National Park Service
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Fire and Aviation Management

Grand Canyon National Park / GRCA
Fire Ecology Annual Report
Calendar Year 2021

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1. Summary

A resumption of stability was the 2021 hallmark of the Grand Canyon National Park (GRCA) Fire Ecology Program, as for the first time since 2016, no turnover occurred in any permanent position and multiple seasonal crewmembers returned. Although the permanent Assistant Lead Monitor position remained vacant for a 3rd consecutive season, a returning temporary GS-6 employee was hired to fill the role, supported by another returning seasonal crewmember, a new seasonal crewmember, and a graduating student intern. The global COVID-19 pandemic continued, but impacts were minimized due to freedom to telework, established protocols, and full vaccination by all Fire Ecology staff. A moist summer monsoon season in Arizona and no large wildfires locally allowed for broadcast prescribed burning in the park, and gave flexibility for staff to go on multiple fire assignments off-district to support a challenging fire season nationally. Over the course of a typically long but productive field season, a suite of 44 Fire Monitoring Handbook (FMH) plots at GRCA (Table 5); 20 Southern Colorado Plateau Network Inventory and Monitoring (I&M) pinyon-juniper plots at GRCA; 46 Structure From Motion (SFM) Rapid Assessment Protocol (RAP)-style plots on the North Kaibab Ranger District (NKRD); and 20 FMH plots at Saguaro National Park (SAGU) were monitored by the crew in 2021.

Grand Canyon Fire Ecology expanded upon its tradition of assisting and partnering with other long-term monitoring programs this season. For the third consecutive year, the entire crew traveled to Saguaro National Park, reading 20 plots for the Southern Arizona Fire Ecology Program burned in the recent Mica Bowl Prescribed Burn and Spud Rock Fire. Extra assistance was again graciously provided by the Teton Interagency and Yellowstone Fire Effects crews to accomplish all work in one visit. Unplanned assistance was requested by the Pueblo Fire Ecology program to read 15 plots at El Malpais (ELMA) and El Morro (ELMO) National Monuments in New Mexico, providing the first opportunity for Grand Canyon and Bandelier Fire Effects crews to work together since 2008. Finally, the fieldwork partnership with the I&M Southern Colorado Plateau Network (SCPN) was increased to include pinyon-juniper monitoring on the South Rim. Fifteen existing upland forest plots were collaboratively measured by both crews, and 5 plots

were individually read by the SCPN crew after training from GRCA staff. As usual, the sharing of knowledge and skills, collaboration, and relationship building are high values worth perpetuating.

An old friend returned to the active monitoring program in 2022: pinyon-juniper forest (PJ). Spurred by large-scale, drought-caused juniper mortality across the Southwest, the vegetation type becoming increasingly receptive to fire spread in recent years, and the SCPN I&M crew visiting 20 of their 30 PJ plots in 2021, the decision was made to resurrect and expand data collection for both fire and long-term vegetative structure analysis. To maximize the suite of data available in the shortest amount of time, data from existing FMH and I&M plots on the South Rim were gathered by partnering the efforts of both crews. Fifteen original Pinyon-Juniper Woodland (PIED) FMH plots which had not been visited since the 1990s were located using traditional compass & chaining methodology, as modern, accurate GPS coordinates were not available when these plots were last read. Once found and re-monumented with visible rebar, the variables with historic data of most interest were re-sampled: surface fuels, overstory trees, pole-sized trees, herbaceous transects, and visual change via photos. Additionally, tree height and live crown base height (CBH) were added via accurate hypsometer measurements. To complement the same protocols available for analysis, 20 I&M plots had surface fuels, tree height, and CBH added to the standard suite of I&M measurements, mirroring methodologies established through the North Rim mixed conifer plot partnership aimed at providing data comparable to FMH plots on all vegetative and fuels strata. Ultimately the Fire Effects crew had to split to simultaneously gather data on both FMH and I&M plots, and we relied on the generosity of the SCPN crew to gather our fire-specific data on 5 plots they visited later in the season. But through the efforts of both programs planning and working together, GRCA Fire Ecology went from having zero to 35 plots of long-term, FMH-quality PJ data available in just one month of field work, laying the foundation for not just Fire & Aviation, but the whole park to quantitatively track and manage PJ woodland.

For the eighth straight season, 100 percent of Grand Canyon field data was collected on tablets and managed electronically, enhancing efficiency. Only Excel, iPads, and iPhones were used all year at both GRCA & SAGU, to mostly great success. Knowledge of CSV file-based processes pioneered in 2020 were shared with other programs, with Yellowstone Fire Ecology incorporating the methodology into their monitoring all year. Teaching the Regional Fire Ecologist the full field and office process while on the South Rim in June allowed her to create a version for the Sonoran Desert Network (SODN) I&M program to collect fire effects data at Chiricahua National Monument. The Bandelier Fire Effects crew was briefly exposed to the process at El Malpais; and after beginning on paper, the majority of data collected for the Kaibab Fire Ecologist's SFM plots were also entered via an adapted electronic version. Expanding on 2020's initial trials, all data management exclusively used the new cloud-based FFI RemoteApp throughout the season for both data export and import, giving the National office much-needed insight on performance for multiple users attempting to share multiple files. With an online national training led by National & Regional Ecologists along with the GRCA Lead Monitor, we hope even more programs will feel empowered to incorporate this process in 2022.

Even with the extensive time dedicated to refining, adapting, and sharing new software and techniques, exclusive use of tablets for data collection still saved enough time compared to traditional data entry that seasonal crewmembers learned advanced skills by performing query-based quality assessment-quality control (QAQC); and creating Access-based, PDF exports of our electronic datasheets ready for filing in hardcopy format. We cannot recommend this approach enough to both increase programmatic efficiency and advance employee development.

Extended time in national Level 5 fire preparedness once again saw all seasonal crewmembers simultaneously leaving on full 14-day fire assignments. The program also supported suppression and fire behavior monitoring of several local fires, with crewmembers expanding their skill sets and their variety of contributions to fire operations. In some capacity, the crew worked on 11 incidents and boosted severity staffing over 95 total operational periods and completed 4 different NWCG training classes (basic firefighter course bundle counted as 1 class). Highlights of this experience included qualifying the seasonal Assistant Lead as READ/REAF after 2 weeks on the Bruler Fire in OR; two Fire Effects crewmembers and one North Rim Engine-831 crewmember detailing for 2 weeks with the Olympic Wildland Module on the Pincer Creek Fire in WA; 3 weeks detailing with South Rim Engine-812 staff on the Schneider Springs Fire in WA;

independently locating and performing initial attack as a crew with the Ecologist as IC; assisting multiple initial attacks for North Zone Fire Management (USFS North Kaibab Ranger District-Kaibab National Forest & NPS North Rim-Grand Canyon National Park); and returning to our role providing primary FEMO support for 2 prescribed burns on both North and South Rims.

Cross-training Fire Ecology crewmembers with other field disciplines in the fire & resource management programs continued to allow the crew to build diverse skills and increase staffing flexibility. Personal interest by the crew greatly facilitated this multi-disciplinary learning, be it assisting researchers with historic burn severity plots, joining Science & Resource Management (SRM) staff for Sentry milk-vetch surveys, fuel sampling, saw work on prescribed burn prep, or backfilling on the Type 6 engine. To spread the wealth of knowledge further, multiple crewmembers from both South and North Rim engines, staff from the Vegetation program on both rims, staff from the Interpretation program, the Kaibab NF Fire Ecologist, the GRCA Fire Ecologist, and the Regional Fire Ecologist (totaling 11 people) were trained in GRCA Fire Effects plot protocols.

