USDA

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Biennial Monitoring Evaluation Report

for the Kaibab National Forest

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Executive Summary

This FY16-FY 17 Biennial Monitoring Report is the second monitoring report prepared for the revised Kaibab Forest Plan (2014) and the first Biennial Monitoring Report prepared under the recently transitioned monitoring plan to the 2012 Planning Rule requirements. FY16 and FY17 experienced an agency and stakeholder driven emphasis in accelerated landscape-scale forest restoration in an environment with limited capacity for harvesting and processing wood products. With signed decisions for the first phase of the Four Forest Restoration Initiative and the Bill Williams Mountain project, and limited industry capacity, many of the accomplishments that were achieved were done so through partnerships and stewardship authorities. In addition to complex and unstable industry infrastructure, FY 16 and 17 were also challenged with hiring freezes, vacancies, and employees rotating through multiple acting assignments that influenced the ability to make progress toward the desired conditions. While this environment has limited the ability to achieve certain goals, it also forced some rethinking of how we move forward with enabling adaptive management that will be key to a successful and sustainable monitoring program.

This objectives for this report are to 1) assess the current condition (i.e., status) and trend of selected forest resources, 2) document implementation of the plan monitoring program 3) evaluate management effectiveness and progress towards achieving the selected components described in the Forest Plan 4) document monitoring actions that have not been completed and the reasons and rationale why, 5) present any new information not outlined in the current plan monitoring program that is relevant to the evaluation of the selected monitoring questions, and 6) present recommended change opportunities to the responsible official.

Several changes to the monitoring program, either in the form of administrative changes to the Land Management Plan (USDA-Forest Service, 2015) or edits to the Draft Monitoring Implementation Guide (in prep), are recommended based on the results of this first biennium of monitoring. These recommendations are focused on improving the linkage between monitoring results and selected Plan direction so that the Responsible Official can make informed decisions about potential changes to Plan direction. Much of the information presented in this report are considered baseline, and clear trends are not yet apparent.

Table 1. Summary of findings.

Monitoring Question	Progress toward Plan targets.	Changes warranted?	Comments
1. Are snags, downed logs and large old trees at desired levels at the midscale (100-1,000 acre average)?	291 plots collected 2013 & 150 plots collected in 2017. Baseline data only, no trend available. Large old trees and snags lower and down logs higher than desired on most plots.	Maybe	Due to rarity of occurrence, plot may be too small to adequately capture these components. This may be addressed with larger sample size. If not, may need to adjust.
2. Is the coarse woody debris within the desired range?	Rapid plots collected 2013 & 2017. Additional plots collected on North Kaibab Ranger District in the Tipover and Burnt Corral using NPS RAP protocol.	Yes.	Better coordination with fire effects monitoring program could achieve increased efficiency by aligning protocols to meet dual purpose.

Monitoring Question	Progress toward Plan targets.	Changes warranted?	Comments
	No trend available. Based on current sampling, fuel loading appears higher than desired on the North Kaibab Ranger District.		
3. Does height to live crown and crown bulk density put the forest at risk for uncharacteristic high severity fire at the mid-scale and above?	Plots Collected 2013 & 2017. Baseline data only; no trend available.	Maybe.	Rapid plot protocol records the height of the lowest live branch (height to live crown) on overstory trees. This variable is likely to be responsive to treatment effects, and a good indicator of ladder fuels, but overestimates crown bulk density. Interpretation and applications of this data should recognize this.
4. Is regeneration occurrring at a rate that will support uneven aged forests over time?	Plots Collected 2013 & 2017. Baseline data only; no trend available	Yes.	Data was collected and appears to meet desired conditions. Lack of clear criteria for achievement of regeneration and recruitment prevents determination. Follow up with silviculturists to establish clear criteria is needed.
5. What is the percent of effective ground cover? What is the proportion of live and dead vegetation, litter, rock, and bare ground?	Plots Collected 2013 & 2017. Baseline only; no trend available	Data are preliminary.	Effective ground cover is around 75%, Generally, vegetation is lower and litter and bare soil are higher than desired. Planned restoration treatments are expected to make progress towards desired conditions.
6. Is there evidence of erosion (pedastalling of vegetation or rock, rills, sheet flow, or deposition)?	Plots Collected 2013 & 2017. Baseline data only; no trend available	No	Evidence of erosion observed on 4% of district wide plots on the Williams District.
7. What is the percentage and pattern of plots that have evidence of soil disturbance from activities that used mechanical equipment?	Plots Collected 2013 & 2017. Baseline only; no trend available	Data are preliminary	Some evidence of mechanical soil disturbance observed on approximately 9% of plots.
8.What is the frequency of area occupied by noxious weeds by species?	Plots Collected 2013 &2017. Baseline data only; no trend available	Data are preliminary	In the 2013 effort, thistles were the most common non-native species observed, in 2017, cheatgrass (BRTE) was the most common non-native species observed, occurring on 16% of the plots. Toadflax, non-native thistle, and other species were observed on less than 2% of the plots.

Monitoring Question	Progress toward Plan targets.	Changes warranted?	Comments
14.What is the areal extent and configuration of aspen on the Kaibab NF?	A “census” survey mapped 5,595 acres of aspen on the Williams District.	No	Survey of aspen extent and condition on the Williams District indicated moderate to heavy encroachment by conifer species. Although less of a concern on the North Kaibab District, we hope to be able to map and track changes over time.
16. How many acres were burned with desired and undesired fire behavior and effects?	Through a combination of prescribed fire and managed wildfire, 53,712 acres received low to moderate intensity fire in fire adapted landscapes on the Kaibab in FY 16 and 17.	No	The inclusion of managed wildfire for resource benefit to meet objectives helped to return fire to these fire-adapted landscapes. Some patches burned with higher intensity and severity than desired. Post fire monitoring is being conducted to determine the extent. Lessons Learned from Boundary Fire resulted in some recommendations for future management particularly with regard to desired consumption of heavy fuels.
17. How many acres were treated with mechanical thinning by PNVT?	A total of 10,700 acres of mechanical treatments in grassland and woodland types and Ponderosa pine and mixed conifer.	No	Mechanical thinning was completed in grassland, woodland, and forest vegetation types. Grassland restoration met plan objectives. Thinning in the ponderosa pine and frequent fire mixed conifer did not achieve plan objectives due to economic and capacity issues.
19. What was the total area of aspen fenced?	26 acres of aspen was fenced.	No	Implementation is accomplished as resources are available.
20. How many acres were treated for conifer encroachment?	Conifers were removed from 15 acres of aspen stands.	No	Although little was accomplished in FY 16 and 17, 388 acres were accomplished in FY 14 and 15, putting the cumulative total within plan revision objectives.
22. How many miles of fence were modified for pronghorn?	13.8 and 6.1 miles of fence was modified in 2016 and 2017 respectively.	No	Work is being done as resources allow. Areas and are prioritized in areas of known use. Recently Arizona Game (in partnership with the Kaibab) and Fish put 30 new telemetry collars on pronghorn which will yield important data for prioritizing future work.
23. What is the acreage of outbreaks of insects and disease? Does this follow regional patterns?	Defoliation for 2016 and 2017 was about 22,000 acres with almost all occurring in 2017 with a cyclic Pandora moth event. Bark beetles totaled a little more than 5,000, mostly in the ponderosa pine type.	No	The North Kaibab Ranger District has had a recent Pandora moth outbreak that caused widespread defoliation, but minimal mortality. More of a public education concern than an ecological concern. Bark beetle activity was lower on the Kaibab than the rest of the region.

Monitoring Question	Progress toward Plan targets.	Changes warranted?	Comments
26. How many acres of invasive plants were treated?	926 acres and 1854 acres of weeds were treated in FY 16 and 17 respectively, mostly through IDIQ contracts.	No	Treatment rates are about half of the objective in the plan. Treatment have been accomplished as budget resources allow.
27. How many springs were protected and restored?	Two springs were restored, one each year.	Possibly. May need either additional indicators or objectives.	While the rate of springs restoration has met plan objectives (~one per year), the improvements have follow up needs and need revisiting. Counts may not be a meaningful measure.
28. How many acres of wetlands were restored?	Duck Lake (50 acres) Dog Lake (0.47 acres) Fracus Lake (0.9 acres)	Possibly different indicator than just acres	Duck Lake project and others will likely need follow up treatment for multiple years. Indicator of “acres” may not be meaningful when the same acres are reported multiple years.
30. How many 6th code watersheds were moved to an improved condition this year?	None. Coconino Wash Headwaters. (HUC 150100040802) was moved to an improved condition late in FY15.	Yes.	Work is being done in the Upper Hell Canyon Watershed. The Restoration Action Plan was recently modified to address resources concerns. Progress is lower than objectives, but underway.
31. Did any project or site require corrective action in the Best Management Practices (BMP) monitoring database?	Multiple projects.	Yes.	Several recommend management actions to reduce sedimentation and erosion. Recreation program would benefit from adapting BMP plan and monitoring practices, similar to timber projects.
32. Was adaptive management recommended for any BMP monitoring item and what were the monitoring results?	Yes, particularly for recreation areas: spill prevention, etc.	Yes.	Forest should consider developing an operation and maintenance plan for boat launches on the Forest and having a spill contingency plan for boat launches.
34. How many days did fine particle concentrations exceed 10 µgm/ m^3?	Nineteen days fine particle particulates spiked in FY 16 and 17. Reading were taken every three days.	Yes	Need to look back and correlate spikes in particulates with known events to determine what may have been within management control.
40. How many acres of the Kaibab NF had a change in ROS or SMS classification and what were the classification changes?	No changes to ROS or SMS classification has occurred since the plan decision in 2014.	No	This should be a rare occurrence, and would be achomplished through a plan amendment.
42. How many acres of non-project related cultural resource surveys were conducted?	Met 200 per year objective both years. Additional 103 acres in 2017	No	Additional 103 acres were accomplished by University Nevada Reno Field School across Williams, Tusayan, and North Kaibab Districts.

Monitoring Question	Progress toward Plan targets.	Changes warranted?	Comments
49. Were there any incidences of insect outbreaks in recently treated areas? If so, where?	No. Beetle outbreaks were overlaid with recently treated areas and there were no outbreaks in areas with recent treatment on the Kaibab.	Yes.	This question was originally identified as an "interview question, but will be moved to "existing sources." Analysis was conducted by the Region Forest Health group and is a now iintended to be completed annually and included in the annual report.
52. Did we receive any comments that reflect visitor satisisfaction? Were there common themes?	Yes. Common themes were about information availability, particularly with regard to conditions and access on forest roads. Other themes of dissatisfaction centered around other visitor behaviors.	Maybe.	There is room for improvement. The forest recently launched a collector app for documenting and managing forest road conditions. If we can ensure that this information is available to frontliners, we may be able to provide more real time updates. Enforcement is always a concern. Better funding of the LE and Recreation staff could improve visitor compliance regarding trash, fires, and vehicle violations.
57. Are plant species of known medicinal and cultural value being depleted?	Some concerns have been raised. Citizen Science program with tribes should help over the long run.	Unknown	Recently launched program will provide more robust data. See narrative for details.
59. Were the monitoring requirements met as identified in the *Pediocactus paradinei* conservation agreement?	Baseline data was collected.	Unknown	No analysis was conducted.
60. Were there any events or changed circumstances that would indicate a potential change to timber suitability?	There were no events or projects that led to a change in timber suitability.	No	We expect that changes in suitability will be rare, but still believe it is important to ask this question.
62. Is aspen regenerating and becoming established in treated areas?	Fencing and conifer removal are helping prevent ungulate browse. Progress has been made in achieving objectives.	Maybe	Although fencing and conifer removal help, drought and oyster-scale can cross fences. Complexity of the solution will need to match the complexity of the problem.
64. In treated or protected areas, are waterflow patterns and vegetation intact?	Monitoring is conducted regularly through a cost-share agreement with the Springs Stewardship Agreement.	No	Results vary. Historical modification, ungulate access, and nonnative species contribute to degradation on some places, We will continue to evaluate and manage these important resources toward ecological function.
67. What is the area of forest occupied by area of forest occupied by Grace's warbler, and western bluebird?	Detection probability is fairly high. Trend line not clear.	Unknown	Plan to continue to work with Bird Conservancy of the Rockies to evaluate.

Monitoring Question	Progress toward Plan targets.	Changes warranted?	Comments
How does this compare to regional trends?			
68.What is the area of forest occupied by ruby-crowned kinglet? How does this compare to regional trends?	Detection probability is very low.	Unknown	Survey data are inconclusive, possibly due to small sample size and survey effort.
70.Are Mexican spotted owls present in PACs?	Owls were detected in all eight PACs, with pairresponses in 3.	No	Due to steep topography and no activities planned, follow up reproduction visits were not conducted.
71. What is the population trend of *Pediocactus peeblesianus* var. *fickeisenii*?	Baseline data collected. No trend available.	Unknown	Data not analyzed.

Introduction

Purpose

The purpose of the biennial monitoring evaluation report is to help the responsible official determine whether a change is needed in forest plan direction, such as plan components or other plan content that guide management of resources in the plan area. The biennial monitoring evaluation report represents one part of the Forest Service's overall monitoring program for this national forest unit. The biennial monitoring evaluation report is not a decision document, it evaluates monitoring questions and indicators presented in the Plan Monitoring Program chapter of the forest plan, in relation to management actions carried out in the plan area.

Monitoring and evaluation are continuous learning tools that form the backbone of adaptive management. For this reason, we will produce an evaluation report every two years. This is the second written report of this evaluation since the Kaibab National Forest Plan was finalized in 2014, and the first since the monitoring plan was transitioned to the 2012 planning rule. This report indicates whether a change to the forest plan, management activities, monitoring program or forest assessment may be needed based on the new information.

Objectives

There are several objectives for this report, including:

- Assess the current condition (i.e., status) and trend of selected forest resources.
- Document implementation of the Plan monitoring Program including changed conditions or status of key characteristics used to assess accomplishments and progress toward achievement of the selected Land and Resource Management Plan components.
- Evaluate relevant assumptions, changed conditions, management effectiveness, and progress towards achieving the selected desired conditions, objectives, and goals described in the Forest Plan
- Document any scheduled monitoring actions that have not been completed and the reasons and rationale why it has not.
- Present any new information not outlined in the current plan monitoring program that is relevant to the evaluation of the selected monitoring questions.
- Present recommended change opportunities to the responsible official.

How to Use this Report

This report is a tool and a resource for the Forest Service to assess the condition of forest resources in relation to Forest Plan direction and management actions. It is also a tool and a resource for the public to learn more about how the Forest Service is managing forest resources. The Kaibab National Forest will use this report to inform the status of key desired conditions as well as the effects and effectiveness of plan implementation. New information on resource status, threats, technology and methodologies may indicate needed changes or refinement of the plan monitoring program.

The biennial monitoring evaluation report is designed to help the public, as well as Federal, State, local government, and Tribal entities anticipate key steps in the overall monitoring program. These steps include upcoming opportunities for public participation and how the public will be informed of those opportunities, and how public input will be used as the monitoring program progresses. The biennial monitoring evaluation report is also intended to help people better understand reported results in relation to past monitoring reports, future monitoring reports and the broader-scale monitoring strategy that is issued at the Forest Service Regional level.

The Importance of Public Participation

We informed the public of the availability of the FY17 biennial monitoring report for the Kaibab National Forest (hereafter referred to as KNF) on November 1, 2018 by announcing it through the Kaibab National Forest Twitter site, Facebook, and by posting the full report with appendices to it to the Forest website. Additionally, an email was sent to key stakeholders, including tribes, which have been involved in the development or implementation of this monitoring plan.

The Kaibab NF is committed to adaptive management and recognizes that the public plays an important role in keeping the monitoring plan relevant. We will consider all substantive comments received and welcome an open and engaged dialogue and participation.

About Our Forest Plan Monitoring Program

Roles and Responsibilities

The Forest Plan Monitoring Program requires a coordinated effort of many people, from the people who collect the data, to the people outside the Forest Service who provide feedback and assistance, to the decision maker.

Responsible Official

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Key Partners

The Kaibab NF monitoring program and biennial evaluation report are supported, in part, by the work of our partners. For example, in collaboration with partners, the Kaibab NF has been developing applications and methods that integrate robust, transparent, and repeatable sample designs, data collection methods, statistical analyses, and predictive modelling tools. The use of best available science to develop these tools will allow the Kaibab NF to more effectively respond to emerging issues such as climate change and associated landscape scale disturbances (e.g. wildfire, insect and disease outbreaks), and, in the spirit of the 2012 Forest Service planning rule, to better engage in multi-party monitoring efforts by leveraging multiple data sources and collaborative resources. The 2012 planning rule “provides a process for planning that is adaptive and science-based, engages the public, and is

designed to be efficient, effective, and within the Agency's ability to implement…..the planning rule requires the use of best available scientific information to inform planning and plan decisions". Input from stakeholders is important because risk evaluation involves social considerations associated with values as well as scientific and technical processes. An adaptive management plan that is robust, integrated, and transparent, is essential to be able to gain social license, buy-in, and move forward together to implement the work that needs to be done.

The following individuals and groups have played a key role in monitoring program development, data, collection, data analyses or all three, making valuable contributions by adding capacity, skill sets, and scientific knowledge. The forest intends to continue to work with stakeholders to facilitate the collaborative aspects of the 2012 planning rule through partnership work.

Northern Arizona University

- **The Ecological Restoration Institute** (ERI) is nationally recognized as a leader in research, scholarship, and education, and collaborative efforts to help solve the problem of unnaturally severe wildfire and degraded forest health throughout the American West. The ERI works to help land management agencies and communities by providing comprehensive focused studies, monitoring and evaluation research, and technical support. The Kaibab NF has been collaborating with ERI on several fronts related to multiparty monitoring, and the Four Forest restoration Initiative (4FRI), a Collaborative Landscape Restoration Project. Recent efforts include implementation of rapid plots (see next bullet) in the 4FRI footprint area, preliminary data analyses and future recommendations. In 2012, the ERI helped facilitate and monitoring and adaptive management workshop during the final stage of the Kaibab National Forest plan revision effort. Through that workshop, the forest was able to identify top stakeholder concerns with regard to forest plan management objectives and the kinds of monitoring that would be needed to track those actions. This dialogue helped the forest to fine tune the monitoring plan to address stakeholder needs in a socially responsive way. This initial monitoring and evaluation report under the 2012 planning rule, provides an opportunity to revisit the workshop outcomes through an adaptive management lens. Additionally, ERI has hosted a series of regionally sponsored workshops to support development of a BSM strategy in regions 2 and 3. The Kaibab has participated in and intends to continue to contribute to the framework currently under development. As such, the unit monitoring will be coordinated and integrated with the Broader scale Monitoring Strategy when it comes on-line. See https://nau.edu/ERI/

- **The Lab of Landscape Ecology and Landscape Conservation Initiative** (LLECB and LCI) address challenges associated with policy, land use, and the conservation and management of species and ecosystems across the West. LCI uses basic and applied applications in conservation biology and landscape ecology to educate students, conduct community outreach, and inform land use planning, forest management, and public policy. By engaging students, decision makers, and the public in meaningful dialog grounded in robust science, the LCI and LLECB provide solutions at scales that make a difference The LLECB and LCI have been working with the Kaibab NF to develop several habitat-based modeling approaches to establish a "baseline" for future monitoring of focal and other species. A "monitoring toolbox" has also been developed to address plan monitoring questions that relate to landscape scale forest structural changes, while a "rapid plot" monitoring design was developed and piloted in 2014 to focus on ecological indicators better collected at the plot level (Dickson et al 2011, Ray et al. 2012, Wang et al. 2013, Horncastle and Dickson 2015). These tools provide the forest with an empirically based platform for assessing ecological change over time, provide a

basis for refining future management, and were designed to complement and support broad scale monitoring strategies that are currently in development for the region, as well as landscape scale restoration projects such as the Four Forest Restoration Initiative, a 1.6 million acre project which spans the Kaibab, Coconino, Apache-Sitgreaves, and Tonto National Forests. For more information see https://nau.edu/LCI/Research/

The Springs Stewardship Institute (SSI)

A global initiative of the Museum of Northern Arizona, works to improve communication among land managers, to survey, rehabilitate, and steward springs systems across the southwestern U.S. The SSI has an ongoing working relationship with the Kaibab NF, providing springs inventory and monitoring data and applied research using established protocols. Data is managed in a user friendly database so that the most up to date information is available and accessible to all partners. Springs data collected through this effort supports the Kaibab NF's monitoring plan and also helps the forest to prioritize future management goals and climate adaptation strategies for select ecological conditions. More information can be found here: http://springstewardshipinstitute.org/

Bird Conservancy of the Rockies (BCR, formerly known as Rocky Mountain Bird Observatory)

A non-profit organization chartered to conserve birds and their habitats through monitoring, research, stewardship, and education. The partnership between the Kaibab NF and BCR implements science based monitoring and allows BCR to compile data on birds that contributes to forest plan monitoring while also contributing to BCR's greater mission of conserving Rocky Mountain, Great Plains and Intermountain West birds and their habitats. The data contributes to BCR's efforts to establish a regional database that compiles point count data at an international scale. This collaboration drives consistent and comparable monitoring and data sets throughout the western United States. These data are available to southwestern U.S. Forest Service wildlife and land managers to assist in evaluating trends on management units compared to a larger region. The overall end goal of these databases is to provide a venue to store regional point count data and apply consistent techniques to collect point count data. These data are then analyzed using statistically sound and rigorous methods, allowing managers to understand, investigate, and assess avian population trends and status. The forest has been collecting data on songbirds in collaboration with BCR since 2007 and these data are widely available on a user friendly website. Annual reports, survey locations and occupancy and density trends can all be downloaded from the web. More recently, BCR has also implemented regional surveys for Northern goshawk and Mexican spotted owl using peer reviewed protocols, these data will contribute to the broader scale monitoring program and support monitoring recommended by the recovery plan for the Mexican spotted owl. More information on this effort can be found here: http://www.birdconservancy.org/

The Nature Conservancy (TNC)

A private; non-profit organization whose mission is to conserve the lands and waters on which all life depends. TNC works with a wide-range of landowners, agencies and organizations to achieve this goal, and also acquires and manages lands for this purpose. TNC has significant scientific and management expertise, and conducts eco-region and site conservation planning, while building partnerships with land management agencies to put science into practice. The Forest service maintains a national Memorandum of Understanding with TNC that formally acknowledges a desire to work together to accomplish mutually beneficial conservation goals. More specifically through a cooperative agreement on the Kaibab NF,TNC is currently helping the forest develop and implement several landscape scale monitoring applications using LiDAR and vegetation

structural data that will facilitate large-scale restoration and monitoring and adaptive management projects across Arizona's forests. Habitat connectivity models have already been already developed for pronghorn and Abert's squirrels (Hurteau and Smith 2012). These models can be updated over time and will help inform project planning as well as project outcomes, and also provide baseline data for monitoring pronghorn desired conditions.

