to help train Fire Ecology/Effects staff with tablet-based data collection and management. The program will also continue our commitment to working with researchers to develop solid scientific datasets for management decision-making and with outreach staff to educate internal and external audiences about fire in GRCA and the NPS.



Figure 2. Boys will be boys.

CONTRIBUTORS

Casey Teske
Fire Ecologist
casey_teske@nps.gov
928-638-7358

Windy Bunn
Fire Ecologist
windy_bunn@nps.gov
928-606-5599

Li Brannfors
Lead Fire Effects Monitor
li_brannfors@nps.gov
928-638-7942

Dominic Ali
Assistant Lead Monitor
dominic_ali@nps.gov
928-638-7063

Greg Hamby & Daniel Leach
Fire Effects Crewmembers