Narrative by the Fire Ecologist, Matthew Engbring

Beginning in the 2021 calendar year the Grand Canyon Fire Ecologist embarked on his second year with the NPS and Grand Canyon National Park. As the season kicked off in January, the ongoing pandemic continued to pose challenges to everyday activities professionally and personally for the Fire Ecologist. Teleworking from his home (also temporarily a one room Kindergarten) in Flagstaff, AZ the Fire Ecologist continued to receive on-the-job (OJT) training from the Lead Fire Effects Monitor during the construction of the 2020 annual report. Training was received in FFI on how to conduct analysis of the monitoring objectives outlined in the 2010 monitoring plan. Institutional knowledge retained by the Lead Monitor has proven to be invaluable to the development of the Fire Ecologist as he continues to seek proficiency in monitoring related activities/analysis.

Hiring for the 2021 season was conducted during the winter and spring. Grand Canyon was fortunate enough to retain two exceptional seasonals, solicit one new seasonal, and train one new intern for the Fire Effects crew. While hiring of agency personnel was ultimately successful, the DOI Fires process posed moderate communication challenges between the Fire Ecologist and the AZ Servicing Human Resources Office (SHRO). Hiring of the intern was conducted by Northern Arizona University (NAU) with feedback from the Fire Ecologist and Lead Monitor. The collaboration between the NPS, Colorado Plateau Cooperative Ecosystems Study Unit (CPCESU), and NAU to support a non-federal intern turned out to be an extremely challenging process. Further collaboration with the CPCESU will need to be evaluated and the Fire Ecologist would like to explore more agency-centric programs similar to Pathways, SCEP, or solely NPS-sponsored internships for future student opportunities. Ultimately, hiring and onboarding were completed for 2021 and the crew began their season on the North Rim of the Grand Canyon.

As fire season kicked off in the southwest, the Fire Ecologist supported the adjacent Coconino National Forest as a Type 3, Team Safety Officer (C & G). The Regional and National preparedness levels quickly ramped up and all restorative work using fire was halted. Influenced by policies on neighboring USFS lands, strict suppression strategies were implemented at Grand Canyon NP and fires were not allowed to be managed for resource benefit during the summer of 2021. Grand Canyon was once a leader in allowing fire to naturally burn across the landscape and now the Park has had no notable fires being managed for resource benefit since the 2019 Ikes Fire. To break this trend, restrictive National policies based on preparedness levels will need to be re-evaluated and the local capacity to staff wildfires will need to be bolstered.

Notably during the 2021 summer season the Fire Ecologist participated in processes to reconstruct Standard Position Descriptions (SPD) for the Fire Ecology group. Bi-weekly meetings occurred throughout the summer to as part of a process to write and approve SPDs for the Biological Technician - Fire Effects Monitor GS-04, 05, 06, and 07 positions. This effort was in-line with future program direction identified

within the Grand Canyon program of work and will aid in establishing a clear career ladder for seasonals to obtain the GS-07 Lead Monitor position.

The 2021 monsoon season in the southwest was robust. During this time the Fire Ecologist was able to travel to the North and South Rims to join the Fire Effects crew as they conducted plot work. Additional training was provided by the Lead Monitor on plot work and protocols. Also, during this time the Fire Effects crew and Fire Ecologist supported local initial attack and national fire efforts. In total, approximately 132 days of total support was provided to local and national fire efforts by the fire effects crew and fire ecologist for the 2021 field season.

Throughout the 2021 fire season a reoccurring theme of inequity was felt by the seasonal Fire Effects crew on the North Rim. Activities and behaviors from coworkers on the North Zone and policy dictated by the NPS created a state of mind that left the Fire Effects crew feeling undervalued. This perception, created by disparities within the Branch, lead to a narrative of marginalization. This situation was verbally communicated by the seasonal workforce to the Fire Ecologist on multiple occasions as the seasonals felt at times their positions were downplayed within the organization. Moving forward, the Fire Ecologist would like to continue exploring ways to provide relevancy and value to the work conducted by the Fire Effects crew. Additionally, the Ecologist wants to provide equitable incentives, when compared to Forestry Technicians, within the Fire Effects and Fire Ecology group (Biotech or Ecologist series). Without relevancy and equality within the Branch of Fire and Aviation, the entire Fire Ecology workgroup will experience a downturn in employee retention and recruitment.

To close out the 2021 fire season the Fire Ecologist and Lead Monitor both traveled to the South Rim to participate in a prescribed fire. Critical positions were filled by the Ecology group as the Lead Monitor served as a FEMO and the Fire Ecologist served as a RXB2. The weeklong operation was a success and contributed to the overall fuels targets for the Grand Canyon.

Overall the 2021 season was a success for the Fire Ecologist. Initiatives that were crafted by previous Ecologists have continued to come to fruition including multiple presentations of Climate Drivers of Extent and Severity and the hosting of an internship through a collaboration with CPCESU. The Ecologist has continued to gain proficiency in daily activities and has additionally grown more into the role his position fills with the NPS. Through the recording of Daily Logs, the Ecologist has made estimates on his time spent within specific focus areas and accomplishments. See Table 4 below for a detailed workload analysis.

2. Staff Accomplishments and Areas of Focus

Table 1. Fire Ecology staffing for the 2021 calendar year.

Employee	Starting Date	Ending Date	# Pay Periods	READ Qualified (Yes or No)	Training	NWGG Taskbooks[1]
Matt Engbring, GS-11	1/1/21	12/31/21	26	No	RT130 OJT	DIVS-t
Li Brannfors, GS-07	1/1/21 2/28/21[2] 4/11/21	1/30/21 3/27/21 12/31/21	22[2]	No	RT130	LTAN-t
Alexandra Lalor, GS-6	5/9/21 10/18/21[2]	8/28/21 11/6/21	9[2]	Yes	RT130	READ/REAF[3] FEMO-t FAL3-t HECM-t SRT2-t
Chazz Lakin, GS-5	4/25/21	11/6/21	14	No (READ/REAF-t)	RT130 S290	FAL3 FEMO-t READ/REAF-t[3] ICT5-t FFT1-t HECM-t
Isabella Muscettola, GS-5	5/9/21	11/6/21	13	No	S130/190 L180 ICS100 IS700 S212	FEMO-t FAL3-t HECM-t
Savannah Cierley, intern[4]	5/9/21	9/29/21	9	No	RT130 S212 Tech SAR	FEMO-t FAL3-t HECM-t

[1] This represents both open (trainee) taskbooks and those completed in the 2021 season.
[2] Time for Li Brannfors & Alexandra Lalor reflects cumulative hours, with total pay periods consolidated due to part-time work.
[3] NWCG taskbooks do not yet exist for the READ & REAF positions.
[4] Savannah Cierley was the intern for this year and her time reflects cumulative hours, with total pay periods consolidated due to part-time work. Savannah's time was funded through a CPCESU agreement with Northern Arizona University and NOT from the fire effects base account.

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	21	3	<1	1	7	16	22	4	1	1	1	22
Alexandra Lalor, GS-6	30	11	1	0	10	11	10	<1	<1	15	2	10
Chazz Lakin, GS-5	28	7	1	4	9	19	7	3	2	13	1	6
Isabella Muscettola, GS-5	29	8	1	1	10	13	7	<1	2	19	2	8
Savannah Cierley, intern	33	7	0	2	2	13	15	<1	1	20	3	3

"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 details with GRCA Helitack, GRCA and NKRD engines, admin. 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 and accomplishments for the 2021 calendar year.