Kane and Two Mile Research and Stewardship Partnership (RSP)

Aa formal partnership established in 2012 by an Memorandum of Understanding between the Grand Canyon Trust, Bureau of Land Management, US Geological Survey, US Forest Service - Kaibab National Forest, Arizona Game and Fish Commission, Northern Arizona University, and University of Arizona. The work of the RSP is guided by an Applied Research Plan, collaboratively developed in 2011, which includes a suite of management-relevant research foci including arid lands restoration, cheatgrass and wildfire feedbacks, wildlife habitat, and livestock grazing interactions. The Applied Research Plan also specifically highlights landscape-scale monitoring as an essential tool. The RSP meets annually or biannually to check in on the progress of research and stewardship goals, meetings which also include researchers and representatives from other groups, including ranching partners, in addition to those on the MOU. This partnership facilitates scientific inquiry on actual projects and management actions, helping to inform real world on the ground action.

Forest Health Protection-Southwestern Region State and Private Forestry

Provides assistance and expertise to Federal, State, and Tribal land managers in Arizona and New Mexico concerning forest health conditions and issues. In support of plan monitoring, Forest Health Protection conducts survey flights to monitor forest health conditions and provide land managers with information on current issues, with an emphasis on detecting insect activity. Additionally, they provide advice and support for projects to help prevent or suppress insect and disease outbreaks.

How Our Plan Monitoring Program Works

Monitoring and evaluation requirements have been established through the National Forest Management Act (NFMA) at 36 CFR 219. Additional direction is provided by the Forest Service in Chapter 30 – Monitoring – of the Land Management Handbook (FSH 1909.12).

The Kaibab NF monitoring program was updated September 2016 to ensure consistency with the 2012 planning regulations [36 CFR 219.12 (c)(1)]. The Kaibab National Forest Plan was administratively changed to include the updated monitoring program (Chapter 5). For a copy of the current monitoring program see Appendix A of this report or go to Chapter 5 of the Land and Resource Management Plan for the Kaibab National Forest. Monitoring questions and indicators were selected to inform the management of resources on the plan area and not every plan component was determined necessary to track [36 CFR 219.12(a)(2)]. See the white paper titled Kaibab National Forest Monitoring Plan Transition to the 2012 Planning Rule for discussion on how the monitoring questions were selected to be consistent with the 2012 planning regulations 36 CFR 219.12.

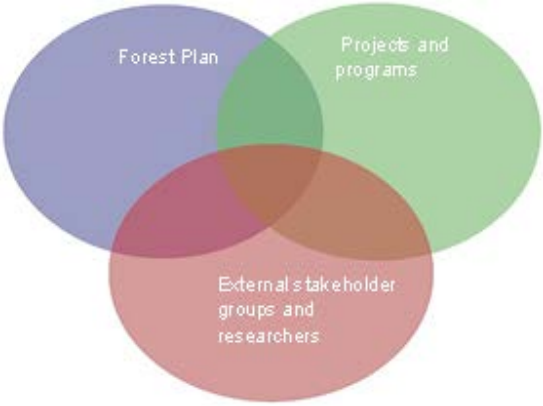
The monitoring evaluation implementation guide (draft) is part of the overall plan monitoring program and provides more specific direction for implementing the more strategic plan monitoring program and details monitoring methods, protocols, and analytical procedures. The Monitoring Guide is not part of the plan decision and is subject to change as new science and methods emerge.

Providing timely, accurate monitoring information to the responsible official and the public is a key requirement of the plan monitoring program. This biennial monitoring evaluation report for the Kaibab National Forest is the vehicle for disseminating this information.

In the context of forest planning there are three main monitoring goals:

- Are we implementing the Forest Plan implemented as intended? Are we meeting our management targets and project guidelines? (implementation monitoring)
- Are we achieving our Forest Plan management goals and desired outcomes? (effectiveness monitoring)
- Does our hypothesis testing indicate we may need to change the Forest Plan? (validation monitoring)

Implementation monitoring is important for tracking progress and accomplishments. However, it is effectiveness and validation monitoring that drive and support the adaptive management process. Effectiveness monitoring evaluates condition and trend relative to desired conditions. Validation monitoring tests hypotheses and provides information that might necessitate changes to desired conditions in the plan.



Monitoring Evaluation

Monitoring Activities

This monitoring report includes a combination of effectiveness and implementation monitoring. It is organized by five primary methods of data acquisition. Each category is described in detail below. The order of monitoring items within each subheading follows the order of each resource area within the monitoring plan.

In many cases, data collected on one indicator may help to answer several questions, and meet multiple monitoring requirements of the 2012 planning rule, improving efficiency and utility of the data. Efficiency is achieved by leveraging existing and complimentary data sources from internal as well as external parties to the extent practicable. Frequency of data collection, evaluation, and reporting varies by resource area and monitoring question. The full monitoring matrix including drivers for question as well as the factors specified in Planning Rule is included as Appendix A. Not every item identified in the matrix is monitored or reported out at every interval.

Monitoring Category 1: Rapid Plots

Rapid Plots address a subset of monitoring plan questions that cannot be adequately answered using existing or remotely sensed data. These data typically inform desired conditions at the 1 to1000-acre scale, although measurements in multiple locations may provide wide spatial coverage able to inform broader scale questions. They also may be used to calibrate and validate some remotely sensed variables of interest. Data include relatively simple field based metrics that can be collected by staff or citizen scientists with minimal training and resource backgrounds (e.g. semi-skilled technicians or volunteers). Having built-in flexibility was a key consideration in the design of the rapid plot methods. Rapid plots are very important for assessing attainment of desired conditions, both at the forest and project levels. Rapid plots represent a cost effective approach to monitoring via integration and statistical rigor.

The Forest worked with partners at Northern Arizona University to develop a rapid plot design and statistical guide for these specific questions (below) The objective of this 'rapid plot' design is to provide a transparent method of data collection to track changes in major vegetation types through time in a financially and time-efficient manner. The approach should inform progress toward, or attainment of, desired conditions related to vegetation structure, function, and composition. Rapid plot data are collected on key parameters using a systematic sampling framework superimposed across the entire Kaibab NF. Data include relatively simple field based metrics, but provides the necessary amount of information to detect a 2-6% annual change at an 80% power level in variables related to understory conditions (e.g., shrub cover, herbaceous cover), forest structure and regeneration (e.g., sapling density, tree size class), wildfire fuels, and non-native invasive species. This level of change is equivalent to a 10-25% change between 5-year sampling intervals, a range reasonably expected with a forest treatment prescription. Forest plan monitoring questions 1-8 were developed to answer questions about finer scale resources addressed by the Rapid Plot protocol.

1. ***Are snags, downed logs and large old trees at desired levels at the midscale (100-1,000 acre average)?***
2. ***Is the coarse woody debris within the desired range?***
3. ***Does height to live crown and crown bulk density put the forest at risk for uncharacteristic high severity fire at the mid-scale and above?***
4. ***Is regeneration occurring at a rate that will support uneven aged forests over time?***
5. ***What is the percent of effective ground cover? What is the proportion of live and dead vegetation, litter, rock, and bare ground?***
6. ***Is there evidence of erosion (pedastalling of vegetation or rock, rills, sheet flow, or deposition)?***
7. ***What is the percentage and pattern of plots that have evidence of soil disturbance from activities that used mechanical equipment?***
8. ***What is the frequency of area occupied by noxious weeds by species?***

The rapid plot approach is meant to complement, not replace, project-level monitoring. The design has the flexibility to add plots within project boundaries as treatments are planned and completed or as specific questions arise. Planned and existing projects guide the plot placement process with the intent that data collected at the project level would be aggregated with other rapid plot data to make inferences at the Forest level. The Rapid Plot Monitoring Design and Statistical Guide for the Kaibab NF (Ray et al. 2012) supports the monitoring plan and provides more detailed information.

An initial pilot of the Kaibab NF rapid plot protocol was tested in 2013 to determine costs and make recommendations based on lessons-learned. A total of 291 spatially balanced plots were sampled on all three Districts. For the sample design and summary statistics for this effort, see "Implement a Rapid Plot Design across the Kaibab National Forest" (Horncastle, V.J. and B.G. Dickson. 2015). This initial pilot work on the Kaibab NF, informed a more comprehensive publication exploring multiparty monitoring efficiencies through the Collaborative Forest Landscape Restoration Program, see Davis et al. 2015.

Another key goal of the rapid plot approach is to foster efficiencies across the Four-Forest Restoration Initiative (4FRI) CFLR project area, where forest plan level monitoring and CFLR indicators complement and inform one another. Adjustments were made in the initial 2013 protocol to address lessons learned as well as to align with 4FRI stakeholder concerns. The alignment of the monitoring indicators and sampling design allows for across-forest (Coconino-Kaibab) comparisons and summaries of the key questions that relate to both plan desired conditions as well as project (plan implementation) effectiveness. The 2017 protocol also modified to gain a better understanding of the natural range of variability (NRV) for the Kaibab NF by identifying living trees as presettlement or post settlement based on characteristics, as well as documenting presettlement snags, stumps, and logs. These NRV data are important for informing the forest plan desired conditions.

Two separate efforts were implemented in 2017. The first effort was implemented through a partnership with Northern Arizona University's Ecological Restoration Institute along with Kaibab NF staff. It was a densified overlay on four 4FRI task orders that were scheduled for treatment (Cougar, Coyote, Ham, Moonset). The intent of the densified overlay is to evaluate treatment effects and effectiveness. Seventy-one plots were installed to establish pretreatment conditions. Remeasurement of these plots will allow for assessment of changed conditions: treatment effects, effectiveness, and progress towards desired conditions.

A second effort collected an additional 74 plots across the Williams District. The objective of this second effort was to supplement the original 291 forest-wide plots by increasing the sample size with the intent of better estimating the number and distribution of rarer elements such as snags and presettlement trees. Summary results are presented below. To reduce reporting redundancy in this section, the Williams District effort, which is an augmentation of initial Forest-wide effort are presented here along with the task order "units."

1. Are snags and logs at desired levels at the midscale (100-1,000 acre average)?

Snag density varied, but were below the desired condition for a most plots.

Table 1. Snags per acre

Unit	Total number of snags	Snags per Acre
Cougar (n=10)	0	0
Coyote (n=15)	0	0
Ham (n=16)	3	0.94
Moonset (n=30)	2	0.33
Williams (n=75)	45	0.6

Log density also varied widely, but were generally higher than the desired condition.

Table 2. Logs for wildlife habitat

Unit	Avg # logs/plot	Max logs/plot	Min Logs/plot	Avg # logs/acre
Cougar (n=10)	2.00	7	0	10.00
Coyote (n=15)	3.13	11	0	15.67
Ham (n=16)	3.50	11	0	17.50
Moonset (n=30)	2.13	11	0	10.67
Williams (n=75)	1.6	10	0	8

2. Is the coarse woody debris within the desired range?

In the rapid plots, woody fuels (fuels larger than 100 hr.) were visually estimated based on photo series. Results by project are summarized below. According to visual estimations, most plots within Coyote and Ham fall within 3 to 10 tons per acre. Moonset had the most variation, with 27% of plots over 10 ton range and 47% of plots under 3 tons. Cougar had the lowest woody fuel loads, with 50% of the plots with less than 3 tons. The plots spatially balanced plots across the Williams District indicated that fuel loading for most plots were similar to desired conditions. Note: some of these plots were in grassland or woodland vegetation types where desired woody debris is lower.

Table 3. Percent of plots within each woody fuel tonnage estimate, by unit

Task Order	<3 tons	3 to 10 tons*	>10 tons
Cougar (n=10)	50%	40%	10%
Coyote (n=15)	20%	60%	20%
Ham (n=16)	25%	63%	13%
Moonset (n=30)	47%	23%	27%
Williams (n=75)	54%	38%	8%

*Desired condition for woody debris in Ponderosa pine is 3 to 10 tons per acre.

5. What is the percent of effective ground cover? What is the proportion of live and dead vegetation, litter, rock, and bare ground?

Effective ground cover is anything that covers and holds bare soil. For 2017 forest-wide plots collected on the Williams District, the median effective ground cover was 85%. Max was 100%, with most of the highest percent cover composed of litter. Minimum was 39% and occurred in the pinyon juniper vegetation type where juniper encroachment has suppressed grass cover and contributed to bare soil and erosion. Similar results were observed in the 2013 effort.

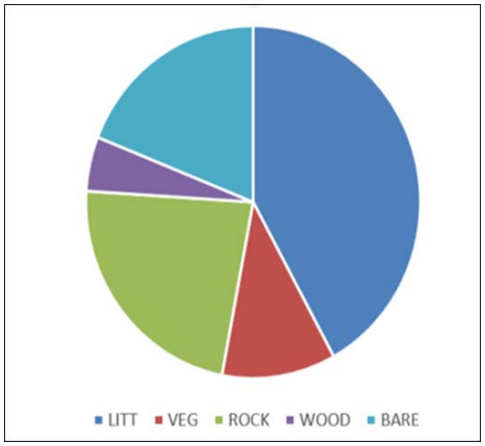


Figure 1. Proportion of live vegetation, litter, wood, rock and bare ground for 2017 forest-wide plots collected on the Williams District.

8. What is the frequency of area occupied by noxious weeds by species?

Cheatgrass (BRTE) was the most common non-native species observed, occurring on 16% of the plots. Toadflax, non-native thistle, and other species were observed on less than 2% of the plots.

Table 4. Percent of plots with invasive species present, by unit

	Russian Thistle	Other Thistle Spp	Cheatgrass	Knapweed Spp	Dalmatian Toadflax	Other weed species
Cougar (n=10)	0%	0%	40%	0%	0%	0%
Coyote (n=15)	0%	0%	7%	0%	0%	0%
Ham (n=16)	0%	0%	13%	0%	0%	6%
Moonset (n=30)	0%	3%	0%	0%	3%	3%
Williams (n=74)	0%	1%	23%	0%	3%	0%

Monitoring Category 2: Remotely Sensed Data

This type of monitoring indicates the status of key ecological attributes at landscape scales or at coarser spatial resolution. Data sources include GIS and remote sensing imagery, which would indicate changes in land cover across the entire Kaibab NF, as well as adjacent and nearby lands. Examples of outputs include landscape composition, pattern, and fragmentation. Some data collected through rapid plots also may be used to validate and improve the accuracy of remote sensing data. Remotely sensed forest structure variables are considered very important to evaluate progress toward desired conditions and objectives. They provide a cost efficient and comprehensive data set for change detections and risk evaluation.

Aspen Mapping Project

Aspen is an important species because of its contribution to local ecological diversity and its high social and economic value associated with scenery and tourism. Aspen has declined in areas across the West due to the combined effects of ungulate browsing, insects, disease, severe weather events, and lack of fire disturbance. Aspen decline has been of particular concern on the Williams Ranger District. To answer the question below, the aspen mapping project was implemented by the Southwestern

Region Forest Health Protection specialists at the request and with the support of the Kaibab National Forest.

14. What is the areal extent and configuration of aspen on the Kaibab NF?

The scope of this 2017 effort was limited to the Williams Ranger District, where aspen decline is of particular concern. This effort assessed the extent and degree of encroachment of aspen stands on the Williams Ranger District. Aerial detection and mapping of the aspen stands was conducted using digital mobile sketch mapping software on a tablet from a fixed wing aircraft. Post Processing was completed using 2015 NAIP imagery. Red spectrum was manipulated to create infrared layer (Red-4, Green-2, Blue-3). This helped to differentiate between the evergreens and deciduous trees in order to clean the initial tablet data.

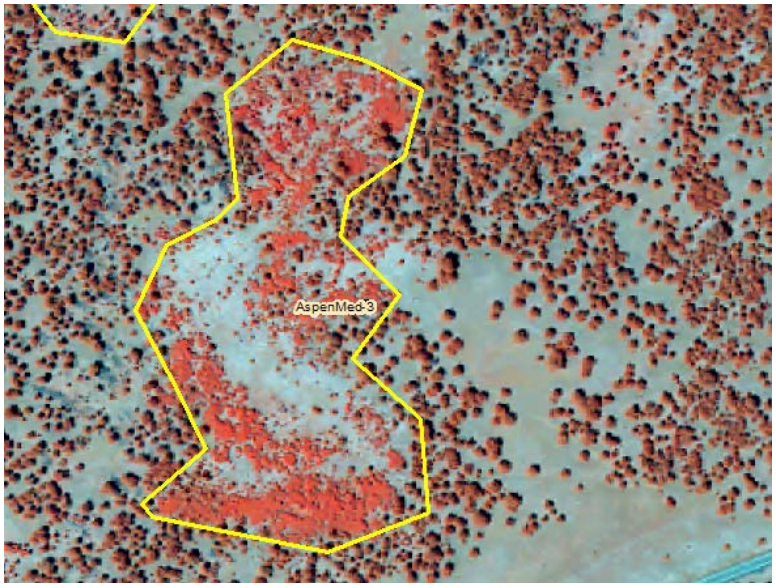


Figure 2. Example of post processing of aspen stand polygon using infrared layer.

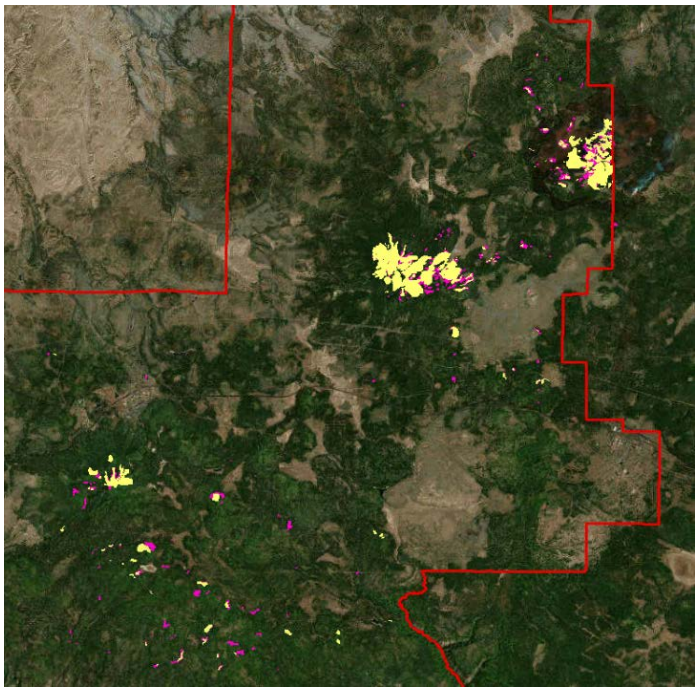


Figure 3. Geographic extent of aspen stands on the Willims Ranger District.

A total of 5,595 acres of aspen were mapped on the Williams Ranger District. Assessment of encroachment indicated that over 80% of aspen stands had at least moderate encroachment by conifer species.

Table 5. Aspen stand count, size, and level of conifer encroachment.

