Attachment B

Huachuca Firescape Project
Monitoring Plan

Background

The objective of the Huachuca FireScape Project is to integrate the fire and fuel management activities of three Federal agencies across 270,000 acres of Federal lands . Cooperating agencies include the U.S. Department of Agriculture (USDA), Forest Service (Coronado National Forest), the U.S. Department of the Interior (USDI), National Park Service (NPS, Coronado National Memorial), and the Department of Defense (DOD, Fort Huachuca Army Installation). At present, the Forest Service provides most of the wildland fire management resources for all three agencies.

Activities planned within the project area include both prescribed fire and non-fire treatments. Non-fire treatments include a variety of options for thinning dense stands of trees and shrubs, reducing surface and ladder fuels, and creating openings in forest canopy where it exists. Fire treatments consist of prescribed burning and burning piles of hand cut materials. Projects will be implemented incrementally over approximately 10 years. Each proposed activity applies a defined prescription (a plan that describes what and how much vegetation should be manipulated) and a cost-efficient treatment (a method to achieve the prescription).

In *Protecting People and Sustaining Resources in Fire-Adapted Ecosystems – A Cohesive Strategy* (Federal Register 2000), the Forest Service acknowledged that some uncertainty surrounds fire management treatments despite a considerable amount of science supporting an understanding of fire adapted ecosystems, stating "It is essential that monitoring be conducted to validate assumptions, reduce uncertainties, and measure progress." and "The strategy relies on "adaptive management…monitoring, research, and further integration of social sciences."

The Huachuca FireScape Project proposes "ecological restoration" (FSM 2020.5) across broad landscapes rich in biodiversity. Knowledge about the ecosystems is uncertain, as are the outcomes. Clearly, implementation of the project needs to follow an adaptive management strategy.

Adaptive management comprises four steps:

1) objectives are developed to achieve a desired condition;
2) management is designed to meet the objectives, or existing management is continued;
3) the response of the resource is monitored to determine if the objective has been met; and

4) management is adapted (changed) if objectives are not reached (Elzinga et al. 1998).

Based on this, and many other published definitions, monitoring of resources is an essential step in the adaptive management cycle.

In the FireScape planning area, the Huachuca Mountains, Patagonia Mountains, and Whetstone Mountains are "sky islands"– isolated mountain ranges that rise above the desert floor. As a result of their geographic location, sky islands harbor an impressive diversity of ecosystems that provide habitat for myriad plant and animal species.

The Coronado National Forest is the most biologically diverse National Forest in the western United States. Nine major vegetation communities have been mapped on it. It is home to 25 threatened and endangered species and 359 species listed by NatureServe as "imperiled" or "vulnerable to extirpation or extinction" (http://www.natureserve.org/). Of the 361 bird species on the Coronado National Forest, 42 are listed by U.S. Fish and Wildlife Service as Birds of Conservation Concern and 41 are on the Partners-in-Flight Watch List.

The identification of a large suite of species of conservation concern suggests there are many species whose presence and condition may need to be addressed beyond just providing for healthy ecosystems. Some species are likely to benefit from restoration projects, while others may not respond as predicted. A strategic monitoring plan, which identifies appropriate levels of monitoring, coordinated among partner agencies and other groups will provide data essential for adaptive management.

The monitoring objectives and actions listed in this monitoring plan are subject to individual agency funding, staffing, and programmatic priorities and therefore will be implemented within the constraints determined by these variables. The Huachuca FireScape Project is a cooperative endeavor that provides opportunities to share limited resources among its partners, pursue grants, and develop new partnerships with non-governmental organizations and the academic community. These opportunities will be used to leverage agency resources to implement needed monitoring.

Monitoring Policy

National direction specific to USDA and the USDI to monitor ecosystem restoration projects is focused primarily at the region or program level. Each agency has its own project level monitoring policy. Following is a brief summary of national and agency level monitoring policy and directives.