Focus Area	Percent Time	Accomplishments and Activities
FMH Plots	27*	• 28 remeasurements and 1 install at GRCA • 15 modified remeasurements of PIED plots discontinued since 2000 • 20 remeasurements at SAGU • 10 remeasurements and 5 installs assisted at ELMA & ELMO
RAP Plots	6*	• 46 Structure From Motion installs coordinated with Kaibab NF Fire Ecologist in 2020 Mangum Fire
CBI Plots	<1	• Assisted researcher w/ custom plots in 2019 Ikes Fire for 1 day
I&M Plots	2*	• 20 baseline measurements of fuel and tree data in existing I&M pinyon-juniper plots at GRCA (data on 5 plots collected exclusively by SCPN staff)
Data Entry/ Management	8*	• *ALL 2021 plot data collected and checked electronically with tablet computers in the field; data entry and field checking are included in percent time under each plot type* • QAQC queries completed for 2021 GRCA standard (non-PIED) data by Nov 3 • QAQC queries completed for 2021 SAGU data by Nov 3 • Refined new electronic data entry using FFI CSV file exports, Excel, and iOS tablets/phones • Assisted National office w/ testing cloud-based FFI Remote App • Refined & further automated Access-based hardcopy datasheet creation process • Includes FFI/Excel electronic data prepping, merging, and checking for all standard (non-PIED) plots at GRCA & SAGU, as well as hardcopy datasheet creation at GRCA
Data Analysis	<1	• *Annual Report analysis on all major variables in program completed in January 2022*
Plot Office	15*	• Includes plot preparation, plant ID, photo filing, tree mapping, hardcopy data filing/organization, and plot-related projects
General Office/ Supervision/ Admin	13	• Includes paperwork for travel, credit cards, non-plot related projects • Hiring, evaluations, and supervision by Lead • Lead hired seasonal crew • Lead supervised 3 seasonals and 1 intern for 6 months
Fire Monitoring (Rx or Wildfire)	2*	• Lead FEMO & FEMO-trainees on 2 Rx fires at GRCA • Trained E812 crewmember as FEMO-trainee on 1 Rx fire at GRCA
Fire Operations/ Assignments (Rx, Wildfire, Engine, Helitack, Non-fire Fuels Projects)	13*	• Completed qualification for 1 crewmember as READ/REAF • 1 crewmember detailed on READ/REAF trainee assignment for 2 weeks in OR • 2 crewmembers detailed with Olympic Wildland Fire Module for 2 weeks at WA • 1 crewmember detailed with GRCA engine 812 for 3 weeks in WA • FFT1 and FFT2 support on total of 3 North Zone fires • Cross-trained crewmembers with GRCA engines and fuel sampling
Training	2*	• All attended annual fire refresher • 1 completed S130/190, L180, ICS100, & IS700 (Basic Firefighter Training) • 2 completed2+ S212 • 1 completed S290 online • 1 completed Technical Search & Rescue (SAR) training
Travel Away from Duty Station	–	• Total of ~2 months for crew spent on South Rim, at El Malpais & El Morro National Monuments, and at Saguaro National Park for plot work & training, ~4.5 months for Lead including an extra 2.5 months teleworking in Flagstaff
Other	12	• ~3% of crew time spent on PT • ~5% of crew time spent on leave

*1057 hours of combined overtime and comp time on both fire and plot duties, equaling 16 percent of total crew work time (base + OT + CTE), are not reflected.

Table 4. Fire Ecologist Focus Areas and Accomplishments for the 2021 calendar year.

Focus Area	Percent Time	Accomplishments and Activities
Planning	10	• Managed activities in NFPORS • Technical Reviewer and editor for multiple prescribed fire burn plans • Provided limited GIS support and data organization for Fire Branch • Construction of Biological Technician SPDs • Served a WFDSS "driver" for GRCA • Served as an IDT lead for the Branch utilizing PEPC • Provide Fuels information form the FFI database to Leadership for Fire Management decision making
Presentations/ Education	<1	• Co-Hosted a WFDSS training for WACA • Provided an introductory overview of WFDSS to the SRM Division • Facilitated a Q&A during a Southwest Fire Science Consortium Webinar • Synthesized current literature on Wildfire/Prescribed fire and provided summaries to the GRCA Fire Staff • Presented Superintendent binder to staff to educate leadership on Ecology program
NPS Meetings/ Task Groups	5	• Fire and aviation weekly staff and strategy meetings • Attended bi-monthly SRM program manager meetings • Participated in regional Fuels calls and annual Fuels workshop • Attended Regional Fire Ecology collaboration call
Interagency Work	<1	• Coordinated with Kaibab NF and GRCA Lead Monitor on data requests for stereographic Lidar stitching project on the North Rim • Attended field trip with collaborative Pinyon Juniper working group at Sunset Crater • Coordinated with CPCESU and NAU on the recruitment and hiring of an intern
Internal Collaboration	5	• Outreached to employees in SRM to initiate relationships and collaborations • Participated in Climate Adaptation Strategy workshop with SRM • Aided in the construction of a Research Proposal for Bat monitoring • Participate in the construction of Standard Position Descriptions for the Fire Ecology/Fire Effects Group • Coordinated with GIS shared services to introduce GRCA users to new applications offered by NPS
Fire Assignments and Project Work	20	• RXB2 for the RX 300 Prescribed Fire • FOBS assignment to the McCash Fire • SOFR (Type 3 Team Safety) for the Slate Fire • ICT5 for initial attack on the North Rim
Research	5	• Provided input on 58 Research Requests for SRM • Collaborated with the GRCA wildlife group on a proposal for soundscape monitoring of bats on the South Rim • Coordinated with Soundscape crew at GRCA for new research and collaboration
Data Collection	2	• North Rim FMH data collection totaling one week of Ecologist time • South Rim re-establishment of PIED plots approximately one week
Data Analysis	3	• Co Authored the Fire Ecology Annual Report • Provided fuel loading reports to fire managers on the South Rim
GIS	3	• Created maps and shapefiles for planning and support • Served as a liaison between GRCA Fire and IMR GIS Shared Services • Coordinated a review of the GRCA Fire Severity analysis
Supervision/ Administration	30	• Routine Program Manger responsibilities • Supervised the Lead Monitor and aided in administrative functions for seasonal workforce • Managed fire monitoring and ecology budgets and purchasing • Facilitated training opportunities for seasonal crew as REAF/READ, FEMO, and FFT1 • Fire Effects crew PTBs, QuickTime, Concur, e-mails, EPAPs • Regularly coordinated with administrative support staff on budget and programming
Training and Conferences	10	• Daily experiences equated to continual OJT for second season of Ecologist's tour of duty • Continued to review the Grand Canyon Fire Monitoring Plan • FFI OJT with Lead Monitor
COVID and Other	5	• COVID related information and emails • COVID Family Leave • Other forms of leave • PT

3. Fire Effects Plot Workload

3.1. Grand Canyon National Park Fire Effects Plot Workload

The 2021 season included a light standard workload at Grand Canyon proper, which increased in scale late in the summer as monitoring of pinyon-juniper forest was brought back into the program via long-defunct FMH as well as I&M plots on the South Rim. Additional plot visits assisting the Kaibab National Forest Fire Ecologist on the North Kaibab Ranger District, the Pueblo (Bandelier) Fire Effects crew at El Malpais and El Morro National Monuments, and at Saguaro National Park amounted to more plots being read at sites other than GRCA in 2021 (81 total non-GRCA plots).