Level of Conifer Encroachment	Acres	Percent Acres Encroached	Count	Ave. Size	Smallest Stand	Largest Stand	Standard Deviation
Very Low	330	5.9%	9	36	5	110	36
Low	490	8.7%	16	30	0.25	170	44
Moderate	3,020	54.3%	41	74	0.5	295	88
High	1,755	31%	81	21	0.25	267	40

Note: encroachment levels: high. >75%, moderate 25-75%, low <25%, very low <1%

Adaptive Management Considerations

The revised Kaibab forest plan identified aspen as a priority needs for change. Aspen is an important species because of its contribution to local ecological diversity and its high social and economic value associated with scenery and tourism. Aspen has declined in areas across the West due to the combined effects of ungulate browsing, insects, disease, severe weather events, and lack of fire disturbance. Aspen decline has been of particular concern on the Williams Ranger District. Oyster shell scale has emerged as a new threat since the plan was finalized. We will continue to monitor and mitigate threats to aspen. Discussions and strategies for aspen management have been dynamic and ongoing.

Rangeland Productivity Monitoring

The Rangeland Productivity dataset was developed by Matt Reeves at the Rocky Mountain Research Station. The Rangeland Production Monitoring Service (RPMS) includes a retrospective dataset quantifying annual production of all 662 million acres of US rangelands from 1984 to present. Although the original objectives of this program were to create better grazing management strategies, the Kaibab NF is using it to inform plan-level questions about trends and changes in grassland habitat quality and total acres on the Kaibab NF.

The data were created in the Thematic Mapper data suite warehoused on Google Earth Engine and generated Normalized Difference Vegetation Index (NDVI). The data were originally at 30 m spatial resolution but resampled to 250 m to reduce file size and enhance download capability. Using the Rangeland Vegetation Simulator (RVS), they were converted to annual production. The RVS is a simulation system that enables quantification of 1, 10, 100, 1000 hour fuels, standing carbon in shrubs, annual production of herbs, stems per acre, and vegetation response to fire and herbivory. This simulation program was also used to calibrate the NDVI to annual production. While this is a preliminary look, some interesting patterns were observed:

Monitoring Results

Over the past 34 years, the median value for estimated biomass increased by an average of 18% across all three districts of the Kaibab.

Table 6. Biomass production for the Williams, Tusayan, and North Kaibab Ranger Districts 1984 to 2017.

District	1984	2017	Mean	Standard Deviation	CV	Trend
Williams	861	1108	902	145	.161	.419
North Kaibab	548	605	599	67	.112	.406
Tusayan	583	662	639	72	.112	.435

The increasing trend in total biomass indicating persistent woody vegetation can be observed spatially in the figure below where green indicates it was forested or woodland in 1984 and remains forested, yellow indicates the area was classified as rangeland (grass) and remains rangeland, and purple are areas that were classified as rangeland, and are now forest or woodland.

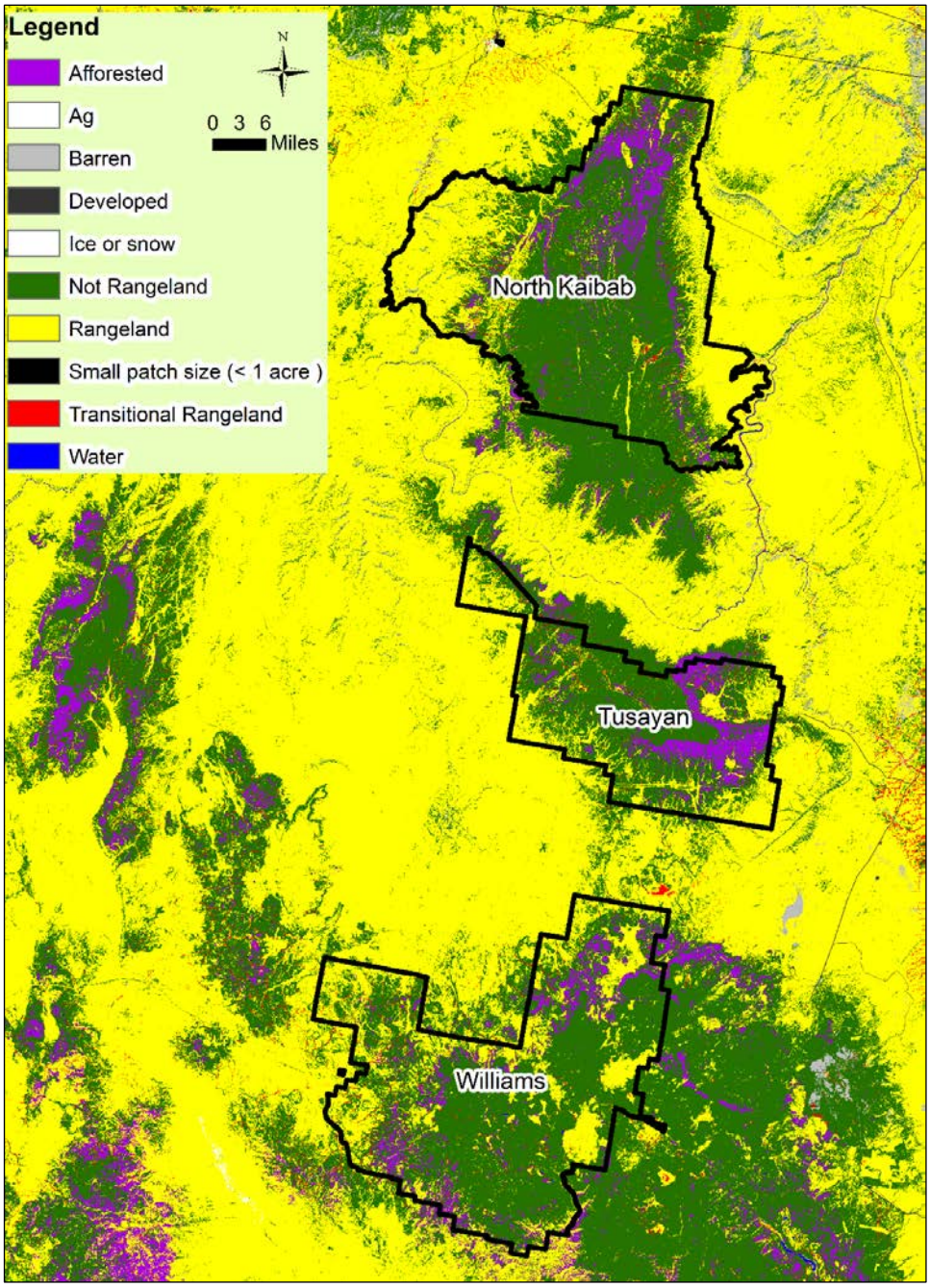


Figure 4. Change in classification from rangeland to forest/ woodland based on NDVI from 1984-2017.

Adaptive Management Considerations

These results are fairly coarse, but indicate an obvious increase in biomass in areas classified as grasslands across the forest. The occurrence of woody species invasion has long been known and observed, these data are the first time the Kaibab has had data to quantified and characterize these trends over time on a landscape scale. While we recognize that there are limitations to the data, they may help to inform priority areas for restoration. Through further work with Matt Reeves and others, we hope to validate these results and also explore other these and similarly derived data to answer

others questions of interest related to climate influences, including soil moisture, patterns in winter snowpack, forage availability, extent of cheatgrass invasion.

For more information on this project, go to https://www.fs.fed.us/rmrs/projects/development-rangeland-production-monitoring-service-could-improve-rangeland-management

Forest Structure

The Kaibab NF previously collaborated with NAU to develop methods for utilizing remotely sensed data to inform monitoring of forest structural change. The "Monitoring Toolbox" includes multiple refreshed (i.e., 2006, 2010) data products characterizing contemporary forest structure conditions, as well as a framework and template for future data refresh and analyses. It leverages freely available US Forest Service permanent Forest Inventory and Analysis (FIA) plots, Landsat Thematic Mapper (TM) imagery, and a USGS 30m digital elevation model (DEMs) as the principal data sources. These data sources were combined to develop medium resolution and multi-temporal digital forest structure data layers that cover the Kaibab NF, in addition to adjacent landscapes. Basal area (BA), stand density index (SDI), canopy cover (CC), mean tree height (HGT), trees per acre (TPA), and quadratic mean diameter (QMD) were the principal forest structural variables developed for evaluating model accuracy and consistency. Dickson et al. (2011) describes these methods in detail. These data were not reassessed for this monitoring cycle, but the Kaibab NF hopes to refresh these data in the future to inform some of the following questions:

9. *How many acres of the Kaibab NF is in an uneven aged open state, at the midscale (above 100 acres)?*
10. *How many acres are predicted to support active crown fire as modeled under typical peak fire danger conditions at the midscale?*
11. *Is the stand density within a range that will allow for a robust understory?*
12. *How many acres are at high risk for insect outbreaks (SDI)?*
13. *What is the total area within the desired range for basal area and openings?*

LiDAR

When planning landscape scale (> 10,000 acres) restoration projects, it can be challenging to obtain site-specific data on existing conditions over these larger areas. The ability of remotely sensed data sets such as Light Detection and Ranging (LiDAR) and innovative approaches to applying that data are key to assisting project planners and specialists with large landscape scale restoration projects. In 2013, Region 3 of the USFS contracted to collect LiDAR, data across of the North Kaibab Ranger District. The acquisition and subsequent data/products cover 457,925 acres of forest and woodland vegetation types. The Kaibab NF in collaboration with partners at TNC and NAU has continued make progress over the last several to years to develop and test new tools for applying LiDAR data to project design, implementation and monitoring.

In 2014, the Kaibab NF entered into a cost-share agreement with TNC to develop analytical methods that would help the forest better integrate existing LiDAR data into project level planning and analysis with the goal of achieving more informed management, improved transparency, and stakeholder consensus. The Kaibab NF was interested in answering several forest structure questions in the Burnt

Corral Project area. These kind of data had previously proven difficult to quantify during the forest plan revision process making it challenging to reach stakeholder consensus during the development of some plan components. The Burnt Corral project was used as a case study to pilot these new approaches. The resulting information provided the Kaibab NF with an improved ability to meet forest plan desired conditions, by being able to better identify those large trees (>18 inches in diameter) contributing the largest percentage of basal area in ponderosa pine vegetation types (Woolley 2016). As projects are implemented across the forest, these data can be refreshed and change comparisons made over time.

Data products developed to support the Burnt Corral project planning and effects analysis include:

1. Canopy Cover layers derived from 1-meter LiDAR Canopy Height Model (CHM) raster.
2. Raster layer illustrating areas of higher large (tall) tree density with even-aged structural characteristics.
3. Point layer of all individual trees detected using LiDAR 1-meter CHM.
4. Raster layer illustrating areas of higher large tree density based on individual tree detections.

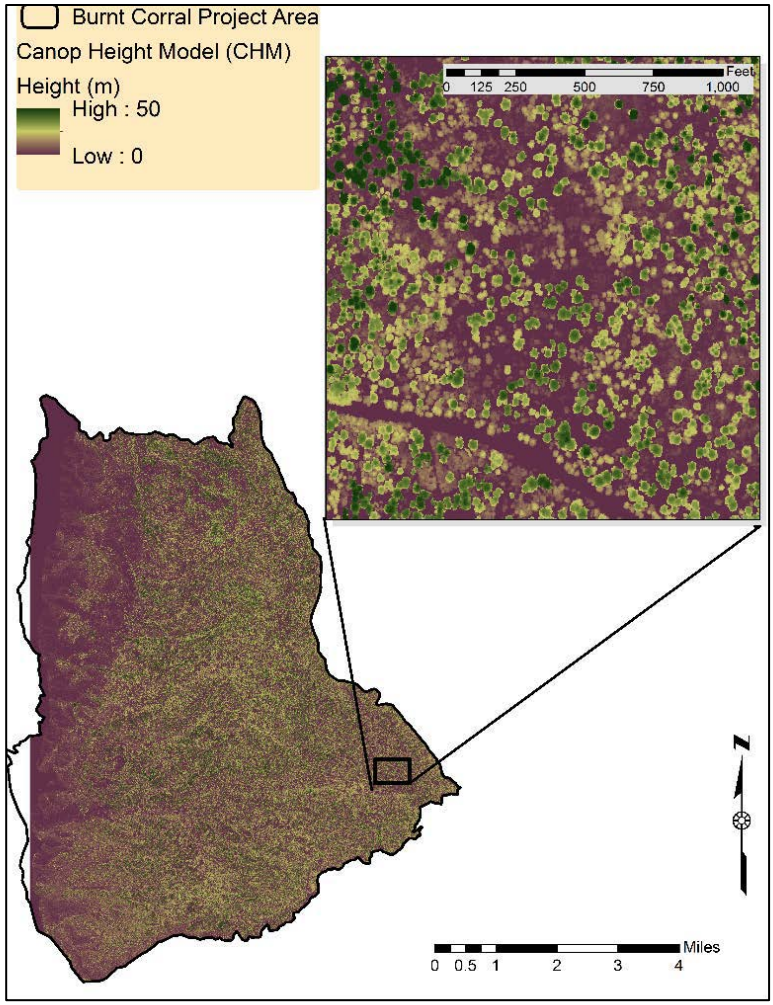


Figure 5. Canopy height model display of tall tree clusters.

Building upon this previous work, the Kaibab NF recently had a LiDAR acquisition flown for the entire Williams and Tusayan Ranger Districts. A 2018 effort will provide the training data needed to derive a set of forest vegetation structure variables. We will be working with NAU Professors Andrew Sanchez Meador and Tekki Sanke to answer several forest plan questions. We believe that through this effort, we will be able to quantify and assess the existing conditions for each Potential Natural vegetation Type (PNVT) and also yield data and analysis for other questions of interest that we did not previously have the ability to address.

Broader Scale Monitoring

Although Region 3 does not currently have a broad scale monitoring strategy, this suite of remotely sensed tools and methods could be used to inform one in the future. The data can readily be used for monitoring at multiple scales (individual tree to stands to landscapes), making it extremely relevant under new planning rules that require broad scale monitoring approaches across forests/regions (National Forest System Land Management Planning 2012). Comparison could be made from forest to forest or forest to region.

Monitoring Category 3: Existing Data Sources

These questions are answered from data that are already being collected by the Forest Service or our partners for other purposes. Much of these data are managed under the Natural Resource Manager system, a system of database tools for managing Agency data across the Forest Service. Natural Resource Manager includes Forest Service Activity Tracking System, Infrastructure, and the Natural Resource Information System databases, among others. Data routinely collected by the Arizona Department of Environmental Quality, Arizona Game and Fish Department, and USDA Animal and Plant Health Inspection Service are additional sources of existing data that can be leveraged to answer Forest-wide questions.

Accomplishments Contributing to Plan Objectives

Several monitoring questions were developed to track progress in meeting objectives identified in the forest plan. Objectives are plan components that specify intent to do the work needed to make progress toward desired conditions. These following set of monitoring questions were developed to answer the questions regarding “Did we do what we said we would do?

16. How many acres were burned with desired fire behavior and effects?
17. How many acres were treated with mechanical thinning by PNVT?
18. How many acres of conifer species were planted? Was it successful?
19. What was the total area of aspen fenced?
22. How many miles of fence were modified for pronghorn?
26. How many acres of invasive plants were treated?
27. How many springs were protected and restored?
28. How many acres of wetlands were restored?
42. How many acres of non-project related cultural resource surveys were conducted?

Table 7. Work accomplished toward meeting plan objectives.

Question	Forest Plan Objective	2016	2017
Acres were burned with desired fire behavior and effects?	13,000-55,000 acres annually	Rx 10,400 Managed wildfire 11,407 Total 21,807	Rx 22,980 Managed wildfire 8, 925 Total 31,905
Acres treated with mechanical thinning by PNVT?	Grassland: 5,000 acres annually PIPO 11,000-19,000 acres annually	Grassland/Juniper Woodland 2,695 PIPO 2,054	Grassland 8,008 PIPO 2,131 MC 1,314
How many acres of invasive plants were treated?	2,000-3,000 acres annually	926	1854
How many springs were protected and restored?	10 within 5 years of plan approval	Elk Spring (.34 acres)	Parissawampitts Spring
How many acres of wetlands were restored?	6 acres within 5 years of plan approval	Duck Lake (50 acres)	Dog Lake (0.47 acres) Fracus Lake (0.9 acres)
What was the total area of aspen fenced?	200 acres within 10 years of plan approval	15 acres	11 acres
How many acres were treated for conifer encroachment?	800 acres within 10 years of plan approval	15 acres	NA
How many miles of fence were modified for pronghorn?	50 miles within 10 years of plan approval	13.8 removed or modified	6.1 miles removed or modified
How many acres of non-project related cultural resource surveys were conducted?	200 acres per year	FY 2016 – 200 acres during Saddle Mountain Pit Project!	FY 2017 – 312 acres (209 – Scott Fire) and 103 acres by University Nevada Reno Field School across Williams, Tusayan, and North Kaibab Districts.

Water Quality Monitoring

One of the original purposes for establishing the National Forest Service was to protect our Nation's water resources and the restoration of watersheds and forest health is a key management objective of the national forests. This set of plan monitoring questions focus on variables used to assess conditions specified in the "Watershed Condition Classification Technical Guide" (USDA, 2011) and draw upon data from existing sources of information.

29. Are there any waterbodies not meeting Arizona water quality standards?

The Arizona Surface Water Monitoring and Assessment program fulfills federal Clean Water Act (CWA) requirements for statewide water quality monitoring and assessments. Four lakes on the Kaibab National Forest are monitored as part of this program: Kaibab Lake, Whitehorse Lake, Dogtown Reservoir, and Cataract Lake. These water bodies are currently meeting ADEQ standards for designated uses and are meeting State or Federal water quality standards and no Total Maximum Daily Loads (TMDLs) are imposed on any Kaibab NF water bodies by the Arizona Department of Environmental Quality.

30. How many 6th code watersheds were moved to an improved condition this year? Forest Service Watershed Condition Framework dataset.

In 2016, the Coconino Wash Headwaters HUC12 (i.e., 6th level) (HUC 150100040802) on the Tusayan RD was moved to an improved condition (i.e., from Functioning at Risk to Properly Functioning). There were no watersheds moved to an improved condition in 2016 or 2017. Upper Hell Canyon is a priority watershed and restoration work is ongoing in that watershed. We may be able to move it to an improved condition in FY2019 if essential projects are completed including vegetation treatments and prescribed burning in the Bill Williams Mountain and McCracken project areas, obliteration of almost 16 miles of roads, and treatments to control noxious weeds. https://www.fs.fed.us/naturalresources/watershed/condition_framework.shtml

Best Management Practices Monitoring

The National Best Management Practices (BMP) monitoring program is the USFS nonpoint source pollution control program for achieving and documenting water resource protection. Each year national forests complete monitoring evaluations pertaining to the national core BMPs. In FY 16 and 17 the Kaibab NF completed BMP monitoring on boat ramps, campgrounds, roads trails, and timber sales. This information will be aggregated over time to provide national and regional scale evaluations of BMP performance.

Table 8 Activities, corrective action recommended, and adaptive management recommended

Activity	Corrective Action Recommended	Adaptive Management Recommended
2016		
Dogtown Lake Campground (REC A - Developed Recreation Sites)	None	Recommend developing a recreation management plan for the campground, including a spill prevention plan in case

Activity	Corrective Action Recommended	Adaptive Management Recommended
		petroleum hydrocarbons are accidentally spilled.
Cataract Lake Boat Launch (REC G - Active Construction or Operation and Maintenance of Watercraft Launches)	None	Forest should develop an operation and maintenance plan for managing this boat launch as well as a spill contingency plan. Hydrocarbon spill containment and absorbent materials should be on site to contain and absorb spills. This information should be provided to the facility hosts.
Kaibab Lake Boat Launch (REC G - Active Construction or Operation and Maintenance of Watercraft Launches)	Extend the paved or aggregated surface to prevent sediment delivery directly to waterbody.	Forest should consider developing an operation and maintenance plan for boat launches on the Forest and having a spill contingency plan for boat launches. A spill kit that includes material to impound and absorb hydrocarbon spills should be kept on-site with the campground host.
FSR 22 (ROAD C - Road Operation and Maintenance)	Re-blade the road surface to bring sidecast aggregate back onto the road crown. This will eliminate the berms created at the ditch edge. This work was completed. Effectiveness: The small berm of road aggregate that has been pushed to the roadside above the ditch has the potential to concentrate runoff and deliver sediment to stream crossings. When re-blading is performed, this material should be drawn back onto the road surface and redistributed during crowning. This work was completed.	None
KA (4FRI task order) (Veg A - Ground-Based Skidding and Harvesting)	None	None

Activity	Corrective Action Recommended	Adaptive Management Recommended
Indian Hollow Campground (REC A - Developed Recreation Sites)	Very slight erosion originating from campsites and parking area. Small erosion control measures (rock lines, wood structure, etc.) to alleviate and dissipate concentrated flow would resolve erosion issues.	None
Pumpkin, 39 (REC D - Motorized or Nonmotorized Trail Operation and Maintenance)	Lead out could have been turned the other way resulting in more area for sediment to move before entering drainage, but problem is very minor.	None
South Canyon, 6 (REC D - Motorized or Nonmotorized Trail Operation and Maintenance)	Where trees have fallen across trail, they have damaged trail tread and are causing sheet and rill erosion to occur. However banks to waterbody (South Canyon) are heavily vegetated which will reduce amount of soil entering waterbody. Small amounts of trail clearing and work needed.	None
Pearl Stewardship, Pay Unit 3 (Veg A - Ground-Based Skidding and Harvesting)	Slashing of skid trails on steep slopes/skid trails. Water bars on steep slopes and skid trails. Using old road of skid trail, not recommended. Slashing and water features on landings to drain.	Recommend flagging skid trails and at designated crossings. Conversation/Field Visit for reviewing harvest with watershed personnel prior to accepting units for implementing erosion control measures.
Plateau Facilities Fire Protection Project (Veg A - Ground-Based Skidding and Harvesting)	None	Landings should be located outside of drainages and slash should be included as measure for reducing erosion. Reduce instances of locating landings in drainage bottoms and slash skid trails for erosion control.