Table 5. Grand Canyon National Park Fire Effects plot workload for the 2021 calendar year

Rim	Monitoring Unit	Plot Type	Install/ Pre-burn	Immed. Post-burn	Year 1	Year 2	Year 5	Year 10/ 20	Annual Total	Total Plots[1]
South	Ponderosa Pine **PIPO**	FMH - Forest	1	0[2]		4		5	10	41
South	Pinyon-Juniper Woodland **PIED**[3]	FMH - Forest	15						15	17
South	Moqui Rx	RAP[4]							0	5
South	Picnic Rx	RAP[4]							0	10
South	Quarry Rx	RAP[4]							0	10
South	Pinyon-Juniper	I&M[5]	20						20	20
North	Ponderosa Pine **PIPN**	FMH - Forest				2		2	4	30
North	Ponderosa Pine with White Fir Encroachment **PIAB**	FMH - Forest				4	4		8	27
North	Rocky Mountain Subalpine Conifer **PIEN**	FMH - Forest					7		7	17
North	Grassland Interior **GRIN**	FMH - Brush							0	10
North	Grassland Edge **GRED**	FMH - Forest							0	6
North	Fawn Spring Rx[6]	RAP[4]							0	20
North	Highway 67 Rx[6]	RAP[4]							0	20
North	Range Rx	RAP[4]							0	20
North	Spring Canyon Rx[6]	RAP[4]							0	20
North	Thompson Rx	RAP[4]							0	20
North	Burnt Corral-NKRD	RAP[4]							0	50
North	Tipover Rx-NKRD	RAP[4]							0	40
North	Walla Valley Rx	RAP[4]							0	6
North	Mixed Conifer	I&M[5]							0	46
Total			**36**	**0[2]**	**0**	**10**	**11**	**7**	**64**	**435**

[1] Total Plots includes all permanent plots (FMH, RAP, or I&M) installed to date within a monitoring unit/type.
[2] One plot burned late in the season and environmental conditions (snow) prevented immediate post-burn from being gathered in 2021.
[3] PIED monitoring type reads were discontinued in 2000 & resurrected in 2021 for protocols of interest.
[4] Pilot sampling.
[5] Fuel and tree data collected to add to data collected by I&M crews.
[6] While RAP plots were installed with specific projects in mind, the decision was made in 2014 to collect post-burn data on individual plots regardless of what fire affected them - as such, plots in these project units were read after burning in Tipover East Rx and Slopes Rx.

3.2. Flagstaff Area National Monuments Fire Effects Plot Workload

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 (WACA). Going forward, these 13 plots will comprise the foundation of the active network at WACA. A copy of the FFI database containing the existing plot data, as well as the three archived databases, are available on the NPS IRMA portal (Reference Codes: Walnut Canyon NM current-2194013, Walnut Canyon NM historic-2222935, Sunset Crater NM historic-2221713, Wupatki NM historic-2222001).

In 2020, new baseline data for all 13 plots were collected independently by Grand Canyon Fire Ecology staff and Southern Colorado Plateau Network I&M staff due to COVID mitigation measures and concerns. The I&M crew is scheduled to re-visit these plots again in 2022, and the Fire Effects crew will collaborate with I&M on those plot reads if no prescribed burns occur beforehand.

Table 6. Flagstaff Area National Monuments Fire Effects plot workload for the 2021 calendar year.

Park	Monitoring Unit	Plot Type	Install/ Pre-burn	Immed. Post-burn	Year 1 - 20	Annual Total	Total Plots[1]
Walnut Canyon NM	Ponderosa Pine Forest **PIPO**	FMH – Forest / I&M				0	13
Total						**0[2]**	**13**

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

[2] No new data were collected or added to the WACA FFI database in 2021.

Fire Effects staff from Grand Canyon and Bandelier team up to read plots at El Malpais National Monument

4. Monitoring Objectives and Results

4.1. Restoration Fuel Loading and Tree Density – FMH plots

Grand Canyon National Park's Fire Ecology Program has installed 148 permanent FMH-style plots to date. As of 2021, 125 of the 148 plots (84 percent) have burned. This large body of data allows us 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, (2) prescribed fires are not the management focus in these areas, and (3) quantitative objectives have not been updated or established. Of the nine restoration objectives listed in Table 7, we can say with statistical confidence we are achieving seven of the objectives after first entry fire, and four of the objectives after second entry fire.

Targeted mean fuel loading values were achieved during first entry fires in the PIPO, PIPN, and PIAB monitoring types. 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 PIAB monitoring type (Table 7).

In the PIPO and PIPN monitoring types, we have not installed the number of plots needed to overcome the variability in pole-sized tree (1 to 6 inch DBH) 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 second entry fire 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. After second entry fires in the PIAB type, mean pole-sized tree density fell within the targeted range; however the confidence limits extended below the targeted values (Table 7).

For large tree density (greater than 16 inch DBH), 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 fire, mean large tree density fell below the desired range (Table 7).

Table 7. Restoration Management Objectives and Monitoring Results for FMH plots in 2021. 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? (Data Years)		Minimum Plot #s Achieved?
		1st Entry	2nd Entry	1st Entry	2nd Entry	
Ponderosa Pine (PIPO) South Rim	Reduce total fuel load to 0.2-9.3 tons/acre immediate post-burn	**7.1** ± 0.8 tons/acre (-48%) (n=39)	**7.2** ± 1.5 tons/acre (-51% due to fire 1 & 2) (-12% due to fire 2 only) (n=24)	**YES** (1992 – 2019)	**YES** (1998 – 2019)	**YES** n=10
	Reduce poles (PIPO) with DBH of 1-6" to 16-81 trees/acre 2 years post-burn	**75.9** ± 29 trees/acre (-24%) (n=40)	**90.3** ± 36 trees/acre (-34% due to fire 1 & 2) (-10% due to fire 2 only) (n=24)	**YES*** (1994 – 2021)	**NO*** (2000 – 2021)	**NO** n=61
	Maintain overstory (PIPO) density with DBH ≥16" of >14 trees/acre 5 years post-burn	**21.2** ± 2.5 trees/acre (0%) (n=39)	**19.2** ± 3.4 trees/acre (0% due to fire 1 & 2) (-1% due to fire 2 only) (n=20)	**YES** (1997 – 2018)	**YES** (2003 – 2016)	**YES** n=14
Ponderosa Pine (PIPN) North Rim from	Reduce total fuel load to 0.2-15.7 tons/acre immediate post-burn	**12.1** ± 1.6 tons/acre (-56%) (n=30)	**9.9** ± 1.9 tons/acre (-63% due to fire 1 & 2) (-40% due to fire 2 only) (n=28)	**YES** (1992 – 2011)	**YES** (2005 – 2018)	**YES** n=11
	Reduce conifer poles with DBH of 1-6" to 16-81 trees/acre 2 years post-burn	**70.2** ± 33.4 trees/acre (-58%) (n=30)	**17.9** ± 6.5 trees/acre (-80% due to fire 1 & 2) (-23% due to fire 2 only) (n=28)	**YES*** (1994 – 2013)	**YES*** (2007 – 2020)	**NO** n=48
	Maintain overstory conifer density with DBH ≥16" of >17 trees/acre 5 years post-burn	**40.9** ± 3.8 trees/acre (-10%) (n=30)	**40.1** ± 9.0 trees/acre (-18% due to fire 1 & 2) (-8% due to fire 2 only) (n=11)	**YES** (1997 – 2016)	**YES** (2010 – 2019)	**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	**15.9** ± 2.9 tons/acre (-55%) (n=25)	**16.0** ± 5.0 tons/acre (-58% due to fire 1 & 2) (-43% due to fire 2 only) (n=17)	**YES** (1993 – 2017)	**YES*** (2000 – 2019)	**YES** n=5
	Reduce conifer poles with DBH of 1-6" to 16-100 trees/acre 2 years post-burn	**71.3**± 20.5 trees/acre (-70%) (n=26)	**28.0** ± 24.8 trees/acre (-87% due to fire 1 & 2) (-45% due to fire 2 only) (n=17)	**YES** (1995 – 2019)	**YES*** (2002 – 2021)	**YES** n=9
	Maintain overstory conifer density with DBH ≥16" of >20 trees/acre 5 years post-burn	**24.8** ± 3.5 trees/acre (-32%) (n=24)	**14.0** ± 5.2 trees/acre (-50% due to fire 1 & 2) (-13% due to fire 2 only) (n=15)	**YES** (1998 – 2017)	**NO** (2005 – 2021)	**YES** n=7

NOTE: Assessment of objective success and fulfillment of minimum plot requirements are based on 80 percent 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.
Red box indicates updated results in 2021. Yellow box indicates plot burned late in 2021, but environmental conditions prevented data collection.

4.2. Maintenance Fuel Loading and Tree Density – FMH plots

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. The objectives help define fire return intervals for prescribed fires on the South Rim, and initiate planning for prescribed fires on the North Rim (if wildfires are regularly suppressed or opportunities for managed fires are insufficient). Measurement periods currently correspond to those for restoration targets but can be adjusted based on management needs. Of the six maintenance objectives listed in Table 8, we can say with statistical confidence we are achieving four of the objectives after third or fourth entry fire.

Maintenance burning in the PIPO and PIPN monitoring types has resulted in achievement of the fuel loading objectives for each type. Although the sample size in the PIAB monitoring type is smaller, minimum plot numbers have been achieved for pre fire values and total mean fuel loading slightly exceeds the targeted range, with lower confidence limits falling within the targeted values.

However, in all three monitoring types, we have not both installed and burned the number of plots needed to overcome the variability in tree density. In the PIPO type, mean tree density now falls outside the targeted range after maintenance burning, but the confidence limits extend within the targeted range of objective values. The PIPN monitoring type has achieved the target range for maintenance of conifer pole-sized tree density objectives, although minimum plot numbers have not been met. This precautionary statement should be extended to the PIAB monitoring type, where only six plots have provided data two years post-burn following a third entry fire and one plot following a fourth entry. Mean conifer pole density for PIAB was within the targeted range; however, when viewing the confidence interval, limits extend well below the targeted threshold and values outside the interval are rejected as plausible values for that parameter. When considering the maintenance objectives for poles in all monitoring types there is extreme variability in the number of pole-sized trees, both pre- and post-fire. Within the current methodology, all macro plot reads are being considered for the final descriptive statistics to represent the full range of natural landscape variability in these monitoring types.

It should be noted that in all instances where the sample size is small and the minimum number of plots has not been reached, each additional plot reading in that monitoring type has the potential to greatly influence the result, and any interpretation of results should take this lack of statistical confidence in existing values into account.

Table 8. Maintenance Management Objectives and Monitoring Results for FMH plots in 2021. 3rd entry and 4th entry refer to the third and fourth time an area has burned in any fire type (prescribed fire or wildfire).

Monitoring Unit	Maintenance Management Objectives	Monitoring Results 3rd/4th Entry (n = # of plots)	Objectives Achieved? (Data Years)	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 percent due to fire 1, 2, & 3) (-25% due to fire 3 only) (n=16)	**YES** (2005 – 2011)	**YES** n=10
	Maintain tree (PIPO) density with DBH ≥1" of 43-135 trees/acre 5 years post-burn	**151.3** ± 34.5 trees/acre (-21% due to fire 1, 2, & 3) (-8% due to fire 3 only) (n=16)	**NO*** (2010 – 2016)	**NO** n=43
Ponderosa Pine (PIPN) North Rim	Maintain total fuel load of 0.2-15.7 tons/acre immediate post-burn	**10.9** ± 3.0 tons/acre (-56% due to fire 1, 2, & 3 or 4)[1] (-18% due to most recent entry) (n=16)	**YES** (2007 – 2019)	**YES** n=11
	Maintain conifer pole density with DBH of 1-6" of <81 trees/acre 2 years post-burn	**15.7** ± 7.2 trees/acre (-80% due to fire 1, 2, & 3 or 4)[1] (-5% due to most recent entry) (n=16)	**YES** (2009 – 2021)	**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	**19.5** ± 5.8 tons/acre (-50% due to fire 1, 2, & 3 or 4)[1] (-14% due to most recent entry) (n=7)	**NO*** (2017 – 2019)	**YES** n=5
	Maintain conifer pole density with DBH of 1-6" of <100 trees/acre 2 years post-burn	41.6 ± 50.5 trees/acre (-48% due to fire 1, 2, & 3 or 4)[1] (+16% due to most recent entry) (n=7)	**YES** (2019-2021)	**NO** n=9

NOTE: Assessment of objective success and fulfillment of minimum plot requirements are based on 80 percent 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.
[1] Both 3rd and 4th entry fires are considered maintenance burns, and only the most recent maintenance burn data are analyzed for each plot. In future years, we will likely analyze 3rd and 4th entry results separately, but currently lack the statistical strength to do so.
Red box indicates updated results in 2021

4.3. Burn Severity – MTBS Data and CBI Plots

To augment the Monitoring Trends in Burn Severity (MTBS) program, Composite Burn Index (CBI) burn severity assessments occurred annually at Grand Canyon from 2001 to 2019. Recently the feasibility and repeatability of the current process has come under question and GRCA's process of analyzing fire severity data is being reviewed. An analysis is being performed by the IMR, GIS Shared Service group and the GRCA Fire Ecologist to assess the Burn Severity program at GRCA and recommend changes to the current workflow. The goal of this assessment is to design and recommend a process where time commitments are commensurate with the staffing available to maintain the burn severity program. The target date for this assessment to be completed is spring of 2022.

5. Additional Program Information

Table 9. Additional Program Information through 2021.