Activity	Corrective Action Recommended	Adaptive Management Recommended
Buck Lake, Payment Unit 5 (Veg A - Ground-Based Skidding and Harvesting)		Minimize landings and skid trails in drainage where possible. Reduce the amount of skid trails and landings in or adjacent to drainages.

Air Quality Monitoring

The goal of air quality management is to meet human health standards, to meet visibility goals in areas of high scenic value, and to address and respond to other air quality concerns, such as nuisance smoke. Temporary decreases in air quality from management activities on the Kaibab NF from prescribed fires. Wildfires originating on the Kaibab NF also produce emissions. The National Ambient Air Quality Standards pollutant of concern from wildland fire is fine particulate matter, including PM10. Air quality was measured with the IMPROVE Air Quality Station protocol on the Sycamore Canyon Wilderness, a class I airshed. This protocol addresses the following question:

34. How many days did fine particle concentrations exceed 10 µgm/ m3?

There were 19 days that fine particle concentrations exceeded 10 µgm/ m3. The IMPROVE samples are collected once every three days resulting in about 120 sampling days per year. All of the exceedance dates were either in pre-monsoon summer, likely from wildfires, or in the fall when prescribed burning is common. Data were not analyzed to determine how many of these days Kaibab management activities may have contributed to an exceedance of the air quality standard. SYCA2 area receives smoke and other particulate influences from a wide variety of sources. A Smoke Management Group housed in the Arizona Department of Environmental Quality coordinates planned burning activities from all Federal agencies on a daily basis, and works closely with officials in ADEQ to approve or disapprove prescribed fire activities to help maintain compliance with both health standards and visibility goals.

Table 9. FY 16-17 dates that fine particle concentrations exceeded 10 µgm/ m3 in SYCA2

Sample Date	Parameter	Value	Unit
6/5/2016	PM2.5	14.353	µg/m3
6/8/2016	PM2.5	14.484	µg/m3
6/17/2016	PM2.5	14.039	µg/m3
9/9/2016	PM2.5	14.452	µg/m3
10/21/2016	PM2.5	11.015	µg/m3
6/18/2017	PM2.5	13.695	µg/m3
6/21/2017	PM2.5	13.595	µg/m3
6/24/2017	PM2.5	17.668	µg/m3
6/30/2017	PM2.5	13.321	µg/m3
7/9/2017	PM2.5	11.183	µg/m3
9/4/2017	PM2.5	10.352	µg/m3
9/7/2017	PM2.5	24.250	µg/m3
10/7/2017	PM2.5	22.389	µg/m3
10/16/2017	PM2.5	10.288	µg/m3
10/28/2017	PM2.5	10.319	µg/m3
11/9/2017	PM2.5	12.078	µg/m3
11/12/2017	PM2.5	19.505	µg/m3
11/15/2017	PM2.5	16.158	µg/m3
11/30/2017	PM2.5	13.541	µg/m3

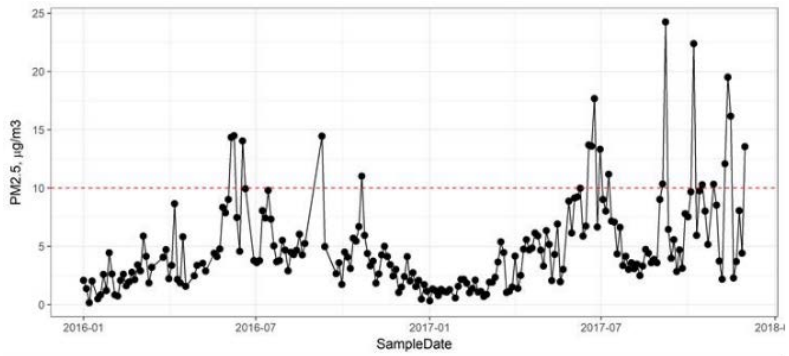


Figure 6. Graph of fine particle concentrations measured for FY16 and 17.

For more detail or to download and view other IMPROVE data, go to http://views.cira.colostate.edu/fed/DataWizard/Default.aspx.

Insect and Disease Aerial Survey

Aerial detection surveys are conducted and processed annually for the Southwestern Region (Arizona, New Mexico) by the Southwestern Region Forest Health Protection staff.

23. What is the acreage of outbreaks of insects and disease? Does this follow regional patterns?

Within the Southwestern Region, bark beetle activity in the ponderosa pine type has remained fairly low since 2013, and has been very low on the Kaibab. Most of the bark beetle activity in the region has occurred in the ponderosa pine type, with the majority of the total 56,800 acres mapped in Arizona occurring on the Apache-Sitgreaves and Coconino National Forests. Bark beetle activity has decreased in ponderosa pine and mixed conifer forests throughout the Southwestern Region over the past 10 years. Pinyon ips, western balsam bark, and cedar bark beetles continued to occur at low levels with less than 2,000 acres across the region. Spruce beetle-caused tree mortality accounted for the majority of bark beetle affected acres in New Mexico, an increase of approximately 6,000 acres from 2016 and a continued increase of tree mortality

On the Kaibab NF, Pandora moth caterpillars defoliated almost 20,000 acres of ponderosa pine trees in 2017. No defoliation was reported in 2016 due to the two-year life cycle of the insect. FHP expects that the population will start to decrease in 2018 due to the spread of the NPV virus which was observed during larval density collections. Defoliation from Pandora moths on the North Kaibab have been documented for many years. The event was characterized by one of the Regional entomologists as a people management issue (i.e education), not a forest management issue.

Defoliation continues to be the largest disturbance event from insects and diseases with 265,200 acres mapped across the Southwestern Region, remaining fairly consistent from 2016 defoliation levels. Western spruce budworm and various insects on aspen were the primary defoliators in New Mexico, whereas dramatic pandora moth and spruce aphid feeding contributed the most to defoliation acres in Arizona.

Table 10. Bark beetle conditions report for the Kaibab National Forest in acres[*]

Bark Beetle	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Western pine beetle	94	16	27	11	7,150	2,869	130	-----	------	------
Ponderosa pine *Ips*	343	196	489	188	9,510	2,273	40	------	------	------
Douglas-fir beetle	106	89	53	16	18	366	7	50	30	17
True fir complex[†]	17	57	5	0	0	130	20	35	0	10
Cedar bark beetle	0	1	0	30	0	1	1.5	1	0	0
Pinyon ips	1	0	5	1	1	2	0	4	91	3
Spruce beetle					2	3	4	0	2	.25

Ponderosa Pine bark Beetles*	------	-----	-----	------	------	------	-------	2,288	685	4,596
Total:	561	359	579	246	16,681	5,644	202.5	2,378	808	4626

†True fir complex includes fir engraver and/or western balsam bark beetle.

* Starting in 2015 western pine beetle and ponderosa pine Ips were combined into “Ponderosa pine bark beetles”

Table 11. Acres of defoliation on the Kaibab NF

Defoliators	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Spruce Budworm	0	0	0	0	0	0			326	339
Pine sawflies	0	1,130	1,140	260	1,847	1,885	-----	-----	-----	-----
Aspen defoliation	65,204	4,667	2,815	6,097	5,240	245	864	1664	439	170
Pandora Moth	-	-	-	-	0	1,833	0	8000	0	19,700
Salt Damage	-	-	-	-	716	419				
Pine needle scale	-	-	-	-	-	-	-	-	-	800
Total:	65,204	5,797	3,955	6,357	7,803	4,382	864	9664	765	21,009

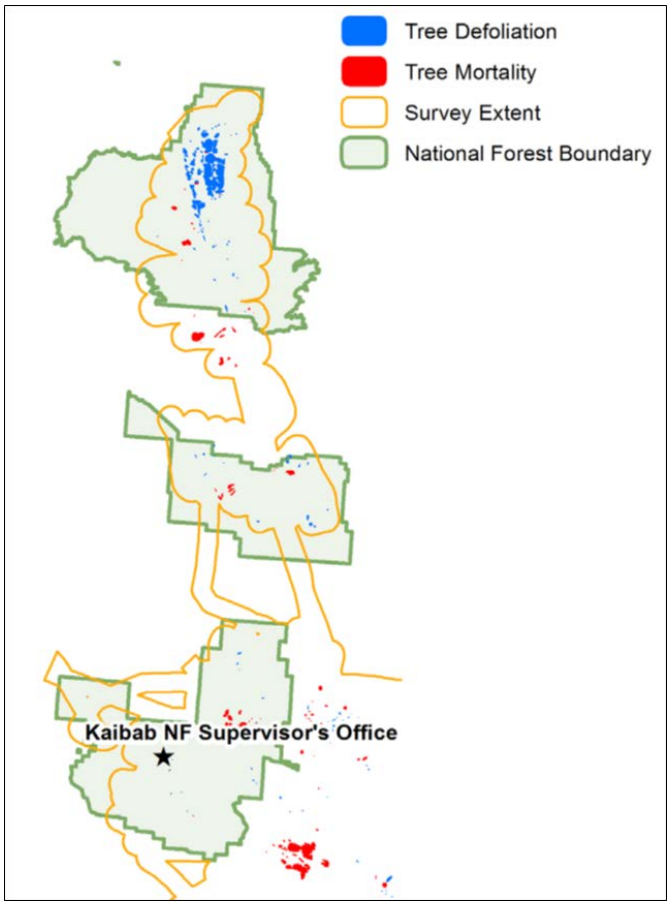


Figure 7. Geographic location and extent of insect and disease damage on the Kaibab NF

Fire Effects Monitoring

Fire personnel on the North Kaibab Ranger District are zoned with Grand Canyon National Park. To inform the effectiveness of prescribed burn projects, pretreatment Fire Effects Monitoring plots were installed using the National Park Service's Rapid Assessment Protocol (RAP) monitoring plots within the Burnt Corral project area.

2. Is course woody debris within the desired range?

Total pre-treatment fuel loading in the Burnt Corral project averaged 26.4 tons/acre with individual plot values ranging from 7 to 79 tons/acre. Small woody fuel (1-, 10-, and 100-hr TLFM) averaged 1.8 tons/acre and coarse woody fuel (1000-hr TLFM) averaged 4.3 tons/acre. Together, litter and duff fuel loading averaged 20.2 tons/acre. Litter and duff depth were each 1 inch, on average. Duff contributed the most to total fuel loading in the plots. Overall plots on the North Kaibab Ranger District have higher fuel loads than the Williams and Tusayan Districts and higher than desired conditions. Large snags are more abundant as well.

Table 12. Mean (± 80% Confidence Interval), minimum, and maximum pre-treatment dead surface fuel loading in the Burnt Corral monitoring plots (n = 50). TLFM = time lag fuel moisture

Dead Surface Fuel Category	Mean ± 80% CI	Min - Max
Total Loading (tons/acre)	26.4 ± 3.0	7.0 – 79.2
1-, 10-, & 100-hr TLFM (tons/acre)	1.8 ± 0.3	0 – 5.4
1-hr TLFM (tons/acre)	0.1 ± 0.02	0 – 0.6
10-hr TLFM (tons/acre)	0.8 ± 0.1	0 – 2.9
100-hr TLFM (tons/acre)	1.0 ± 0.2	0 – 4.2
1000-hr TLFM (tons/acre)	4.3 ± 1.8	0 – 56.0
Sound 1000-hr TLFM (tons/acre)	1.1 ± 0.5	0 – 13.5
Rotten 1000-hr TLFM (tons/acre)	3.3 ± 1.4	0 – 42.5
Litter & Duff (tons/acre)	20.2 ± 2.1	5.3 – 59.2
Litter (tons/acre)	2.8 ± 0.2	1.2 – 5.7
Duff (tons/acre)	17.4 ± 2.0	2.7 – 56.1
Litter & Duff Depth (inches)	2.0 ± 0.2	0.8 – 4.4
Litter Depth (inches)	1.0 ± 0.07	0.4 – 2.0
Duff Depth (inches)	1.0 ± 0.1	0.2 – 3.3

Table 13. Mean (± 80% Confidence Interval), minimum and maximum pre-treatment tree density, basal area, height and crown base height in the Burnt Corral monitoring plots (n = 50). DBH = diameter at breast height, NR = not recorded, NA = not applicable.

	Living Trees		Snags	
Variable / Size Category	Mean ± 80% CI	Min – Max	Mean ± 80% CI	Min – Max
Density (trees/acre):				
Seedling tress (<1” DBH)	1227 ± 389	0 – 9434	NR	NR
Sapling tress (1-6” DBH)	194 ± 44	0 – 1121	NR	NR
Intermediate-sized trees (6-16” DBH)	59 ± 9	0 – 202	3.2 ± 1.4	0 – 27
Large-sized trees (>16” DBH)	38 ± 5	0 – 108	2.2 ± 1.2	0 – 27
Basal area (sq. ft./acre):				
Intermediate-sized trees (6-16” DBH)	34 ± 6	0 – 114	1.4 ± 0.7	0 – 19
Large-sized trees (>16” DBH)	114 ± 15	0 – 331	5.2 ± 2.9	0 – 75
Average tree height (feet)[1]:				
Seedling tress (<1”DBH)[2]	3.6 ± 0.3	2 – 8	NR	NR
Sapling tress (1-6” DBH)[2]	18.0 ± 1.0	8 – 27	NR	NR
Intermediate-sized trees (6-16” DBH)	42.2 ± 4.3	3 – 88	26.4 ± 7.7	1 – 47
Large-sized trees (>16” DBH)	63.1 ± 7.4	2 – 122	58.5 ± 10.0	36 – 85
Average crown base height (feet)[1]:				
Intermediate-sized trees (6-16” DBH)	16.0 ± 1.9	5 – 41	NA	NA
Large-sized trees (>16” DBH)	29.4 ± 2.6	5 – 62	NA	NA

Table 14. Non-native species present in Burnt Corral monitoring plots (n = 50). # Obs. is the number of plots with recorded observations of the species.

Scientific Name	Common Name	# Obs.
Bromus inermis	smooth brome	14
Bromus tectorum	common cheatgrass	5
Conyza canadensis	Canadian horseweed	1
Chenopodium sp.	Non-native species of goosefoot	1
Phleum pratense	timothy	3
Tragopogon dubius	yellow salsify	3
Verbascum thapsus	common mullein	10
unknown grass	non-native	3
unknown forb	non-native	2
unknown Asteraceae	non-native	1

Adaptive Management

These data support the findings from previous assessments that fuel loads are higher than desired. Remeasurement of these plots will help to inform the effects and effectiveness of the restoration treatments proposed for the Burnt Corral project area. These were collected using the National Park Service protocol for fire effects monitoring. Methodologies for the NPS RAP are fairly similar to the Kaibab Forest Plan Rapid Plot protocol. There would be greater efficiency if efforts were combined. A new fire ecologist has recently been hired and we are currently looking into better ways to integrate our objectives and protocols, including data management.

Category 4: Interviews

Interviews are largely qualitative in nature and may be subjective. These may include questions posed to resource specialists or partners or during tribal discussions. Follow-up interpretation of the results is required to inform adaptive management.

52. Did we receive any comments that reflect visitor satisfaction? Were there common themes?

Visitors often come to the Forest Service offices with questions, comments, and complaints. Interviews with front liners at the office indicate that visitors are generally very satisfied. The most common comment theme was regarding information availability, both positive and negative. People appreciate when they get answers to their questions about resources, opportunities and access. Similarly, visitors were dissatisfied when information was not available, particularly about road conditions and ability to access specific remote areas. Other “dissatisfied” themes were mostly about other visitors: leaving trash, fires unattended, noise, speeding /creating dust.

57. Are plant species of known medicinal and cultural value being depleted?

The Kaibab Tribal liaison includes this question as part of the discussion during regular meetings with the seven tribes that traditionally use the Kaibab National Forest. Currently, there are no definitive answers to this question, however, concerns have been raised about various impacts to certain plants used for medicinal and cultural purposes including illegal collection for commercial sale.

To better understand this question, the 4FRI Forests have partnered with the Northern Arizona University Landscape Conservation Initiative on a recently funded Forest Service Citizen Science (CitSci) Fund that provides annual competitive funding for collaborative projects that bring new

information to managers. The project will occur on all Arizona forests within the 4FRI footprint. The Kaibab and Tonto Tribal Liaisons submitted the proposal in response to comments by Arizona and New Mexico tribes about this issue during consultation on the 4FRI project. The project will collect information on traditionally used plants that are important to tribal communities, which is challenging due to the expanse of northern Arizona forests and the need for experienced botanists to correctly identify traditionally used plant species. The Forest Service generally focuses its limited resources to manage botanical resources on species that are threatened, endangered or sensitive (TES). This initiative is a rare opportunity to gather data on non-TES species that are extremely valuable to tribal communities.

Volunteers will record observations of traditionally used plants with the iNaturalist app on their cellular phones; data will be analyzed by trained a botanist at LCI and shared with tribal partners to shape conservation and management goals. Tribal community engagement in public lands management will be strengthened by conserving traditional plants and sharing data between tribes and the Forest Service. In addition, due to the platform for tribal elders and youth to exchange information, cultural heritages will be connected for future generations. The first workshop was attended by nine tribes, which identified the priority list of species that they want to focus on. The initiative will run through 2021, culminating in a report with detailed management recommendations for these traditional plant resources.

9. Were the monitoring requirements met as identified in the Pediocactus paradinei conservation agreement?

The Paradine plains cactus (*Pediocactus paradinei* B. W. Benson) is known exclusively from the eastern slopes of the Kaibab Plateau (East Kaibab monocline) and small portions of adjoining House Rock and Coyote valleys. The Paradine plains cactus was designated as a candidate species under the authority of the ESA on December 15, 1980 (45 FR 82480). Candidate species are plants and animals for which the U.S. Fish and Wildlife Service (USFWS) has sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA, but for which development of a listing regulation is precluded by other higher priority listing activities. Candidate conservation can be facilitated through inter-agency agreements. A CCA is intended to direct specific conservation efforts, to outline management practices that will prevent decline of their habitat, and to ensure regular, periodic review of their status with the goal of working to preclude the need to list the species. Along with protection, robust monitoring is an important of conservation management.

In 2017, Level 1 monitoring as specified in the conservation agreement was completed at several permanent plot locations. A Trimble Total Station was used to record individual plant locations at permanent monitoring sites at four locations: House Rock (2 plots), Valley (3 plots), Trail Canyon (2 plots), and Pasture Canyon (2 plots). All plants detected within these plots were measured (diameter, number of heads, number of buds/flowers) and recorded with very precise and accurate locations (sub-centimeter). While these plots have been monitored in the past, this was the first time these data have been collected with high accuracy and precision. Having precise data about each individual plant location, growth, health, age, and reproduction will allow for better understanding of trends over time.

Category 5: Intensive Monitoring

Intensive monitoring indicates status of key ecological attributes for focal ecological resources at fine spatial scales or spatial resolution, although measurements in multiple locations can provide wide spatial coverage. Data sources might include simple to complex field-based metrics that are usually

quantitative and collected within a statistical sampling design. Examples include surveys of birds to assess density levels, analyses involving specific soil and water chemistry parameters, and quantitative vegetation structure measurements.

Springs Ecosystem Assessment Protocol

The Kaibab NF has partnered with the Springs Stewardship Institute for over 10 years and has inventory data for most of our known springs. Through SSI's Springs Inventory Protocol (SIP) and Springs Ecological Assessment Protocol (SEAP), improved, conscientious planning can lead to restored and properly managed springs. SIP focuses on the physical characteristics and condition of the spring's ecosystem. A team of experts with knowledge of geography, hydrology, biology, socioeconomics, and anthropology can typically gather the field information in 1.5 to 3 hours using SSIs standardized field sheets.

SEAP is the second phase in assessing site's condition and risk level following the first phase of Springs Inventory Protocol (SIP). SEAP is a process of evaluating the inventory data as well as other external information to generate a condition and risk score in each of the six predefined categories of variables. Risk is interpreted as the potential threat or the "condition inertia" of that variable. In other words, what is the probability of that variable remaining unchanged? While six variable categories are assessed, only two (and their subcategories) are reported here and are used to answer the forest plan monitoring question:

64. Are waterflow patterns and vegetation intact?

SSI completed inventories of twelve springs ecosystems in 2016-2017. The field inventory information collected included data collection on geomorphology, soils, geology, solar radiation, flora, fauna, water quality, flow, georeferencing, site photography, and cultural resources, as well as expert assessment of the site's ecological integrity and risks. SEAP scores range from zero to six. Zero is the lowest score indicating no species or habitat remaining and a score of six indicates a pristine condition.

Table 15. SEAP scores for waterflow and vegetation.