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 (Renewal needed)	Not Completed
Planning	Total # project- or community-level monitoring plans	0	0
Planning	Assisted with how many Burned Area Emergency Response (BAER) or Burned Area Rehabilitation (BAR) plans in 2021?	1	0
Monitoring	Percent of total program data entered and quality checked	99[1]	100
Monitoring	Percent of 2021 data entered	95[1]	n/a
Monitoring	Percent of 2021 data quality checked	95[1]	n/a
Monitoring	# 2021 prescribed fires monitored (# total prescribed fires monitored)[2]	0 (11)[3]	0 (0)
Monitoring	# non-fire fuels treatments monitored	0	0
Monitoring	# 2021 wildfires monitored (# total wildfires monitored)[2]	0 (3)	0 (0)
Monitoring	# BAER BAR treatments monitored	0	0
Communication	# project monitoring reports completed in 2021[4]	0	0
Communication	# annual meeting(s) with park staff	1	1
Communication	# formal presentations of results	1	0
Communication	Did you use Minitab?	Yes	
Research	Are research needs identified in Fire Management Plan (FMP) or monitoring plan?	Yes	Yes
Research	# proposals submitted in 2021	1	0
Research	# proposals funded in 2021	0	0
Research	# research projects supported in 2021[5]	4	0
Research	Additional Comments		

[1] Pinyon-Juniper FMH and I&M plot data gathered in 2021 do not yet have a standard database format established.
[2] Number of fires/treatments completed in 2021 with fire/treatment effects monitoring conducted. Includes pre- and post-fire/treatment monitoring, but not on-site fire behavior monitoring (FEMO). Number in parentheses represents 2021 post-fire/treatment monitoring of fires/treatments that occurred prior to 2021.
[3] This number includes eight established prescribed fire units on the S Rim within which Pinyon-Juniper FMH and I&M plots read in 2021 are located. For consistency across the I&M plot collaboration network on both rims, all burn units are included which contain a plot that was read in 2021, regardless of immediate plans for treatment.
[4] Existing GRCA protocol burn-day (FEMO) monitoring reports are not included in this number.
[5] Number of research projects supported including logistical info or support, staffing, data sharing, product reviews, etc.

6. Research

6.1. NPS Fire Funded Research Update

2021 Final Presentation at SWFSC
Fire-weather Drivers of Extent and Severity: Learning from Past Fires' Patterns to Inform Future Wildfire Decision Making (Andrea Thode and Stephanie Mueller – NAU and Erin Banwell, Matt Engbring – GRCA)

We submitted a Federal Reserve Funding Request for this project in November of 2018. Although we did not receive the Federal Reserve Funding Request, this research project was funded by the NPS Intermountain Region in March of 2019 and a cooperative agreement through the Northern Arizona University CESU was completed. An extension of funding was granted in 2020 and a final completion of the project is targeted for Spring 2021. Our goal with this research is to answer the following questions:

1. When fires make "runs", or large increases in size (75th percentile), which weather and/or climatic conditions affect the amount of daily area burned?
2. Does a greater proportion of moderate-high to high burn severity within each fire progression day correlate with certain weather and/or climatic conditions?
3. Do the largest daily fire runs (95th percentile) result in a higher proportion of moderate-high to high burn severity?

Project deliverables include:

- Any applicable data layers, files, tables, and figures of the statistical analysis consistent with the objectives would be delivered to fire management staff.
- A detailed written report of findings
- Presentation of findings to fire and resource managers at Grand Canyon National Park and other interested regional managers and specialists
- Oral presentations at relevant local or regional conferences
- Webinar through the Southwest Fire Science Consortium

6.2. 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 2020.

> ***Li Brannfors*** *provided collaborative insight and technical expertise by assisting Kaibab National Forest Fire Ecologist Alex Spannuth and Northern Arizona University with forest structure data collection efforts aimed at assessing the accuracy of using LiDAR and Structure From Motion for landscape scale fire effects monitoring. The GRCA Fire Effects crew installed and collected data on 46 plots across a gradient of canopy height and canopy cover within the Mangum Fire (2020) footprint on the North Kaibab Ranger District.*

6.3. Publications and Presentations by Collaborators

The following list of publications and presentations highlights the written and oral communication of research done this year (and in which Grand Canyon Fire Ecology data have been used) by our collaborators. While explicit substantial contributions by Fire Ecology staff are not documented, these research projects are the culmination of past funding and partnerships with the GRCA Fire Ecology Program.

Publications

Stevens, Jens T et al. (2021). Tamm Review: Postfire landscape management in frequent-fire conifer forests of the Southwestern United States. *Forest Ecology and Management. https://www.sciencedirect.com/*

Presentations

McClure, Emma. Quantifying historical and contemporary fire regime divergence at tree-ring fire history sites in the Southwestern US. The 9th International Fire Ecology and Management Congress, 2021. November 30- December 4, 2021 [virtual conference].

Mueller, S., A.Thode, J. Young, M. Engbring, C. Marks. Oral Presentation: Fire-weather Drivers of Severity and Spread: Learning from Past Fire Patterns at Grand Canyon National Park to Inform Future Wildfire Decision Making. The 9th International Fire Ecology and Management Congress, 2021. November 30-December 4, 2021 [virtual conference].

Mueller, S., A.Thode, J. Young, M. Engbring, C. Marks (2021, July 29). Fire-weather Drivers of Severity and Spread: Learning from Past Fire Patterns at Grand Canyon National Park to Inform Future Wildfire Decision Making [Webinar]. In *Southwest Fire Science Consortium Webinar Series.* Retrieved from https://www.swfireconsortium.org/2021/06/23/july-29-2021-learning-from-past-fire-patterns-to-inform-future-wildfire-decision-making/

Young, J.D.; Mueller, S., Thode, A.; Engbring, M.; Marks, C. (2021) Oral Presentation: Fire Weather Drivers of Severity and Spread: Learning from the Past Fire Patterns at Grand Canyon National Park to Inform Future Wildfire Decision Making. *16th International Wildland Fire Safety Summit and 6th Human Dimensions of Wildland Fire Virtual Conference, May 24-28th, 2021.*

7. Future Program Direction

As the Fire Ecology Program prepares for the 2022 calendar year, planning for the future is paramount for the leadership at Grand Canyon National Park, with six main topics to be addressed. The primary areas of discussion include workforce and succession planning, burn severity analysis, relevancy of data and presentation, monitoring plans, support for other parks' ecology programs, and continued collaborations with universities and independent researchers.

To continue providing consistent and accurate products for the National Park Service, it is imperative to maintain and additionally bolster the workforce that embraces the Fire Ecology Program. Moving into 2022, Grand Canyon is looking to hire and retain seasonal employees that are interested in making long-term contributions (returning seasonals) to the National Park Service. While although we cannot permanently secure seasonal employees, Grand Canyon aims to identify individuals that have a passion for natural resources and give them opportunities to expand their experience working in natural resource management. In addition to our seasonal workforce, is imperative for our profession that we increase our permanent candidate pool to backfill positions as they are vacated within the Ecology program. One strategy we would like to promote is creating a complete career ladder (GS-4, 5, 6, 7, 9, 11) so that employees have a clear path to career positions within the agency. For 2022 the Grand Canyon National Park Fire Ecology Program will be advocating for a GS-6, Assistant Lead permanent position. This position will be crucial for the program's leadership capabilities as well as provide for better successional planning in the event the GS-7 position is vacated. In addition to bolstering staffing, the Fire Ecology Program is going to re-analyze the current duty station of the North Rim and look for opportunities to create flexibility during the winter season for permanent staff. As the workforce begins to transition back to a more traditional work environment, the Fire Ecology group will be exploring telework agreements for the winter time period. Telework agreements within the program aim to improve work/life satisfaction, accommodate alternate work locations (more available housing options), and ideally lead to increased retention of our permanent employees.

As the Fire Ecologist works into the beginning of his third year with the NPS, the accomplishment of routine daily activities and program manager responsibilities are becoming more commonplace. The Ecologist is becoming more efficient at accomplishing these important yet time-consuming tasks. Because of this, additional time to analyze and present data for 2022 will be allocated to the program of work.

To effectively showcase our data, the Fire Ecologist wishes to seek better ways to present FFI data internally to GRCA's Fire Leadership and externally to partners. To accomplish this, more formal and on-the-job training will be needed, and the Ecologist will be seeking out additional opportunities from internal and external resources. It is our hope that more classes in FFI will be offered beyond the introductory class taught by Duncan Lutes. Additionally to achieve this goal, assistance and instruction from the current Lead Monitor will be paramount, and the Fire Ecologist will look to capitalize on opportunities to adsorb more institutional knowledge.

Building on multiple years of testing and implementation with FFI, FFI Lite, fire monitoring software, and tablet hardware platforms, Grand Canyon would like to continue providing insight into the refinement of applications and protocols for cloud-based and mobile device-based data collection on both plots and active fires. Moving from paper datasheets to mobile applications has been maintained within our program, and we hope to stay heavily involved in the development and implementation of future products.

For 2022 the Fire Ecologist will continue to assist IMR GIS Shared Services with the refinement of the burn severity analysis for Grand Canyon. Burn severity data is directly linked to compliance for wildfire and prescribed fire at this park, and the current state of the severity program is in flux. Moving forward, all old

severity data needs to be consolidated and the collection/calibration of new data will need to be evaluated on a case-by-case basis. Composite Burn Index (CBI) verification may not take place in future severity analysis and the Fire Ecologist looks forward to the re-evaluation of this program for Grand Canyon.

As indicated by the end of year reviews for Grand Canyon National Park and Walnut Canyon National Monument, Fire Monitoring Plans will need to be updated and re-certified for 2022. The Fire Ecologist plans to work collaboratively with Fire/Fuels staff and internal partners at Grand Canyon and Walnut Canyon to review and re-certify these plans before the next annual review.

For 2022 the Grand Canyon Fire Ecology Program will need to review the ability for collaboration and support for other ecology programs. At this time, there are no formal agreements for the Grand Canyon Ecology group to assist with monitoring efforts outside of Grand Canyon NP and Flagstaff Monuments. While Grand Canyon has a long history of exceptional collaboration, competing priorities may inhibit future endeavors. For 2022, augmenting other programs' capacities will be assessed on a case-by-case basis and ultimately the decision will be based on the current workload of the Fire Ecology Program.

To help facilitate GRCA priority research questions, it is important to continue building relationships and collaborating with Northern Arizona University, Ecological Restoration Institute, and the Southern Colorado Plateau Inventory & Monitoring Network. The program will also continue our commitment to develop solid scientific datasets for adaptative management decision-making and to educate internal and external audiences about fire in Grand Canyon National Park and the NPS as a whole.

8. Overall Data Entry Status and FFI suggestions

8.1 Program Data

In an effort to ensure the longevity of NPS fire effects monitoring data, please provide the following:

- *List FFI databases for which no new data were collected this year*

No new data were collected for the WACA or I&M Mixed Conifer FFI databases in 2021.

- *Estimate of the <u>percentage</u> of your park/network **total** monitoring program data (including past and present data) that has been entered into FFI, or another application, and quality checked*

100% of data within the standardized Grand Canyon Fire Effects plot network have been entered into FFI or Excel. All data in FFI have been quality-checked via automated QAQC queries, and data in Excel have been manually checked. New data gathered on PIED FMH and I&M Pinyon-Juniper plots in 2021 do not yet have a standard established for database setup or data entry.

- *Do you have a need for migration of any data to FFI?*

All data are in potentially FFI-compatible formats. The WACA database and 2021 PIED data need to be re-converted & imported, respectively, into the Remote App. I&M PJ fire-specific data gathered in 2021 need to be assessed for proper incorporation into either the existing I&M FFI Mixed Conifer database or a new database. <u>I&M-specific data gathered since 2015 exist only in the SCPN custom SQL database and a solution needs to be found for sharing via CSV file exports and/or script-based data conversion</u>.

9. Appendix A. Workforce Transformation Supplement

The DOI wildland fire workforce transformation strategy and the NPS Wildland Fire Strategic Plan (2020 – 2024) have increased the funding available for wildland fire positions throughout DOI and NPS. The intent of this supplement is to capture the benefits of those initiatives to the NPS fire ecology program and to the wildland fire program as a whole. Please answer the following questions related to regional, national, and departmental workforce transformation efforts.

- Did your fire ecology program receive additional funding for new positions and/or extended seasons this year? If so, please list those positions and detail the changes.

In the spring of 2021 supplementary allocations toward base funding the temporary, seasonal workforce for 13 pay periods was awarded. The base funding of 13 pay periods is an increase from previous allocations of 36 pay periods for three GS-05s (approximately 12 PPs each). In addition to an increase in pay periods, funding was received and utilized to directly support one GS-06 as well as two GS-05 seasonal employees. This is a change from the previous allocations to fund three GS-05 seasonal employees. Support costs (health insurance) are being deducted from the current allocation's, which creates a reduction in the allotted 13 pay periods.

Additional pay periods were awarded in the winter of 2021 for the Lead Fire Effects Monitor to assist with hiring efforts at the Park. During the summer of 2021, Grand Canyon received 4 more pay periods of base funding for the GS-0404-07 Lead Monitor. Subsequently, the Lead position's time in pay status was increased to 24 PPs for the remainder of the year. Because of the timing of this action, direct benefits of this will not be experienced until calendar year 2022.

- Did the changes in staffing allow fire ecology staff greater opportunity to provide wildland fire incident support (e.g., firefighters, REAFs, GISS, helicopter and engine positions, command and general staff, etc.) to broaden their wildland fire experiences? If so, please explain how these opportunities were enhanced. Include information on opportunities for the individuals who were hired or extended with the additional funding as well as opportunities created for other staff because of increased overall staffing.

Historically the Grand Canyon Fire Effects crew has always participated in wildland fire incident support in levels commensurate to their core program of work. During the 2021 season, participation in wildland fire support and fire assignments was consistent with the past. Additional funding that was allocated to Grand Canyon for the 2021 fiscal year did not create a noticeable increase in additional wildland fire support when compared to previous years. In a typical year at Grand Canyon, extensive effort is put into hiring the right individuals for the Fire Effects crew, planning workload pre-season, and adapting in-season to be frequently available to assist on a case-by-case basis with prescribed fire, wildfire, and severity staffing. In 2021, the Fire Ecologist, Lead Monitor, and seasonal employees were able to participate in two prescribed fires at the Park, staff engines during severity on days off, and travel for multiple out-of-Park assignments. It is estimated that for the calendar year, GRCA Fire Ecology staff contributed 134 days of direct support to severity staffing, prescribed, and wildfires. Positions filled included: FFT2, FFT1(T), ICT5, READ/REAF, FEMO, FOBS, SOFR, and RXB2.

Although additional pay periods did not noticeably broaden the fire experience of the Fire Effects crew compared to previous years, the increased allocation did allow for both typical operational fire involvement as well as more time dedicated to the core work of data collection and management through an extended season in the fall of 2021. In addition to data collection at Grand Canyon, in 2021 assistance reading plots was provided at Saguaro National Park, El Malpais National Monument, El Morro National Monument, and for our federal neighbors on the Kaibab National Forest. The ability to support plot work and data

management for other Fire Ecology programs and partners had a more direct correlation with receiving additional pay periods than wildland fire support.