Site Name	Survey Date	Aquifer Function	Discharge L/sec	Flow Naturalness	Flow Persistence	Habitat Patch Size	Micro Habitat Qual	Native Plant Ecol Role	Native Plant RichDiv	Sensitive Plant Rich	NN Plant Rarity	Native Plant Demog
Indian Lake	9/25/2016	5	1	5	4	4	4	4	4	4	4	4
VT Lake	9/25/2016	5	2	5	4	4	5	4	4	4	4	4
West Elk Spring	6/13/2017	5	1	1	3	_	_	4	2	2	5	3
Elk Spring	6/13/2017	5	1	4	3	3	3	4	5	4	5	5
East Elk Spring	7/5/2017	4	2	4	4	3	4	4	5	4	5	4
Castle Spring	8/28/2017	5	2	4	4	4	3	3	3	4	3	4

Site Name	Survey Date	Aquifer Function	Discharge L/sec	Flow Naturalness	Flow Persistence	Habitat Patch Size	Micro Habitat Qual	Native Plant Ecol Role	Native Plant RichDiv	Sensitive Plant Rich	NN Plant Rarity	Native Plant Demog
Fracas Lake	8/28/2017	4	1	5	4	4	3	4	4	4	4	5
Colcord Spring	9/14/2017	5	1	5	5	3	5	4	4		4	4
Parissawampitts	9/24/2017	6	1	4	4	3	4	4	5	5	4	4
Murrays Lake	9/25/2017	5	1	1	3	4	1	3	3	2	3	2
Squaw Spring	9/24/2017	6	3	5	3	3	4	4	4	5	4	4
Rocky Lo	10/13/201	2	1	5	3	2	5	5	5	4	5	5

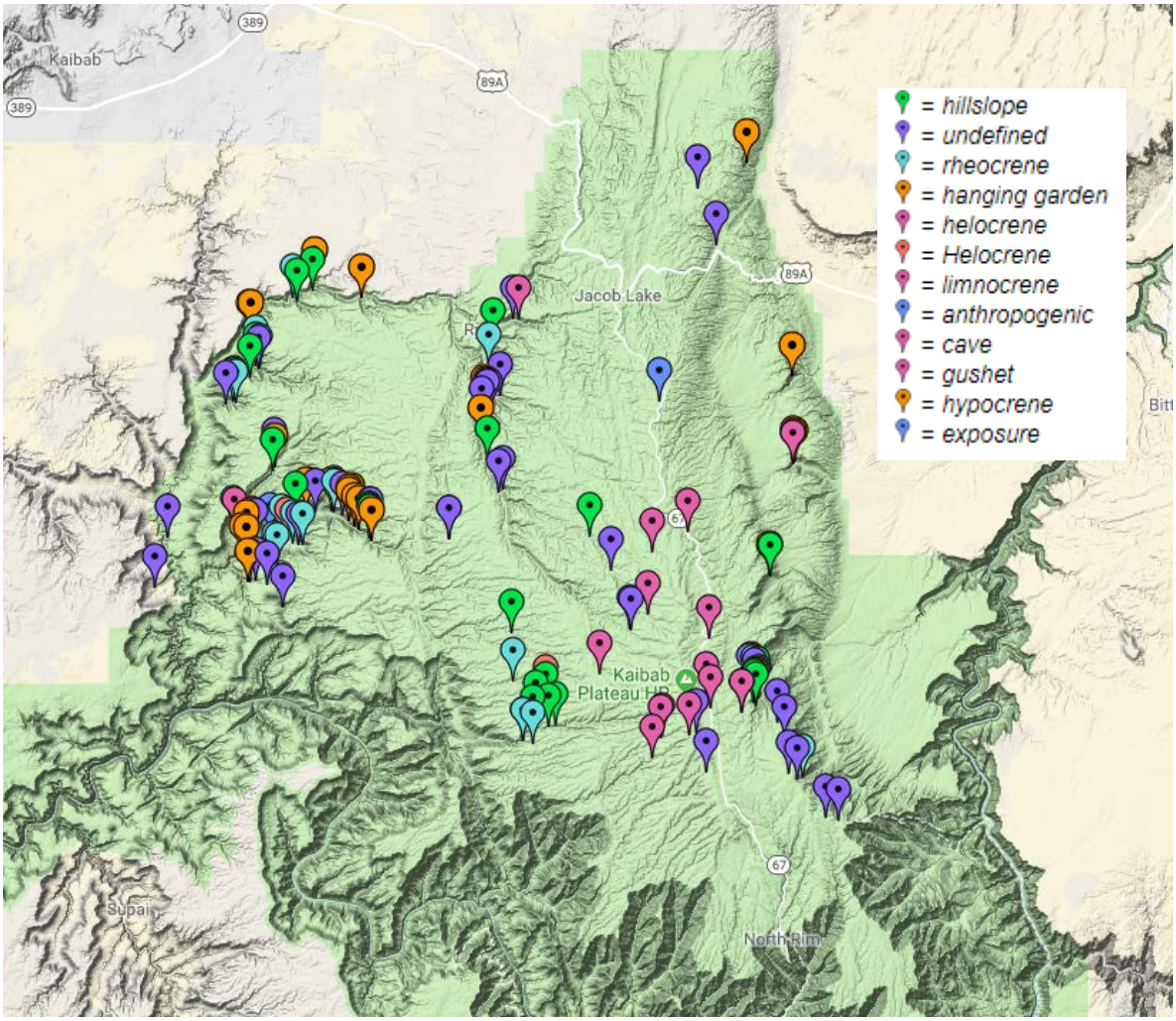


Figure 8. Map of spring locations on the North Kaibab Ranger District in the SSI Springs database.

While the Kaibab maintains a copy of all Kaibab SIP and (SEAP) data, the data are stored in "Springs Online," a secure, user-friendly, online database where users can easily enter, archive, and retrieve springs information (https://springsdata.org). The database is relational, providing the ability to contain many surveys related to each site and to analyze diverse variables and trends over time (Ledbetter et al. 2014). It is broadly framed to accommodate a wide array of variables, schemas, and information types. Other forests, agencies, and tribes are also included in the database, allowing for the potential for landscape-wide assessment.

Integrated Monitoring in Bird Conservation Regions (IMBCR)

Bird Conservancy of the Rockies (BCR), in conjunction with its partners, conducted landbird monitoring for the tenth year in a row for the IMBCR program. IMBCR uses a spatially balanced sampling design which allows inferences to avian species occurrence and population sizes at various

scales, from local management units to entire BCRs or states, facilitating conservation at local and national levels.

67. What is the area of forest occupied by Grace's warbler and western bluebird (Ponderosa Pine Forest)?) How does this compare to regional trends?

68. What is the area of forest occupied by ruby-crowned kinglet (Mixed Conifer Forests)? How does this compare to regional trends?

Background & Driver(s)

Focal Species are defined by the 2012 Rule as "A small subset of species whose status permits inference to the integrity of the larger system to which it belongs and provides meaningful information regarding the effectiveness of the plan in maintaining or restoring ecological conditions to maintain the diversity of plan and animal communities… commonly selected based on their functional role in ecosystems (36CFR

§219.19, emphasis added). Focal species are not selected to make inferences about other species. Focal species are selected because they are believed to be responsive to ecological conditions in a way that can inform future plan decisions. Forest Service handbook direction (FSH 1909.12 chapter 30 § 32.13c) for focal species further specifies that every plan monitoring program must identify one or more focal species and one or more monitoring questions and associated indicators addressing the status of the focal species. The purpose for monitoring the status of focal species over time is to provide insight into the following:

1. Integrity of ecological systems on which focal species depend,

2. Effects of management on those ecological conditions,

3. Effectiveness of the plan components to provide for ecological integrity and maintain or restore ecological conditions, and

4. Progress towards achieving desired conditions and objectives for the plan area. It is not expected that a focal species be selected for every element of ecological conditions.

Focal species represent a part of the monitoring requirements for ecological sustainability and diversity of plant and animal communities. "It is not expected that a focal species be selected for every element of ecological conditions" (77 FR 21233, April 9, 2012). Focal species should be selected to monitor when doing so is feasible and they are the best way to track whether ecological integrity and ecosystem diversity is being maintained or improved.

Focal Species Overview

The following section describes the Kaibab NF's focal species and how they will inform management in terms of maintaining ecological integrity and ecosystem diversity. For additional information on how the focal species were selected for the Kaibab National Forest, see the Administrative Change White Paper associated with the monitoring plan transition required under the 2012 Planning Rule.

Western bluebird (Sialia mexicana): Western bluebird serves as an indicator of understory development within openings in ponderosa pine stands. Adequate ground cover— including the

presence of fine fuels—is integral to maintaining the kind of low-intensity fires characteristic of presettlement conditions. Therefore, it is also necessary to evaluate the post-restoration understory response to overstory removal in ponderosa pine forests. Western bluebird, a ground-foraging species which depends largely on the understory for capture of invertebrate prey, has shown a strong response to burning and thinning in ponderosa pine forest (Wightman and Germaine 2006, Hurteau et al. 2008, Guinn et al.2008, Russell et al. 2009, Dickson et al. 2009, Chambers and Kalies 2011). Wightman and Germaine (2006) found that western bluebird productivity and nest success were significantly affected by tree density (ponderosa pine and Gambel oak) and adequate ground cover (grasses, forbs, and bare ground combined total of at least 20 percent).

Grace's warbler (Setophaga graciae): Grace's warbler serves as an indicator of clumps of mature ponderosa pine/pine-oak forests, yellow pine, and open parklike forest such as the reference condition. This species.is a neotropical migrant and breeding resident in ponderosa pine forest across all three ranger districts on the Kaibab NF (Birek et al.2010). It is strongly associated with forest structure having well-developed canopy and pine-oak forest indicative of the open park-like conditions found historically in northern Arizona (Szaro and Balda 1986, Stacier and Guzy 2002, Saab et al. 2007, Kalies et al.2010).

Ruby-crowned kinglet (Regulus calendula): Ruby-crowned kinglet serves as an indicator of mixed conifer (frequent fire) mature forest, with denser overstory. This species is a year-round resident that occupies mature, well developed mixed coniferous forest (Corman-Gervais 2005). This species may be sensitive to forest logging and wildfire (Swanson et al. 2008).

Plan components addressed

See Appendix A for a full listing of the monitoring question intervals and drivers.

Indicator and Unit of Measure

- Understory development within openings in ponderosa pine stands (Western bluebird)
- Clumps of mature ponderosa pine/pine-oak forests, yellow pine; open park like environments such as in reference condition (Grace's warbler)
- Mature mixed conifer forest, over story (Ruby-crowned kinglet)
    - Proportion of grid cells occupied for each species across the forest/region.

Table 16. Monitoring collection summary

For Monitoring Items 67 and 68:	Year
Data was last collected or compiled in:	2018
Next scheduled data collection/compilation:	2019
Results were last evaluated in:	2015
Next scheduled year for evaluation of data in an evaluation report:	2020

New Science or Other Information

No new science or information collected outside of this monitoring program was considered in the evaluation of this monitoring question.

Monitoring Results

The Kaibab NF continued its multiyear project with BCR to gather long-term trend data for populations of most diurnal, regularly breeding bird species in the forest. In the short term, this program provides information needed to effectively manage and conserve bird populations on the forest. It also supports the forest's efforts to comply with requirements set forth in the National Forest Management Act and other law, regulation, and policy. Stratification by elevation allows for adjusting sampling intensity to target Focal species on the Forest. This data is used to help determine population trends.

The IMBCR program uses a spatially balanced sampling design (Stevens Jr. and Olson 2004) which allows inferences to avian species occurrence and population sizes at various scales, from local management units to entire BCRs or states, facilitating conservation at local and national levels. The sampling design allows analysts to estimate species densities, population sizes, and occupancy rates for individual strata or biologically meaningful combinations of strata. The IMBCR design provides a spatially consistent and flexible framework for understanding the status and annual changes of bird populations. Collaboration across organizations and spatial scales increase sample sizes and improves the accuracy and precision of population estimates. Analyzing the data collectively allows BCR to estimate detection probabilities for species that would have otherwise have insufficient numbers of detections at local scales. See Hanni et al. 2016, Pavlacky et al. 2017 for additional information on BCR sampling protocols and study design.

The following results reflect updates from data collected from 2008-2017. New information collected or compiled from the last evaluation report (2015) has been incorporated.

Data

Field technicians completed 21 of 20 planned surveys (105%) in 2017. Technicians conducted 262 point counts within the 21 surveyed grid cells between May 4 and June 27 2017. They detected 80 bird species, including the 3 focal species for the Kaibab NF (Woiderski et al. 2018) http://rmbo.org/v3/Portals/5/Reports/2017%20Final%20IMBCR%20Report.pdf

The data collected by BCR is located in the Rocky Mountain Avian Data Center. To view a map of survey locations, density and occupancy results and species counts within Kaibab National Forest across all years of the project, follow the web link below for each species and hit the "Run Query" button highlighted in red located near the top of the page. If you want to limit results to 2017, after you click on the link below select "Year" from the Filter drop down box on the top left of the screen. Hit the "Add" button, select 2017, hit "Add Filter", then "Run Query".

Kaibab Results

Densities and population sizes were estimate for 73 species, three of which are priority species. The data yielded robust density estimates (CV < 50%) for 35 of these species. See tables and graphs below for additional detail.

The proportion of 1 km² grid cells occupied (Psi) throughout Kaibab National Forest for 71 species was also estimated, three of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 40 of these species. A CV less than 50% show that the enough data was collected to have a robust estimate for the species for either density or occupancy. The lower the CV percentage the more robust is the data. Starting with the 2010 survey data the BCR was able to do estimated proportion of transects (Psi) occupied by species. A Psi estimate equal to 1 indicates the species was detected on all transects surveyed (White et al. 2011).

Monitoring Discussion and Findings

Grace's Warbler

Overall detection probabilities for Grace's warbler are consistently over .4 psi indicating a modest likelihood of detecting the species on the forest. CVs are well below 50%, however, higher CVs generally correspond with dips in the trend line where survey effort decreased, suggesting that declining trend may be more reflective of survey effort, than other factors. Overall the trend appears stable to upward.

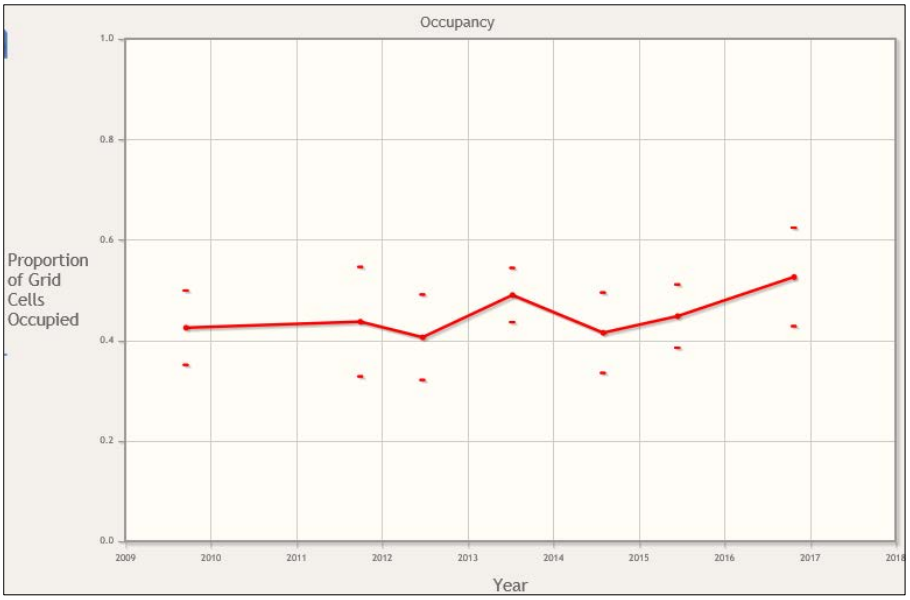


Figure 9. Occupancy results for Grace's warbler on the Kaibab NF by year.

Species	Stratum	Year	Transects	Psi	SE	% CV
Grace's Warbler	Kaibab National Forest	2010	19	0.425	0.074	17
Grace's Warbler	Kaibab National Forest	2012	7	0.437	0.109	25
Grace's Warbler	Kaibab National Forest	2013	11	0.406	0.085	21
Grace's Warbler	Kaibab National Forest	2014	22	0.49	0.054	11
Grace's Warbler	Kaibab National Forest	2015	10	0.415	0.08	19
Grace's Warbler	Kaibab National Forest	2016	20	0.448	0.063	14
Grace's Warbler	Kaibab National Forest	2017	12	0.526	0.098	19

Table 17. Grace's warbler summary

Click the following link and "Run Query" to further explore the data for Grace's warbler

Western blue bird

Overall detection probabilities for Western bluebird are variable ranging from as high as .4 to .8 indicating a high likelihood of detecting the species on the forest. CVs are well below 50%, however, similar to Grace's warbler higher CVs generally correspond with dips in the trend line where survey effort decreased. Declining trend may be more reflective of survey effort, than other factors. The trend line for western bluebird is less clear than for Grace's warbler.

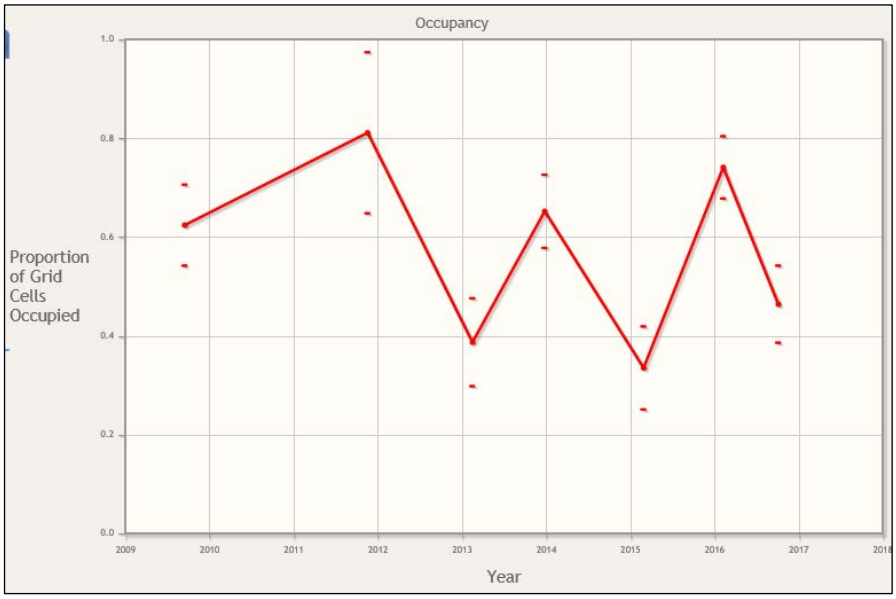


Figure 10. Western bluebird occupancy on the Kaibab NF by year.

Table 18. Western bluebird collection summary

Species	Stratum	Year	Transects	Psi	SE	% CV
Western Bluebird	Kaibab National Forest	2010	25	0.624	0.082	13
Western Bluebird	Kaibab National Forest	2012	12	0.811	0.163	20
Western Bluebird	Kaibab National Forest	2013	10	0.387	0.089	23
Western Bluebird	Kaibab National Forest	2014	27	0.652	0.074	11
Western Bluebird	Kaibab National Forest	2015	8	0.335	0.084	25
Western Bluebird	Kaibab National Forest	2016	33	0.741	0.063	9
Western Bluebird	Kaibab National Forest	2017	11	0.464	0.078	17

Click the following link and "Run Query" to further explore the data for Western Bluebird.

Ruby-crowned kinglet

Overall detection probabilities for Ruby-crowned kinglet are very low ranging from .03 to only .1 indicating the species is much more uncommon on the forest than the other two focal species. In addition, CVs range from 47 to as high as 97. The trend line follows a similar pattern as Grace's warbler and appears relatively flat. However, given the high variance and low detection probably these results should be interpreted with caution.

Table 19. Ruby-crowned Kinglet summary

Species	Stratum	Year	Transects	Psi	SE	% CV
						48
						97
						47
						52
						68
						97

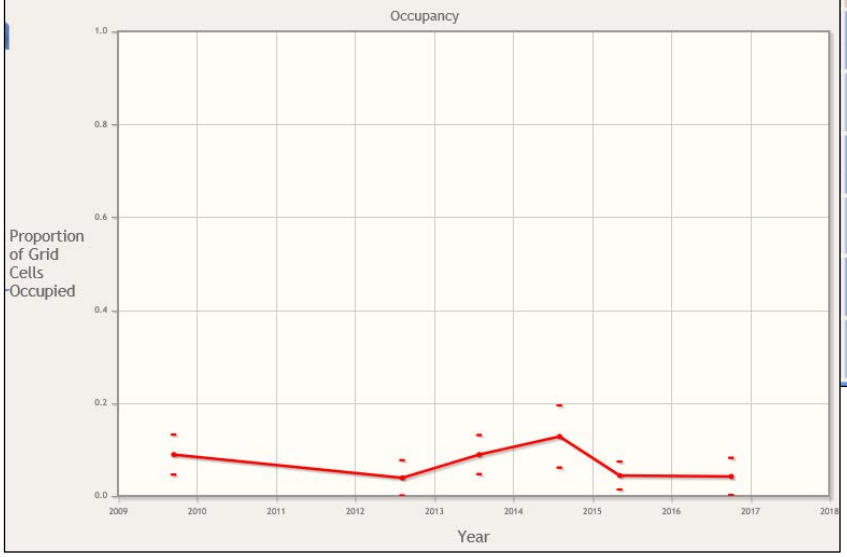


Figure 11. Occupancy results for Ruby-crowned Kinglet on the Kaibab NF by year.