It should be noted that barriers beyond funding exist for Biological Technicians to participate in operational fire. The PD amendment process can take between 60 and 90 days and redcards are not being issued until well within the traditional fire season in the Southwest (June). Leadership structure of the Fire Effects crew is also a barrier to provide incident support. To operate independently as a work module on the fireline, the crew must have a Squad Boss/Advanced Firefighter (FFT1) for leadership. The FFT1 not only needs to be qualified, but there needs to be a willingness of the leader to participate in fire activities as incident support is an optional collateral duty for Biological Technicians. In its current form, we cannot mandate participation but highly encourage and incentivize it with overtime, hazard pay, as well as classroom and on-the-ground training opportunities. In the instance where there is the absence of a qualified FFT1, the Fire Effects crew has been available to "boost" engines and hand crews. For the last two seasons, this has been the primary way the Grand Canyon Fire Effects crew has supported severity staffing, long duration incidents, and initial attack within the park.

Regarding the opportunities the Lead Monitor has to participate in wildland fire incident support, an additional barrier exists within the staffing structure of the Fire Effects crew that can prevent involvement in single resource assignments. Specifically, if the Lead Monitor chooses to pursue fire qualifications that do not involve the entire Fire Effects crew being utilized as a module, there is a high likelihood that there would be no permanent employee in place to supervise the remaining crew members in their daily work assignments. Without an alternative to provide leadership to the seasonal crew, pursuing qualifications at the single resource level would be unlikely/rare within the current structure of the Grand Canyon Fire Effects crew. This situation severely limits opportunity for the Lead Monitor to pursue qualifications and gain proficiency that would advance their career in leadership positions that require specific fire qualifications.

- Did the changes in staffing allow fire ecology staff greater opportunity for other non-incident support (e.g. planning opportunities, details, leadership and other training courses, etc.) to broaden their wildland fire program management experience?
    - If so, please explain how these opportunities were enhanced. Include information on opportunities for the individuals who were hired or extended with the additional funding as well as opportunities created for other staff because of increased overall staffing.

Changes in staffing allocations did allow for additional non-incident support activities to be conducted. Additional pay periods allocated to the Lead Monitor and seasonal staff allowed for more time to be dedicated to the testing and use of the FFI Remote Application and novel electronic data collection methods. In addition, knowing the season could be extended into the fall of 2021 allowed the Grand Canyon Fire Effects crew to travel to help the Pueblo and Southern Arizona Fire Ecology Programs with data collection at their parks while having the time to meet all the programmatic responsibilities at Grand Canyon.

The increase in pay periods also allowed for onboarding seasonal Fire Effects staff more coincidental with the onboarding of seasonal Forestry Technicians that were hired for the engines and helicopter program. The result of this was increased availability of the Fire Effects crew during the spring to participate in pre-season training such as the fire refresher and S-212, wildfire power saws.

Additional pay periods allocated in 2021 for the Lead Monitor were utilized to maximize accumulated use-or-lose annual leave and minimize furlough time in the off season. This additional time was capitalized on in the winter months during annual report construction and extended timelines for hiring of the 2021 seasonal crew due to late arrival of DOI Fires-issued certificates. Having an additional point of contact during the winter months to share the load of seasonal staffing administrative actions was extremely advantageous to the program to complete hiring actions in a condensed timeline. Allowing the Lead Monitor the ability to screen and select the Fire Effects crew they will be supervising the following season provides a tremendous advantage in attaining a competent and cohesive crew.

- How would you use an increase in staff funding (if available in the future) to provide incident support and wildland fire career development opportunities for fire ecology staff?
    - How would your efforts support the NPS Wildland Fire Strategic Plan Desired Outcome 1B measurable outcome:

"By 2024, the overall NPS wildland fire workforce has doubled the number of women in the organization and tripled the number of women in leadership positions (i.e., park FMOs, and central office positions) from baseline data gathered in 2019."

An increase in staffing within the Fire Ecology group at Grand Canyon would allow for an increase in data collection and analysis that would better support assessment of treatment objectives and tracking changes in a fire-adapted landscape. Increasing the capacity to collect data and provide analysis to leadership will increase the likelihood of meeting successful, targeted management objectives during prescribed fires as well as wildfires being managed for resource benefit. Additional support allocated in the winter will allow not only for maintaining existing data analysis and administrative functions such as hiring, but will free up time to conduct more in-depth analysis of previous seasons' data.

Funding for a GS-06 Assistant Lead Monitor would allow for a substitute work group leader in the absence of the Lead Monitor and create a situation more conducive to directly support wildfires, prescribed fires, and data collection in and beyond Grand Canyon. In its current structure it would be unlikely for the Fire Effects crew to function without the Lead if that individual was to pursue qualifications or training that are independent of the Fire Effects crew. This is especially true for pursuing single resource qualifications. Supervision will need to be in place on the home unit when key leadership positions (Lead Monitor) are assigned to incidents. Options to backfill the Lead Monitor while they are on assignment are limited. Staffing a GS-06 will allow for a substitute work group leader and increase the availability for assignments and the ability to work on taskbooks for both the Lead and Assistant Lead, if we choose to fill this position.

Another important challenge to identify when considering increasing incident support (arduous or moderate fireline positions) is that the seasonality of data collection and prime wildfire season overlap. On years where the Fire Ecology/Fire Effects program have a large summer workload, less operational incident support will be provided. The focus for the crew would be geared towards data collection when plot workloads are large. For the Grand Canyon Fire Effects and Fire Ecology group, operational incident support will be assessed on a case-by-case basis in regard to the program of work and competing priorities, as this type of duty (operational support) is supplementary to the core responsibility of data collection within the Park.

When considering the career path of individuals employed as Biological Technicians, it is difficult for employees in this 0404 job series to gain Interagency Fire Program Management (IFPM) qualifications and meet the time-in-grade requirements for the operations-centric positions in the 0462 and 0401 job series. Employees can start their careers on the Fire Effects crew, but if they wish to advance into fire leadership positions (Engine Captain, Fuels Specialist, Assistant Fire Management Officer, FMO, etc) it will be necessary to obtain qualifications such as RXB2, ICT3, DIVS, or higher. Currently, these qualifications are rare for leadership in the ecology profession, and it would be difficult to recommend that employees stay within the 0404 and 0408 job series and expect to quickly attain the qualifications mandated for most fire leadership positions. Under the current structure, if individuals prioritize IFPM qualifications we run the risk of ecology-minded fire professionals choosing the more direct career path of participating in the 0462 job series rather than 0404.

Central office positions that do not require minimum fire experience and IFPM qualifications may be more accommodated by the Fire Ecology group. To analyze this, specific central office positions would need to be evaluated to see if the targeted job series codes are transferrable from 0404 and 0408 (biological/ecological) to the desired job series (fire) for the leadership positions in question. Some central office positions such as Regional Fire Ecologist and GIS Specialist require no minimum fireline experience (90 days) and have more

transferability to those within the Fire Ecology group. Other secondary fire positions such as those in the 0401 series (i.e. Fire Planner, Fire Ecology Program Lead) may not require IFPM qualifications but do require 90 days of fireline experience. This creates a challenge for employees within the Ecology group as they may not meet this requirement. Additionally, for those that do have 90 days of fire experience it has been communicated by potential applicants that validating your 90 days of experience to human resources is a challenge and will be an obstacle to those wishing to transfer from the 0404 or 0408 job series to a fire job series. The goal of bolstering central office positions is achievable by the Fire Ecology group, but notably it is necessary for human resources to support such career opportunities by accommodating changes in job series for employees within the profession.

All good things must come to an end

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