Click the following link and "Run Query" to further explore the data for Ruby-crowned-kinglet.

Focal Species Summary

Survey data are inconclusive regarding occupancy across the ponderosa pine forest PNVT by Grace's warbler and Western bluebird and for the frequent fire dry mixed conifer PNVT for Ruby crowned kinglet. Survey data from 2010-2017 show periodic fluctuations in trend. This could be a result of inconsistent survey budget and effort. Although he BCR design does allow for budget fluctuations, smaller sample size generally correspond to higher CVs and dips in trend over time, making it difficult to assess what role management actions may or may not play.

This is the 7th year the forest has been using the IMBCR design to collect occupancy data for songbirds. It may take another 2-3 years before the forest can make more conclusive statements relating survey results to management actions (or inactions). Completion of more surveys, and or increased sample size, should help these data mature. At present, however, the Kaibab NF is currently

unable to make inference regarding maintenance of the ecological condition of the ponderosa pine forest and mixed conifer PNVTs. Future comparisons to regional trends could be made after the region develops its broad scale monitoring strategy, however, those comparisons are not yet possible.

Adaptive Management Considerations

The forest plan monitoring program is meant to "enable the responsible official to determine if a change in plan components or other plan content that guide management of resources on the plan area may be needed" (36 CFR 219.12).

No changes are recommended to plan components or management activities at this time, however, the forest may consider changes to the monitoring plan, through modification of the associated monitoring plan questions and strategies and or a re-evaluation of Ruby crowned kinglet as a focal species. Further, no alerts or thresholds are currently identified for the three focal species for the Kaibab NF The forest may want to consider adding an adaptive management trigger, or benchmark range for occupancy which could provide a more meaningful evaluation of the data (as opposed to trend). Given the current wording of the monitoring plan questions, it is hard to determine how well the indicators are measuring ecological integrity. Completion of the forest's monitoring guide (in progress) will provide an opportunity to revisit this subject. The forest can work with BCR to address these changes.

Robust occupancy based habitat models were built for all three focal species during the forest plan revision process (DEIS/FEIS). Re-running these models at a predetermined time in the future (e.g. 5-10 years post treatment) could allow the forest to assess if there have been any changes in species occupancy associated with more intensive restoration treatments (e.g. in the Bill Williams Restoration (BWR) and Four Forest Restoration Initiative (4FRI) project areas). In addition, an overlay sample could be applied to target specific treatment areas within the BWR and 4FRI footprint to assess localized response of focal species to management actions. This may provide a more meaningful way to assess ecological integrity, particularly if a comparison can be made to regional trends.

Mexican Spotted Owl Surveys

The Mexican spotted owl is listed as a threatened species under the Endangered Species Act. Monitoring of Mexican spotted owl Protected Activity Centers (PACs) is conducted annually on the Kaibab. These data are reported to the Fish and Wildlife Service and assessed across the species range. On forest, these data are used to inform project-level biological assessments and consultation with the Fish and Wildlife Service about the need to minimize potential effects through timing and intensity restrictions of activities.

70 Are Mexican spotted owls present in PACs?

Mexican spotted owl PACs were monitored using survey methods described in the 2012 U.S. Fish and Wildlife Service Mexican spotted owl survey protocol (USDI 2012). Surveyors imitated the four note call as the primary call but occasionally the bark series or contact calls. All surveys were initiated at sunset. All of the eight designated Mexican spotted owl Protected Activity Centers (PAC) on the Williams Ranger District were monitored during the 2016 field season. Pairs were detected in three PACs, Kendrick, Sitgreaves, and Tule. Females were detected in three PACs. A single male was detected in one PAC. No response was received from the Coleman PAC, but white wash was observed in the area where owls were detected in 2015. Table 20. Mexican Spotted owl PAC monitoring results.

Protected Activity Center	2016	2017
Bear Tank No. 2	Male audio	Male audio
Bill Williams	No response to initial calling. Female alarm call detected using data logger.	Unknown audio response.
Big Spring	Female audio	Unknown audio
Coleman	No response, some white wash observed in area used in 2015	Female audio
Kendrick	Male and female audio response	Male visual, female audio
Pumpkin	Female visual outside PAC	Male audio detection before and after Boundary Fire
Sitgreaves	Male and female audio	Male and female audio
Tule	Male and female audio	Male and female audio

Note: due to steep topography (safety) low staffing, and no planned activities in areas, follow-up visits to obtain visuals and determine nesting status were not always attempted.

In addition to Mexican spotted owls, other owl species were detected during surveys. The 2016 survey and monitoring effort detected 30 flammulated, 7 great-horned, 3 western screech, 3 northern saw-whet, and 3 northern pygmy owls. The 2017 survey effort resulted in the detection of 19 flammulated owls, 15 great horned owls, four saw-whet owls, two pygmy-owls, two western screech-owls, and one Long-eared owl.

Broader scale monitoring

Although the Southwest Region does not yet have its formal broad scale monitoring strategy in place, the region partners with BCR to monitor MSO across regions two and three. This ongoing partnership could inform a broader scale monitoring strategy when it is developed. Like the focal species monitoring described above, occupancy surveys track changes in the number of sites occupied by owls over time. Final survey results for 2017 are not yet available. For the most current report results for MSO site occupancy in the Southwestern Region see Lanier and Blakesly 2016. The data from that effort indicate that while site occupancy by Mexican Spotted Owls increased from 2014 to 2015, it remained essentially unchanged from 2015 to 2016. More years of data are needed to determine if this ostensibly positive trend is indicative of continued and true population growth or simply random variation in demographic processes due to stochastic factors such as weather. Favorable weather has been shown to influence adult survival as well as reproductive output of Mexican Spotted Owls (Seamans et al. 2002).

Adaptive Management Considerations

Additional years of data collection provide the opportunity for BCR to expand current analyses to answer pertinent questions about what factors drive MSO occupancy dynamics which can in turn inform forest service management. In addition, findings from work conducted under these broader scales strategies can help to inform forest level monitoring. For example, recent work by BCR in 2017 (Figure 11) to pilot the efficacy of using acoustical recorders for MSO monitoring could be used to

also gain survey efficiencies at the forest level. Acoustical recorders are widely used to monitor other taxa such as bats and frogs. There may also be the potential to compare regional trends with forest level patterns (e.g. lack of fledglings observed during both regional and forest level surveys) and other environmental phenomena (e.g. drought). These efforts will help us to better understand MSO occupancy dynamics and influences, which will inform adjustments in management and monitoring needs.

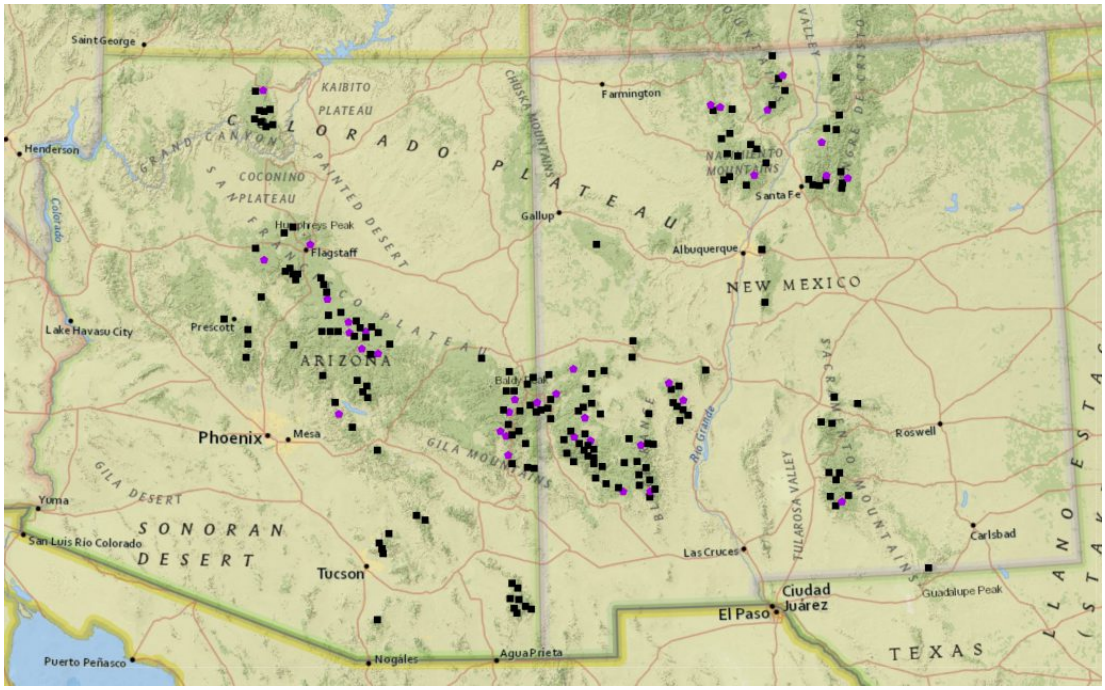


Figure 12. The distribution of 200 sampling units for the Mexican Spotted Owl occupancy monitoring project in Arizona and New Mexico. The spatially balanced, random sample of sites to be included in the acoustic monitoring program are marked by purple pentagons. Symbols are not to scale (BCR 2017)

Fickeisen Plains Cactus Monitoring

Monitoring is conducted on this tiny endangered cactus to determine its distribution, status, and trend. It grows soil in scattered populations stretching along the canyon rims of the Little Colorado and Colorado Rivers mostly on gravel-based substrata. This variety of Peebles pediocactus is known from 11 small different populations. It is threatened by habitat destruction, trampling, grazing and also by illegal plant collection.

71. What is the population trend of *Pediocactus peeblesianus var. fickeisenii*?

Similar to the Paradine plains cactus, a Trimble Total Station was used to record individual plant locations the Fickeisen plains cactus (Pediocactus peeblesianus var. fickeisenii). All plants detected were measured (diameter, number of heads, number of buds/flowers) and recorded with very precise and accurate locations (sub-centimeter). This was the first time these data have been collected with high accuracy and precision. Having precise data about each individual plant location, growth, health, age, and reproduction will allow for better understanding of trends over time.

Conclusions

Plan Monitoring Program

Sound monitoring is fundamental to ensuring actions on the ground are having the intended effects and moving the forest toward a more desired state. This first biennial evaluation report helped illuminate several broad areas ripe for follow up and further inquiry. Collectively these themes support adaptive management of the monitoring program for the forest.

Internal Collaboration and Coordination

- This biennium process highlighted the need for better internal coordination to increase understanding, buy in, and participation by all program areas. Currently, the report burden is largely on the Forest Planner. A more integrated approach would be more efficient and more robust. Adaptive management will be enabled through a cultural change and shift in thinking from outcome to condition based monitoring. Educational outreach by forest planning staff can assist with this shift. Opportunity exists to share this new reporting and evaluation approach through a workshop or presentation focused on monitoring to explain why we care, and how the forest-wide monitoring program can support site specific projects in terms of design, implementation and monitoring. Project-level and forest-level monitoring are not always coordinated or aligned. However, integration and aggregation of data from plan to project and vice-versa provides opportunities for efficiency and illumination. Finalization of the *draft* forest-wide monitoring implementation guide (2015) is another priority task that should also help with this process by providing a clear reference with additional context and intent.

- Multiple data sources and tools are available through the cross deputy Research and Development (R&D) Program. However, forest level staff are frequently unaware of these products and or do not have the capacity or skills sets to fully utilize them. Through this biennial evaluation report process, the Kaibab NF established new relationships with RMRS and the FIA program. The Kaibab NF will continue to work with R&D to take full advantage of emerging tools and data sources that can support forest plan (and broader scale) monitoring. For example, one program that holds promise for further internal integration is the FFI (FEAT/FIREMON integrated) which integrates two commonly used fire effects monitoring systems. The Protocol Manager lets users define their own sampling protocol when custom data entry forms are needed. It supports scalable (project to landscape scale) monitoring at the field and research level, and encourages cooperative, interagency data management and information sharing. See Lutes et al. 2009 for additional information. This tool is complementary too many of the objectives in the forest-wide monitoring program and we will be exploring opportunities on how best to integrate these two efforts and improve efficiency.

Like external agreements, relationships with cross deputy program areas can be fruitful, but take time to build. Investing in theses stablishing and maintaining these relationships should be prioritized.

External Collaboration and Coordination

- The Kaibab NF monitoring program is supported in large part by the work it does with its external partners. Much of this support is formalized through cooperative agreements. Establishing and maintaining these agreements is important and results in win-win outcomes. Follow up opportunity exists to highlight some of the Kaibab NF's most integral partnerships

on the forest's public facing website. Showcase examples of cooperative agreements could inspire additional avenues of collaboration by highlighting the utility of this work both internally and externally. One potential challenge, however, is the rising cost of university overhead, which can be as high as 52%, for indirect costs. This has become an obstacle in recent years, slowing down the process for renewal of the Kaibab NF's master agreement with NAU. This agreement should be revisited soon, and overhead renegotiated to a more feasible amount. The University serves as an impartial conduit or bridge between the forest service and the public. Without this agreement in place, the Kaibab NF will miss key opportunities for collaborative work in and around the Northern Arizona community.

- There are opportunities to revisit the rapid plot protocol and multiparty monitoring aspect of the forest-wide monitoring program through continued collaborative work with the ERI. Upon renewal of the NAU agreement, the ERI can assist with continued implementation and refinement of the field aspect of the rapid plot protocol, particularly in overlay 4FRI treatment/task order areas. In addition the ERI has been providing assistance with data summary and analyses for this effort. Opportunity exists to continue and improve upon the analytical side as well as cross walking information from the original pilot with the current protocol. This is important legacy information that should be documented so that institutional knowledge is not lost. Shared data stewardship has proven to be one of the biggest challenges of the rapid plot pilot program. FS Veg has proven difficult to use in that regard (see Waltz et al. 2018). There may be opportunity for the ERI to assist with database modernization so that information sharing is more supportive of collaborative monitoring and engagement. Also see Fire effects monitoring above under internal collaboration.

- In 2012, as part of the role out for the Kaibab NF's revised land management plan, the ERI facilitated an adaptive management and monitoring workshop to refine the final version of the forest-wide monitoring program. This workshop allowed the forest to hone in those issues that were most concerning to its stakeholders. This resulted in a monitoring program that better reflected the social values of the community. The new monitoring program has been in effect now for four years. Revisiting the outcomes of the 2012 workshop provides an opportunity to: follow up on previously identified issues, adaptively manage the monitoring plan, and be responsive to stakeholder concerns.

- The ERI recently conducted a series of interviews on the Prescott NF to help the forest develop a better understanding of how well forest staff understand their LMP and its associated monitoring program, how well they feel they are currently supporting the monitoring program and what the most critical outstanding needs are to ensure the forest's monitoring program is successful. The ERI could conduct a similar exercise for the Kaibab NF prior to an internal workshop (see above) to assist with monitoring education and outreach.

Overall, these first few years of plan monitoring implementation have illuminated some key lessons: relationships, flexibility, vision and being opportunistic are key to developing a culture of a learning organization. Getting processes in place and engaging in dialogue about risk and uncertainty are needed to prioritize, triage, and invest the resources we have to sustain the forest resources and continue to deliver benefits over time.

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Appendix A – Monitoring Matrix for the Kaibab Forest Plan

This table is the Kaibab monitoring matrix in its entirety. The plan is organized by acquisition type (e.g. ground plots, remotely sensed, existing data sources, interviews, and resource specific). For each question, the indicator, drivers are listed.

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
RAPID PLOT							
01	**Ponderosa Pine and Frequent Fire Mixed Conifer** **Soils and Watersheds** **Threatened, Endangered and Sensitive Species (TES): Mexican spotted owl (MSO), Northern goshawk, Pale Townsend's big-eared bat** **Focal Species[1]: Western bluebird, Graces Warbler**	Are snags, downed logs and large old trees at desired levels at the midscale (100-1,000 acre average)?	Number per acre	**Ponderosa Pine, Frequent Fire Mixed Conifer** **Midscale Desired Condition (DC)s:** Snags 18 inches d.b.h. or greater average 1 to 2 snags per acre. Snags and green snags of variable size and form are common. Downed logs (greater than12 inches diameter at mid-point and greater than 8 feet long) average 3 logs per acre. Coarse woody debris greater than 3 inches in diameter (including downed logs) ranges from 3 to 10 tons per acre (Ponderosa Pine). Coarse woody debris, including downed logs, ranges from 5 to 15 tons per acre (Frequent Fire Mixed Conifer). **Ponderosa Pine, Frequent Fire Mixed Conifer Landscape scale DCs:** Old growth occurs throughout the landscape, generally in small areas as individual old growth components, or as clumps of old growth. Old growth components include old trees, snags, coarse woody debris, and structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). **Soils DC:** Logs and other woody materials are distributed across the surface to maintain soil productivity. **MSO Recovery Plan** **2012 Planning Rule 219.12(a)(5)(ii, iii, iv, vi, vii)**	1-5	2-6	A

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
02	**Ponderosa Pine and Frequent Fire Mixed Conifer** **TES: MSO, Northern goshawk**	Is the coarse woody debris within the desired range?	Tons per acre	**Ponderosa Pine Midscale DC:** Coarse woody debris greater than 3 inches in diameter (including downed logs) ranges from 3 to 10 tons per acre. **Frequent Fire Mixed Conifer Midscale DC:** Coarse woody debris, including downed logs, ranges from 5 to 15 tons per acre. **MSO Recovery Plan** **2012 Planning Rule 219.12(a)(5)(ii, iv, vi, vii)**	1-5	2-6	A
03	**Pondersoa Pine and Frequent Fire Mixed Conifer**	Does height to live crown and crown bulk density put the forest at risk for uncharacteristi c high severity fire at the mid-scale and above?	Height to live crown, crown bulk density	**Ponderosa Pine Midscale DC:** Fires burn primarily on the forest floor and typically do not spread between tree groups as crown fire. **Ponderosa Pine Landscape scale DC:** Forest vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. The risk of uncharacteristic high-severity fire and associated loss of key ecosystem components is low. **Frequent Fire Mixed Conifer Midscale DC:** Fires burn primarily on the forest floor and typically do not spread between tree groups as crown fire. **2012 Planning Rule 219.12(a)(5)(ii, iv, vi, vii)**	1-5	2-6	A
04	**Ponderosa Pine**	Is regeneration occurrring at a rate that will support uneven aged forests over time?	Seedling and sapling count per arcre	**Ponderosa Pine Landscape Scale DC:** The ponderosa pine forest vegetation community is a mosaic of forest conditions composed of structural stages ranging from young to old trees **2012 Planning Rule 219.12(a)(5)(ii, vi, vii)**	1-5	2-6	A

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
05	**Soils and Watersheds**	What is the percent of effective ground cover? What is the proportion of live and dead vegetation, litter, rock, and bare ground?	Percent cover	**Soils DC:** Vegetative ground cover is well distributed across the soil surface to promote nutrient cycling and water infiltration. **Ponderosa Pine, Frequent Fire Mixed Conifer Landscape Scale DC and Mesic Mixed Conifer/Spruce Fir Finescale DC:** Organic ground cover and herbaceous vegetation provide for soil and moisture infiltration, and contribute to plant and animal diversity and to ecosystem function. **2012 Planning Rule 219.12(a)(5)(i, ii, iv, vii)**	1-5	2-6	A
06	**Soils and Watersheds**	Is there evidence of erosion (pedastalling of vegetation or rock, rills, sheet flow, or deposition)?	Presence /absence	**Soil DC:** Soils can readily absorb, store, and transmit water vertically; accept, hold, and release nutrients; and resist erosion. **National Forest Management Act**, 1976 (16 U.S.C. 1604(g)(3)(C)) **2012 Planning Rule 219.12(a)(5)(i, ii, vi, vii, viii)**	1-5	2-6	A/B
07	**Soils and Watersheds**	What is the percentage and pattern of plots that have evidence of soil disturbance from activities that used mechanical equipment?	Percent	**Soil DC:** Soils can readily absorb, store, and transmit water vertically; accept, hold, and release nutrients; and resist erosion. **National Forest Management Act**, 1976 (16 U.S.C. 1604(g)(3)(C)) **2012 Planning Rule 219.12(a)(5)(i, ii, vi, vii, viii)**	1-5	2-6	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
08	**Nonnative Invasive Species**	What is the frequency of area occupied by noxious weeds[2] by species?	Percent cover	**Nonnative Invasive DC:** Invasive species are contained and/or controlled so that they do not disrupt the structure or function of ecosystems or impact native wildlife. **Nonnative Invasive Guideline (GD):** New populations should be detected early, monitored, and treated as soon as possible. **2012 Planning Rule 219.12 (a)(5)(i, ii, vi, vii, viii)**	1-5	2-6	A
REMOTELY SENSED							
09	**Ponderosa Pine and Frequent Fire Mixed Conifer**	How many acres of the Kaibab NF is in an uneven aged open state, at the midscale (above 100 acres)?	Acres	**Ponderosa Pine and Frequent Fire Mixed Conifer Landscape DC:** The ponderosa pine/frequent fire mixed conifer forest vegetation community is a mosaic of forest conditions composed of structural stages ranging from young to old trees. The forest is generally uneven aged and open. **Frequent Fire Mixed Conifer DCs:** The frequent fire mixed conifer forest vegetation community is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. Forest appearance is variable, but generally uneven-aged and open; occasional patches of even-aged structure are present. **Frequent Fire Mixed Conifer and Ponderosa Pine Midscale DC:** Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g. goshawk post-fledging family areas, MSO nesting/roosting habitat, drainages, and steep north-facing slopes). **MSO Recovery Plan** **2012 Planning Rule 219.12 (a)(5)(ii, iii, vi)**	1-5	2-6	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
10	**Ponderosa Pine and Frequent Fire Mixed Conifer**	How many acres are predicted to support active crown fire as modeled under typical peak fire danger conditions at the midscale?	Acres	**Ponderosa Pine and Frequent Fire Mixed Conifer Midscale DC:** Fires burn primarily on the forest floor and typically do not spread between tree groups as crown fire. **Ponderosa Pine Objective (OBJ):** To reduce the potential for active crown fire in ponderosa pine communities: Mechanically thin 11,000 to 19,000 acres annually; Burn an average of 13,000 to 55,000 acres annually using a combination of prescribed fire and naturally ignited wildfires. **Frequent Fire Mixed Conifer OBJs:** Burn an average of 1,000 to 13,000 acres annually using prescribed fire and/or naturally ignited wildfires. Mechanically thin 1,200 to 2,100 acres per year. **2012 Planning Rule 219.12 (a)(5)(ii, vi, vi, vii)**	1-5	2-6	A
11	**Ponderosa Pine and Frequent Fire Mixed Conifer** **Focal Species:** Western bluebird	Is the stand density within a range that will allow for a robust understory?	Acres, SDI[3]	**Finescale DC:** Organic ground cover and herbaceous vegetation provide protection for soil and moisture infiltration, and contribute to plant and animal diversity and to ecosystem function. **2012 Planning Rule 219.12 (a)(5)(ii, iii, vi, vii)**	1-5	2-6	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
12	**Ponderosa Pine, Mixed Conifer, Spruce fir, and Pinyon-juniper Communities.**	How many acres are at high risk for insect outbreaks?	Acres, SDI	**Ponderosa Pine Landscape DC:** The landscape is a functioning ecosystem that contains all components, processes, and conditions associated with endemic levels of disturbances (e.g. fire, dwarf mistletoe, insects, diseases, lightning, drought, and wind). Forest vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. **Frequent Fire Mixed Conifer Landscape DC**: The landscape is a functioning ecosystem that contains all components, processes, and conditions that result from endemic levels of disturbances (e.g., fire, insects, diseases, and wind). **Mesic Mixed Conifer/Spruce Fir Landscape DCs**: The forest landscape is a functioning ecosystem that contains all components, processes, and conditions that result from endemic levels of disturbances (e.g. insects, diseases, wind, snow, and fire), including snags, downed logs, and old trees. The composition, structure, and function of vegetative conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. **Pinyon-juniper Communities DC**: The composition, structure, and function of vegetative conditions are resilient to the frequency, extent, and severity of disturbances (e.g. insects, diseases, and fire) and climate variability.	1-2	2-6	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
13	**Ponderosa Pine and Frequent Fire Mixed Conifer** **Focal Species:** Western bluebird and Grace's warbler **TES:** Northern goshawk	What is the total area within the desired range for basal area and openings?	BA, Open Canopy	**Ponderosa Pine Midscale DCs:** Basal area within forested areas generally ranges from 20 to 80 sq ft/acre, with larger trees (i.e. >18 inches in diameter) contributing the greatest percent of the total basal area. Interspaces with native grass, forb, and shrub vegetation are variably shaped and typically range from 10 to 70 percent, with the more open conditions typically occurring on less productive sites. **Frequent Fire Mixed Conifer Midscale DCs:** Basal area within forested areas generally ranges from 30 to 100 sq ft/acre, with larger trees contributing the greatest percent of the total basal area. Interspaces with native grass, forb, and shrub vegetation typically range from 10 to 50 percent of the area. **2012 Planning Rule 219.12(a)(5)(ii, iii, vi, vii)**	1-5	2-6	A
14	**Aspen**	What is the areal extent and configuration of aspen on the Kaibab NF?	Acres	**Aspen DC:** Aspen occurs in natural patterns of abundance and distribution at levels similar to or greater than those at the time of plan approval. **2012 Planning Rule 219.12(a)(5)(ii, vi, vii)**	1-5	2-6	A
15	**Grasslands**	What percent of the grassland PNVT has <10 percent canopy cover?	Percent cover	**Grassland DC:** Tree and shrub canopy cover are each less than 10 percent. **2012 Planning Rule 219.12(a)(5)(ii, vi, vii)**	1-5	2-6	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
EXISTING SOURCES							
16	**Fire Adapted Ecosystems (Pinyon-junper, Ponderosa Pine, Mixed Conifer Forests, Grasslands, Gambel oak Woodlands, and some Sagebrush Shrublands)**	How many acres were burned with desired and undesired fire behavior and effects?	Acres	**Ponderos Pine and Frequent Fire Mixed Conifer Finescale DC:** Fires generally burn as surface fires, but single tree torching and isolated group torching is not uncommon. **Ponderos Pine and Frequent Fire Mixed Conifer Midscale DC:** Fires primarily burn on the forest floor and typically do not spread between tree groups as crown fire. **Ponderos Pine and Frequent Fire Mixed Conifer Landscape DC:** Fire and other disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris loads, and nutrient cycling. Frequent, low severity fires (Fire Regime I) occur across the entire landscape with a return interval of 0 to 35 years. **2012 Planning Rule 219.12(a)(5)(ii, vi, vii)**	1-2	2-6	A
17	**Fire Adapted Ecosystems**	How many acres were treated with mechanical thinning by PNVT?	Acres	**Ponderosa Pine OBJ:** To reduce the potential for active crown fire in ponderosa pine communities: Mechanically thin 11,000 to 19,000 acres annually. **Frequent Fire Mixed Conifer OBJ:** Mechanically thin 1,200 to 2,100 acres per year. **Grasslands OBJ:** Reduce tree density to less than 10 percent on 5,000 to 10,000 acres of historic grasslands annually. **2012 Planning Rule 219.12(a)(5)(vii)**	1-2	2-6	A
18	**Fire Adapted Ecosystems**	How many acres of conifer species were planted? Was planting successful?	Acres	**Activies Following Large-Scale Disturbance OBJ:** Plant 300 to 700 acres annually **NFMA 16 U.S.C. 1604(g)(3)(C)** **2012 Planning Rule 219.12(a)(5)(vii)**	1-2	2-6	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
19	**Aspen (Tusayan and Williams Ranger Districts)**	What was the total area of aspen fenced?	Acres	**Aspen OBJ:** Fence 200 acres of aspen within 10 years of plan approval. **2012 Planning Rule 219.12 (a)(5)(vii)**	1-2	2-6	A
20	**Aspen**	How many acres were treated for conifer encroachment?	Acres	**Aspen OBJ:** Reduce conifer encroachment on 800 acres of aspen within 10 years of plan approval. **2012 Planning Rule 219.12 (a)(5)(vii)**	1-2	2-6	A
21	**Grasslands**	What is the relative composition and cover of grasslands?	Frequency	**Grassland DCs:** Vegetation is dominated by herbaceous plants composed of a mix of native grasses and forbs. The structure, composition, and distribution of vegetation are within the range of natural variability and occur in natural patterns of abundance and diversity, which may vary depending on soil type and microclimate. Organic litter varies between 30 and 50 percent of the ground cover. Vegetation composition will average 40 to 60 percent grass, and 10 to 30 percent forbs. Understory vegetation reflects the site potential. **2012 Planning Rule 219.12 (a)(5)(ii, iv, vi, vii)**	1-2	2-6	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
22	**Grasslands**	How many miles of fence were modified for pronghorn?	Miles	**Grasslands OBJ:** Modify fences and/or install crossings to facilitate pronghorn movement on 50 miles of fence within 10 years of plan approval. **2012 Planning Rule 219.12 (a)(5)(vii)**	1-2	2-6	A
23	**Ponderosa Pine, Frequent fire Mixed Conifer, Mesic Mixed Conifer/ Spruce-fir, and Pinyon-juniper**	What is the acreage of outbreaks of insects and disease? Does this follow regional patterns?	Acres	**Ponderosa Pine Landscape DC**: The landscape is a functioning ecosystem that contains all components, processes, and conditions associated with endemic levels of disturbances (e.g. fire, dwarf mistletoe, insects, diseases, lightning, drought, and wind). Forest vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. **Pinyon-juniper Communities DC**: The composition, structure, and function of vegetative conditions are resilient to the frequency, extent, and severity of disturbances (e.g. insects, diseases, and fire) and climate variability. **2012 Plannning Rule 219.12 (a)(5)(ii, vi, vii)**	1-2	2-6	A

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
24	**Ponderosa Pine**, **Frequent Fire Mixed Conifer ,Mesic Mixed Conifer/** **Spruce Fir**, **Pinyon-juniper Communities** **Grassland Communities** **Non-native Invasive Species**	What is the trend in Normalized Difference Vegetation Index (NDVI[4])? How does this compare to regional trends	NDVI trend	**Ponderosa Pine Landscape DC:** Forest vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. **Mesic Mixed Conifer/Spruce Fir Landscape DCs**: The forest landscape is a functioning ecosystem that contains all components, processes, and conditions that result from endemic levels of disturbances (e.g. insects, diseases, wind, snow, and fire), including snags, downed logs, and old trees. The composition, structure, and function of vegetative conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. **Pinyon-juniper Communities DC**: The composition, structure, and function of vegetative conditions are resilient to the frequency, extent, and severity of disturbances (e.g. insects, diseases, and fire) and climate variability. **All Grassland Communities DCs**: Vegetation is dominated by herbaceous plants composed of a mix of native grasses and forbs. The structure, composition, and distribution of vegetation are within the range of natural variability and occur in natural patterns of abundance and diversity, which vary depending on soil type and microclimate. **Non-native Invasive species DC**: Invasive species are contained and/or controlled so that they do not disrupt the structure or function of ecosystems or impact native wildlife. **2012 Planing Rule 219.12 (a)(5)(vi, vii)**	1-5	4-10	A
25	**Nonnative Invasive Species**	What is the areal extent of priority nonnative invasive plants on the Kaibab NF?	Acres	**Nonnative Invasive Species GD:** New populations should be detected early, monitored, and treated as soon as possible. **2012 Planning Rule 219.12 (a)(5)(i, ii, iii, vi, vii, viii)**	1-2	2-6	A

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
26	**Nonnative Invasive Species**	How many acres of invasive plants were treated?	Acres	**Nonnative Invasive Species OBJ:** Treat 2,000 to 3,000 acres invaded by nonative plants annually. **2012 Planning Rule 219.12 (a)(5)(i, ii, vii, viii)**	1-2	2-6	A
27	**Natural Waters**	How many springs were protected and restored?	Count	**Natural Waters OBJ:** Protect and/or restore at least 10 individual springs within 5 years of plan approval. **2012 Planning Rule 219.12 (a)(5)(i, ii, vii)**	1-2	2-6	A
28	**Wetlands/ Cienegas**	How many acres of wetlands were restored?	Acres	**Wetlands/Cienegas OBJ:** Restore native vegetation and natural water flow patterns on at least 6 acres of wetlands within 5 years of plan approval. **2012 Planning Rule 219.12 (a)(5)(i, ii, viii)**	1-2	2-6	A
29	**Soils and Watersheds**	Are there any water bodies not meeting Arizona water quality standards? Are there existing TMDLs[5] or are there any in prep? What aspect of the TMDL has been implemented?	Count	**Watershed DC:** Water quality meets or exceeds State of Arizona or Environmental Protection Agency water quality standards for designated uses. Water quality meets critical needs of aquatic species. **2012 Planning Rule 219.12 (a)(5)(i, ii, v, vii)**	2- 6	2-6	A
30	**Soils and Watersheds**	How many 6th code watersheds were moved to an improved condition this year?	Count	**Watersheds DC:** Water quality meets or surpasses State of Arizona or Environmental Protection Agency water quality standards for designated uses. **2012 Planning Rule 219.12 (a)(5)(i,ii,vii)**	1-2	2-6	A

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
31	**Soils and Watersheds**	Did any project or site require corrective action in the Best Management Practices (BMP) monitoring database?	Yes or no	**Watersheds DC:** Water quality meets or surpasses State of Arizona or Environmental Protection Agency water quality standards for designated uses. **Soils and Watershed Management Gds:** Projects should incorporate the national best management practices for water quality management and include design features to protect and improve watershed condition. **2012 Planning Rule 219.12 (a)(5)(i, ii,vii)**	1-2	2-6	B
32	**Soils and Watersheds**	Was adaptive management recommended for any BMP monitoring item and what were the monitoring results?	Yes or no	**Soils and Watershed Management GDs:** Projects should incorporate the national best management practices for water quality management and include design features to protect and improve watershed condition. **2012 Planning Rule 219.12 (a)(5)(i, ii,vii)**	1-2	2-6	B
33	**Soils and Watersheds**	Were at least half the composite ratings for BMP effectiveness "excellent"?	Yes or no	**Watersheds DC:** Water quality meets or surpasses State of Arizona or Environmental Protection Agency water quality standards for designated uses. **Soils and Watershed Management GDs:** Projects should incorporate the national best management practices for water quality management and include design features to protect and improve watershed condition. **2012 Planning Rule 219.12 (a)(5)(i, ii,vii)**	1-2	2-6	B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
34	**Air Quality**	How many days did fine particle concentrations exceed 10 µgm/ m^3?	Count	**Air Quality DC:** Air quality meets or surpasses all state and federal ambient air quality standards. Management activities on the Kaibab NF do not adversely impact Class I airshed visibility as established in the Clean Air Act. **Air Quality DC**: Project design for prescribed fires and strategies for managing wildfires should incorporate as many emission reduction techniques as feasible, subject to economic, technical, safety criteria, and land management objectives. **2012 Planning Rule 219.12 (a)(5)(i, v,vii)**	1-2	2-6	A
35	**Air Quality**	What is the 10-year trend of particle concentrations?	Trend	**Air Quality DC:** Air quality meets or surpasses all state and federal ambient air quality standards. Management activities on the Kaibab NF do not adversely impact Class I airshed visibility as established in the Clean Air Act. **Air Quality DC**: Project design for prescribed fires and strategies for managing wildfires should incorporate as many emission reduction techniques as feasible, subject to economic, technical, safety criteria, and land management objectives. **2012 Planning Rule 219.12 (a)(5)(i, v,vii)**	1-2	2-6	B
36	**Recreation and Scenery**	What are the trends in visitor use?	Trend	**Recreation DCs:** A wide spectrum of high-quality recreation settings exists. Users have access to a variety of developed and dispersed opportunities. The Kaibab NF provides sustainable recreation consistent with public demand. Use levels are compatible with other resource values. User conflicts are infrequent. **2012 Planning Rule 219.12 (a)(5)(v,vii)**	5	10	B
37	**Recreation and Scenery**	What is the overall satisfaction rating for National Forest visits on the Kaibab?	NVUM[6] Rating	**Recreation DCs:** A wide spectrum of high-quality recreation settings exists. Users have access to a variety of developed and dispersed opportunities. The Kaibab NF provides sustainable recreation consistent with public demand. Use levels are compatible with other resource values. User conflicts are infrequent. **2012 Planning Rule 219.12 (a)(5)(v,vii)**	5	10	B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
38	**Recreation and Scenery, Wilderness Areas**	What was the percent of good and very good rating for visitor safety at Developed Sites, Undeveloped Sites (GFAs) and Designated Wilderness?	NVUM Rating	**Recreation DCs:** A wide spectrum of high-quality recreation settings exists. Users have access to a variety of developed and dispersed opportunities. The Kaibab NF provides sustainable recreation consistent with public demand. Use levels are compatible with other resource values. User conflicts are infrequent. **Recreation (front country) DC**: Service centers such as district offices, visitor information centers, developed campgrounds, and other staffed recreation sites provide information and services in communities and along primary forest access corridors and scenic byways. Front-country areas are safe, orderly, and capable of supporting moderate to high visitor use. **Recreation (Back country) DC:** Main access corridors to NFS lands and contact points such as developed trailheads and observation points have information available and provide a transition and orientation place for forest users as they enter back-country areas. Visitors can find information on recreation opportunities in the area. **Wilderness Area DCs:** Wilderness boundary postings are well maintained. Maps, information, and educational material are provided at wilderness access points. **Wilderness Areas OBJs:** Inspect and maintain at least 10 percent of wilderness trails and signs annually. Monitor 10 percent of wilderness campsites each year. **2012 Planning Rule 219.12 (a)(5)(v,vii)**	5	10	B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
39	**Recreation and Scenery, Wilderness Areas**	What are the areas identified as "concentrate here" in the NVUM?	NVUM, count	**Recreation DCs:** The Kaibab NF provides sustainable recreation consistent with public demand. Use levels are compatible with other resource values. User conflicts are infrequent. **Activities Affecting Rcereation and Scenery GD:** Group uses should be concentrated in front-country areas. **Wilderness Areas OBJs:** Inspect and maintain at least 10 percent of wilderness trails and signs annually. Monitor 10 percent of wilderness campsites each year. **2012 Planning Rule 219.12 (a)(5)(v,vii)**	5	10	B
40	**Recreation**	How many acres of the Kaibab NF had a change in ROS or SMS classification and what were the classification changes?	Acres	**Recreation DCs:** A wide spectrum of high-quality recreation settings exists. Users have access to a variety of developed and dispersed opportunities. The Kaibab NF provides sustainable recreation consistent with public demand. Use levels are compatible with other resource values. User conflicts are infrequent. **2012 Planning Rule 219.12 (a)(5)(v,vii)**	1-2	2-6	B
41	**Recreation**	How many miles of trails were maintained to standard?	Miles	**Recreation DCs:** Recreation use levels are compatible with other resource values. **Bugbane Botanical Area OBJ**: Annually inspect the recreation trails and maintain to manage hiking use. **Bugbane Botanical Area GD:** Trail maintenance and any other potentially disturbing activities in the botanical area should be evaluated, and protective measures should be implemented to protect the population. **2012 Planning Rule 219.12 (a)(5)(ii, iv,v,vii)**	1-2	2-6	A
42	**Cultural Resources**	How many acres of non-project related cultural resource surveys were conducted?	Acres	**Cultural Resource OBJ:** Non-project related cultural resource survey (Section 110 survey) is conducted in areas with a high likelihood of historic properties on at least 200 acres per year. **2012 Planning Rule 219.12 (a)(5)(vii)**	1-2	2–6	A

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
43	**Forestry and Forest Products**	How many acres of suitable timberlands were managed (TSI, harvest, etc.) for timber production?	Acres	**National Forest Management Act (1976)** **2012 Planning Rule 219.12 (a)(5)(vii)**	1-2	2-6	A
44	**Forestry and Forest Products**	Have much wood was offered?	CCF[7]	**Forestry and Forest Products DCs:** Wood products (e.g., wood pellets for home and industrial heating, oriented strand board, animal bedding, wood moulding, pallets, structural lumber, firewood, posts, poles, biomass for electricity.) are available to businesses and individuals in a manner that is consistent with other desired conditions on a sustainable basis within the capacity of the land. A sustainable supply of wood is available to support a wood harvesting and utilization industry of a size and diversity that can effectively and efficiently restore and maintain the desired conditions for ponderosa pine and frequent fire mixed conifer communities. **2012 Planning Rule 219.12 (a)(5)(vii)** **FSH 1909.12 (32.13) (f) plan contributions to communities, social and economic sustainability of communities, multiple use management in the plan area, or progress toward meeting the desired conditions and objectives related to social and economic sustainability.**	1-2	2-6	A

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
45	**Forestry and Forest Products**	How many direct jobs does the Kaibab NF support/provid e from harvesting and utilization of wood products?	Number of jobs	**Forestry and Forest Products DC:** A sustainable supply of wood is available to support a wood harvesting and utilization industry of a size and diversity that can effectively and efficiently restore and maintain the desired conditions for ponderosa pine and frequent fire mixed conifer communities. **2012 Planning Rule 219.12 (a)(5)(vii)**	2- 4	2-6	A
46	**Forestry and Forest Products**	Have there been significant investments in the wood har-vesting and utilization infrastructure in the operating area?	Produc-tion capacity	**Forestry and Forest Products DC:** A sustainable supply of wood is available to support a wood harvesting and utilization industry of a size and diversity that can effectively and efficiently restore and maintain the desired conditions for ponderosa pine and frequent fire mixed conifer com munities. **2012 Planning Rule 219.12 (a)(5)(vii)**	2- 4	2–6	B
47	**Forestry and Forest Products**	What was the average cost per acre to the Forest Service for mechanical treatments?	Dollars per acre	**National Forest Management Act (1976)** **2012 Planning Rule 219.12 (a)(5)(vii)**	2-4	2-6	A
48	**Forestry and Forest Products**	What is the ratio of costs to revenues for mechanical thinning activities?	Cost: revenue	**National Forest Management Act (1976)** **2012 Planning Rule 219.12 (a)(5)(vii)**	2-4	2-6	A
INTERVIEWS							

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
49	**Ponderosa Pine, Mixed Conifer, Spruce-fir, and Pinyon-juniper Communities**	Were there any incidences of insect outbreaks in recently treated areas? If so, where?	Presence /absence, location	**National Forest Management Act (1976)** **2012 Planning Rule 219.12 (a)(5)(ii,vi,vii)**	1-2	2-6	A
50	**Ponderosa Pine, Mixed Conifer, Spruce-fir, and Pinyon-juniper Communi-ties.**	What was the median and maximum size openings created through implementation of precribed mechanical treatments?	Acres	**Ponderosa Pine and Frequent Fire Mixed Conifer Finescale DC:** Regeneration openings occur as a mosaic and are similar in size to nearby groups. **Pinyon-juniper Communtities DCs:** Pinyon-juniper communities occur as a shifting mosaic interspersed with openings across the landscape. At the mid-scale and above, canopy cover is at least 10 percent with a mix of young and mature groups and clumps of trees. **Pinyon-juniper (persistant) woodlands DC**: is characterized by even-aged patches of pinyons and junipers that at the landscape level form uneven-aged woodlands. **2012 Planning Rule 219.12(a)(5)(iv, vii)**	1-2	2-~~5~~ 6	A
51	**Pinyon-Juniper Woodlands**	Was a robust crop of pinyon nuts produced on any of the districts?	Presence /absence, location	**Pinyon-Juniper DC:** A robust crop of pinyon pine nuts is regularly produced. **2012 Planning Rule 219.12 (a)(5)(ii, vi, vii)**	1-2	2-6	B
52	**Recreation**	Did we receive any comments that reflect visitor satisisfaction? Were there common themes?	Yes or no, themes.	**Recreation DCs:** User conflicts are infrequent. Service centers such as district offices, visitor information centers, developed campgrounds, and other staffed recreation sites provide information and services in communities and along primary forest access corridors and scenic byways. Front-country areas are safe, orderly, and capable of supporting moderate to high visitor use. **2012 Planning Rule 219.12 (a)(5)(v, vii)**	1-2	2-6	B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
53	**Wilderness**	Were the wilderness trails and campsites monitored? What were the results?	Yes or no; findings	**Wilderness OBJs:** Inspect and maintain at least 10 percent of wilderness trails and signs annually. Monitor 10 percent of wilderness campsites each year. **2012 Planning Rule 219.12 (a)(5)(v, vii)**	1-2	2-6	B
54	**Recreation and Transpor-tation**	Are there areas of the Kaibab NF where recreation or vehicle use is causing detrimental resource effects that are in need of management? Where is it occurring?	Presence /absence, location	**Recreation DCs:** A wide spectrum of high-quality recreation settings exists. Users have access to a variety of developed and dispersed opportunities. The Kaibab NF provides sustainable recreation consistent with public demand. Use levels are compatible with other resource values. **Transportation DCs:** Roads and culverts do not contribute to headcuts or downcuts in ephemeral drainages. Roads allow for safe and healthy wildlife movement in areas of human development. Vehicular collisions with animals are rare. **Transportation and Forest Access DC:** Resource impacts from roads and trails are balanced with the benefits of having the road or trail available for use. **2012 Planning Rule 219.12 (a)(5)(ii, iv, v, vii, viii)**	2-4	2-6	A/B
55	**Cultural Resources**	Are cultural resources being protected in place?	Yes or no	**Cultural Resource DC**: Cultural resources, including known traditional cultural properties, are preserved, protected, or restored. **2012 Planning Rule 219.12 (a)(5)(vii)**	1-2	2-6	B
56	**Livestock Grazing**	Are livestock numbers balanced with forage capacity on each allotment?	Yes or no	**Livestock Grazing DCs:** Grasses and forbs provide adequate forage for permitted livestock. Livestock use is consistent with other desired conditions. **2012 Planning Rule 219.12 (a)(5)(ii, iv,vii)**	1-2	2-6	B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
57	**Tribal Traditional and Cultural Uses**	Are plant species of known medicinal and cultural value being depleted?	Yes or no	**Tribal Traditional and Cultural Use DCs:** Traditional tribal uses such as the collection of medicinal plants and wild plant foods are valued as important uses. Traditionally used resources are not depleted and are available for future generations. **2012 Planning Rule 219.12 (a)(5)(vii)**	1-2	2-6	B
58	**Arizona Bugbane Botanical Area, TES Species**	Were the monitoring requirements met as identified in the AZ Bugbane conservation agreement?	Yes or no	**Bugbane Botanical Area DCs:** Arizona bugbane has a sustainable population and is at low risk for extirpation. **Other**: Arizona Bugbane Conservation Agreement **2012 Planning Rule 219.12 (a)(5)(ii, iv,vii)**	5	2-6	B
59	**Pediocactus Conservation Area**	Were the monitoring requirements met as identified in the *Pediocactus paradinei* conservation agreement?	Yes or no	**Pediocactus Conservation Area DC:** Paradine plains cactus (*Pediocactus paradinei)* has a sustainable population and is at low risk for extirpation. **Other**: Pediocactus Conservation Agreement **2012 Planning Rule 219.12 (a)(5)(ii, iv,vii)**	5	2-6	B
60	**Timber Suitability**	Were there any events or changed circumstances that would indicate a potential change to timber suitability?	Acres of suitable timber lands	**2012 Planning Rule 219.12 (a)(5)(vii)** **National Forest Management Act (1976)**	2-6	2-6	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
INTENSIVE							
61	**Restricted and Endemic Species**	Were design features incorporated to protect restricted and endemic species?	Yes or no	**Restricted and Narrow Endemic Species DCs:** Habitat and refugia are present for narrow endemics or species with restricted distributions and/or declining populations. Locations and conditions of restricted and narrow endemic species are known. **Restricted and Narrow Endemic Species GDs:** Project design should incorporate measures to protect and provide for restricted and narrow endemic species where they are likely to occur. **2012 Planning Rule 219.12 (a)(5)(ii, iv,vii)**	1-3	2-6	A/B
62	**Aspen**	Is aspen regenerating and becoming established in treated areas?	Regener-ation and recruit-ment	**Aspen DCs:** Aspen is successfully regenerating and recruiting into older and larger size classes. Size classes have a natural distribution, with the greatest number of stems in the smallest classes. Aspen occurs in natural patterns of abundance and distribution at levels similar to or greater than those at time of plan approval. **2012 Planning Rule 219.12 (a)(5)(ii,vii)**	3	2-6	A/B
63	**Natural and Constructed Waters**	What is the functional condition of the lakes and wetlands on the Kaibab NF?	PFC[8]	**Natural Waters DC:** Water levels, flow patterns, groundwater recharge rates, and geochemistry are similar to reference conditions. **Constructed Waters DC:** Reservoirs maintain high water quality for parameters such as temperature, pH, and dissolved oxygen, and water levels are within the seasonal range of variable conditions. **2012 Planning Rule 219.12 (a)(5)(i, ii, iv, vi,vii)**	2-10	2-10	A/B
64	**Natural Waters**	In treated or protected areas, are waterflow patterns and vegetation intact?	Yes or no	**Natural Waters DC:** Water levels, flow patterns, groundwater recharge rates, and geochemistry are similar to reference conditions. **2012 Planning Rule 219.12 (a)(5)(i, ii, iv, vi,vii)**	2-10	2-10	B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
65	**Soils and Watersheds**	Is there downcutting or embeddedness in intermittent or ephemeral drainages?	Presence /absence	**Watershed DC:** Vertical down cutting and embeddedness-are absent in drainages. **2012 Planning Rule 219.12 (a)(5)(i, ii,vii,viii)**	1-3	2-6	B
66	**Soils and Watersheds**	What is the trend in soil moisture? How does this compare to regional trends?	Trend	**Soils DCs:** Vegetative ground cover is well distributed across the soil surface to promote nutrient cycling and water infiltration. Soils can readily absorb, store, and transmit water vertically; accept, hold, and release nutrients; and resist erosion. **Ponderosa Pine, Frequent Fire Mixed Conifer Landscape scale DC, Mesic Mixed Conifer/Spruce Fir Finescale DC:** Organic ground cover and herbaceous vegetation provide for soil and moisture infiltration, and contribute to plant and animal diversity and to ecosystem function. **2012 Planning Rule 219.12 (a)(5)(i, ii,vii,viii)**	Annually	2-10	A

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
67	**Wildlife (Focal Species)**	What is the area of forest occupied by area of forest occupied by Grace's warbler, and western bluebird? How does this compare to regional trends?	Occupan-cy	**Priority Need for Change**: Modify stand structure and density towards reference conditions and restore historic fire regimes. **Ponderosa Pine DCs (Landscape-scale):** The ponderosa pine forest vegetation community is a mosaic of forest conditions composed of structural stages ranging from young to old trees. The forest is generally uneven-aged and open. Groups of old trees are mixed with groups of younger trees. Occasional areas of even-aged structure are present. Denser tree conditions exist in some locations such as north-facing slopes, canyons, and drainage bottoms. **Ponderosa Pine DCs (Mid-scale):** Basal area within forested areas generally ranges from 20 to 80 square feet per acre, with larger trees (i.e. >18 inches in diameter) contributing the greatest percent of the total basal area. Interspaces with native grass, forb, and shrub vegetation are variably shaped and typically range from 10 to 70 percent, with the more open conditions typically occurring on less productive sites. **2012 Planning Rule 219.12 (a)(5)(iii)**	1-5	4-10	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
68	**Wildlife (Focal Species)**	What is the area of forest occupied by ruby-crowned kinglet? How does this compare to regional trends?	Occupan-cy	**Priority Need for Change**: Modify stand structure and density towards reference conditions and restore historic fire regimes. **Frequent Fire Mixed Conifer DCs (Fine-scale):** Trees typically occur in irregularly shaped groups and are variably spaced with some tight clumps. Trees within groups are of similar or variable ages, often containing more than one species. Crowns of trees within mid-aged and old groups are interlocking or nearly interlocking. **(Mid-scale):** The frequent fire mixed conifer forest vegetation community is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. Forest appearance is variable, but generally uneven-aged and open; occasional patches of even-aged structure are present. The more biologically productive sites contain more trees per group and more groups per area. Basal area within forested areas generally ranges from 30 to 100 square feet per acre, with larger trees contributing the greatest percent of the total basal area. **2012 Planning Rule 219.12 (a)(5)(iii)**	1-5	5-10	A/B

No.	Resource Area	Monitoring Question	Indicator	Driver (desired conditions (contain select ecological conditions), objectives, policy, etc.)	Measure-ment Interval (years)	Evaluation/ Report Interval (years)	Precision
69	**Wildlife**	For wide ranging species like pronghorn does habitat configuration provide functional connectivity? Does habitat configuration and availability allow wildlife populations to adjust their movements in response to climate related changes (e.g., seasonal migration, foraging, etc.)?	Suitabil-ity Index[9]	**Wildlife DCs:** Interconnected forest and grassland habitats allow for movement of wide ranging species. Habitat configuration and availability allows wildlife populations to adjust their movements (e.g. seasonal migration, foraging, etc.) in response to climate change and promote genetic flow between wildlife populations. **Grasslands OBJ:** Modify fences and/or install crossings to facilitate pronghorn movement on 50 miles of fence within 10 years of plan approval. **Grasslands GDs**: Pronghorn fence crossings should be installed along known movement corridors. **Livestock Grazing DC:** Allotment fencing allows for passage of animals susceptible to movement restrictions such as pronghorn. **Transportation DC**: Roads allow for safe and healthy wildlife movement in areas of human development. **2012 Planning Rule 219.12 (a)(5)(ii, iv, vii)**	5-10	5-10	A/B
70	**TES Species**	Are Mexican spotted owls present in PACs?	Presence/ absence	**Mexican Spotted Owl Recovery Plan** **2012 Planning Rule 219.12 (a)(5)(ii, iv, vii)**	1-5	2-6	B
71	**TES Species**	What is the population trend of *Pediocactus peeblesianus* var. *fickeisenii*?	Trend	**FSM 2670:** Determine distribution, status, and trend of threatened, endangered, proposed, and sensitive species and their habitats on Forest lands. **2012 Planning Rule 219.12 (a)(5)(iv,vii)**	1-5	2-6	A/B

Key: [1] Focal Species are defined by the 2012 Planning Rule as "A small subset of species whose status permits inference to the integrity of the larger system to which it belongs and provides meaningful information regarding the effectiveness of the plan in maintaining or restoring ecological conditions to maintain the diversity of plan and animal communities… commonly selected based on their functional role in ecosystems (36 CFR §219.19, emphasis added).

[2] Noxious weed is a legal term applied to plants or plant parts regulated by Federal and State laws. Arizona Administrative Codes R3-4-244, R3-4-245 (Arizona Department of Agriculture 1999) regulate certain invasive species in the state: "A noxious weed is defined as any species of plant that is detrimental or destructive and difficult to control or eradicate and includes plant organisms found injurious to any domesticated, cultivated, native, or wild plant."

[3] Stand density index (SDI) is a relative measure that converts a stand's current density into a density at a reference size (Reineke 1933).

[4] The normalized difference vegetation index (NDVI) is a simple graphical indicator that can be used to analyze remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation or not. Applications examples: NDVI can be used to estimate the start and end of the growing season, the time of peak production, and seasonal productivity. Comparison of these attributes among years can indicate substantive changes in the extent of vegetation conditions, changes in the duration of the growing season, impacts due to drought, or large-scale natural or human-caused disturbances. In grassland systems, the shape of the NDVI curve can also indicate the relative extent of exotics (e.g., cheatgrass), because their phenology (timing of significant growth stages) tends to differ from that of native vegetation.

[5]A total maximum daily load (TMDL) is a regulatory term in the U.S. Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards

. [6]The National Visitor Use Monitoring (NVUM) program surveys over 100,000 visitors to National Forest System lands every five years, with 20% of the national forests conducting surveys each year. This nationwide visitor use survey provides statistically sound estimates of visitation to each national forest and to each site type. The surveys also provide information about who these visitors are demographically, why they come to the national forests, how satisfied they are with the facilities and services provided, and how much money they spend on their visit.

[7] CCF: Wood volume (hundred cubic feet)

[8] Proper functioning condition: a methodology for assessing the physical function of riparian and wetland areas.

[9] Based on connectivity modeling (Hurteau 2010)

Appendix B – Monitoring Questions Not Evaluated

Table 2. Summary of findings

Monitoring Question	Comments
9.How many acres of the Kaibab NF is in an uneven aged open state, at the midscale (above 100 acres)?	LiDAR flown for most of the forest. Scheduled for assessment next reporting cycle.
10.How many acres are predicted to support active crown fire as modeled under typical peak fire danger conditions at the midscale?	LiDAR flown for most of the forest. Scheduled for assessment next reporting cycle.
11. Is the stand density within a range that will allow for a robust understory?	LiDAR flown for most of the forest. Scheduled for assessment next reporting cycle.
12. How many acres are at high risk for insect outbreaks?	LiDAR flown for most of the forest. Scheduled for assessment next reporting cycle.
13. What is the total area within the desired range for basal area and openings?	LiDAR flown for most of the forest. Scheduled for assessment next reporting cycle.
15.What percent of the grassland PNVT has <10 percent canopy cover?	LiDAR flown for most of the forest. Scheduled for assessment next reporting cycle. Restoration of historic grasslands is ongoing
18. How many acres of conifer species were planted? Was planting successful?	Planting was done 1st and 3rd year survival surveys were conducted. Survival varied by species and site. Averages ranged from 50 to 70 percent
21. What is the relative composition and cover of grasslands?	Data collected on several range allotment, but not assessed this period. Earlier coordination with range staff would have allowed for reporting, but data not in form easily assessed.
24. What is the trend in Normalized Difference Vegetation Index (NDVI[4])? How does this compare to regional trends.	Working with Matt Reeves to address this and other questions.
25. What is the areal extent of priority nonnative invasive plants on the Kaibab NF?	There are data in the database, but observations are mostly opportunistic and do not necessarily represent the extent. This is flagged as needing attention.
33. Were at least half the composite ratings for BMP effectiveness “excellent”?	Data pull showed not all BMP rating were excellent. Additional time was needed to appropriately display and explain the results. This report is not needed to inform management actions at this time.
35. What is the 10-year trend of particle concentrations?	Ten year trend not available. Air monitoring station was moved/replaced a few years ago. Will report 5 year trend next Biennial Report
36 What are the trends in visitor use?	National Visitor Use Monitoring (NVUM) is scheduled for FY20
37. What is the overall satisfaction rating for National Forest visits on the Kaibab?	National Visitor Use Monitoring (NVUM) is scheduled for FY20
38. What was the percent of good and very good rating for visitor safety at Developed	National Visitor Use Monitoring (NVUM) is scheduled for FY20

Monitoring Question	Comments
Sites, Undeveloped Sites (GFAs) and Designated Wilderness?	
39. What are the areas identified as “concentrate here” in the NVUM?	National Visitor Use Monitoring (NVUM) is scheduled for FY20
40. How many acres of the Kaibab NF had a change in ROS or SMS classification and what were the classification changes?	There have not been any changes in classification of ROS or SMS since the plan was revised
41. How many miles of trails were maintained to standard?	Work was done, but data not pulled from DB.
43. How many acres of suitable timberlands were managed (TSI, harvest, etc.) for timber production?	Analysis not conducted for this report
44. Have much wood was offered?	Analysis not conducted for this report
45. How many direct jobs does the Kaibab NF support/provide from harvesting and utilization of wood products?	Economic analysis of 4FRI implementation pending.
46. Have there been significant investments in the wood har-vesting and utilization infrastructure in the operating area?	Economic analysis of 4FRI implementation pending.
47. What was the average cost per acre to the Forest Service for mechanical treatments?	Economic analysis of 4FRI implementation pending.
48. What is the ratio of costs to revenues for mechanical thinning activities?	Economic analysis of 4FRI implementation pending.
49. Were there any incidences of insect outbreaks in recently treated areas? If so, where?	
50. What was the median and maximum size openings created through implementation of precribed mechanical treatments?	Analysis not conducted for this report
511. Was a robust crop of pinyon nuts produced on any of the districts?	Incidental observation say not this period. Typically occurs on about a 10-year cycle.
53. Were the wilderness trails and campsites monitored? What were the results?	Not monitored. Need to revisit partner071096
54. Are there areas of the Kaibab NF where recreation or vehicle use is causing detrimental resource effects that are in need of management? Where is it occurring?	Travel Management implementation monitoring is ongoing. Issues are being addressed as they arise. Will plan to summarize key finding for the next report.
55. Are cultural resources being protected in place?	Yes, but no specifics provided for this report.
56. Are livestock numbers balanced with forage capacity on each allotment?	Yes, but no specifics provided for this report.
58. Were the monitoring requirements met as identified in the AZ Bugbane conservation agreement?	The conservation agreement is currently in the process of being renewed. Monitoring protocols developed and implemented in FY 14 will likely be included in the new agreement. In FY 2015, a survey was conducted outside the

Monitoring Question	Comments
	Level I monitoring area, in a side drainage northwest of the Level I survey transect. A healthy population (500+ plants or groups/clusters of stems) was re-located (known from about in 1982).
61. Were design features incorporated to protect restricted and endemic species?	Not assessed,
62. Is aspen regenerating and becoming established in treated areas?	Not assessed
63. What is the functional condition of the lakes and wetlands on the Kaibab NF?	Wetland assessment completed in 2015. Not due in rotation
64. In treated or protected areas, are waterflow patterns and vegetation intact?	Only one restored spring revisited. Not a full survey. Additional work is needed.
65. Is there downcutting or embeddedness in intermittent or ephemeral drainages?	Only incidental observations. No robust monitoring implemented in FY 16 and FY 17
66. What is the trend in soil moisture? How does this compare to regional trends?	Gypsum blocks were installed at existing snow survey sites. These should yield sites specific moisture data. Looking into evaluating soil moisture from NDVI images.
69.For wide ranging species like pronghorn does habitat configuration provide functional connectivity? Does habitat configuration and availability allow wildlife populations to adjust their movements in response to climate related changes (e.g., seasonal migration, foraging, etc.)?	This model may be rerun using same gap and spur distances, but with higher resolution LiDAR data when it is available (flown, but not yet processed). This assessment could be strengthened with a Fragstats analysis and also data about grassland species composition, which is known to play an important role in pronghorn health, reproduction, and survival (Ockenfels et al. 2002).