National Monitoring Policy

- *Protecting People and Sustaining Resources in Fire-Adapted Ecosystems--A Cohesive Strategy* (Federal Register Notice Vol. 65, No. 218, pp. 67479-67511)
    - Monitor to evaluate the effectiveness of various treatments to reduce unnaturally intense fires while restoring forest ecosystem health and watershed function.
    - Study, document and monitor examples of various treatments and their effectiveness in restoring ecological processes, protecting communities, and protecting key ecosystem components.
- *The Federal Wildland Fire Management Policy and Program Review* (2001 Federal Fire Policy)
    - Fire management planning, preparedness, prevention, suppression, fire use, restoration and rehabilitation, **monitoring**, research, and education will be conducted on an interagency basis with the involvement of cooperators and partners.*(emphasis added)*
- *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment – 10-year Comprehensive Strategy* (August 2001)
    - Guiding principle for Goal 3 (Restore Fire Adapted Ecosystems): Monitor restoration and rehabilitation projects for effectiveness and share the results in order to facilitate adaptive implementation
- Healthy Forest Restoration Act (2003)
    - Monitoring and assessment shall include a description of the changes in condition class, using the Fire Regime Condition Class Guidebook or successor guidance, specifically comparing end results to: (A) pretreatment conditions; (B) historical fire regimes; and (C)

any applicable watershed or landscape goals or objectives in the resource management plan or other relevant direction.

- The Secretary shall, to the maximum extent practicable, develop a process for monitoring the need for maintenance of treated areas, over time, in order to preserve the forest health benefits achieved.

USDA Forest Service Policy

- Ecological restoration activities should be planned, implemented, monitored, and evaluated in consideration of current and desired conditions and the potential for future changes in environmental conditions, including climate change [Forest Service Manual (FSM) 2020.3].
- Adaptive management, monitoring, and evaluation are essential to ecological restoration (FSM 2020.6).
- The District Ranger has the authority and responsibility to (1) monitor and evaluate wildlife and fish management prescriptions to measure compliance with objectives, determine effects and adjust subsequent management actions when needed (FSM 2604.22); and (2) conduct monitoring and evaluation of management indicators on the District (FSM 2620.45).
- Conduct fire management planning, preparedness, suppression, monitoring, and research, and fire use on an interagency basis and involve affected partners. Integrate with forest planning whenever possible (FSM 5103.3).

USDI National Park Service Policy

Monitoring of wildland fires and non-fire fuels treatments is the primary way of assessing whether the fire program is meeting management goals and objectives for hazardous fuels reduction, ecosystem restoration, and maintenance of ecosystem health. Information gathered during fire monitoring is essential for decision-making, and it provides documentation and an administrative record of fire activities. The information gained through monitoring serves to increase the knowledge of fire effects and fire behavior on park lands. Additionally, monitoring provides a feedback loop for adaptive management that allows fire managers to improve prescriptions and fire plans based on the new knowledge gained from field measurements. For effective adaptive management, monitoring must be based on and designed to assess both short- and long-term objectives. (RM-18, section 4).

DOD Fort Huachuca Policy

The DOD requires military installations to prepare and implement Integrated Natural Resources Management Plans (INRMP) under authority of the Sikes Act Improvement Act (16 U.S.C. 670 et seq.). The *Fort Huachuca Integrated Resource Management Plan* (2001) provides direction to inventory and monitor resources that are "indicators of overall ecosystem integrity, habitat conditions, capability of lands to support military missions, status of sensitive species or communities, and other special interests", and to analyze monitoring data to implement an adaptive management strategy, using landscape level monitoring protocols (p. 91). Fire monitoring includes a goal to "monitor effects of fire and fuels management on Fort Huachuca ecosystems" (p. 107).

FireScape Project Goals and Objectives

Project Goals

Project goals are: 1) to reduce the costs, resource damage, and threats to public and firefighter safety from future wildland fires; 2) to restore and sustain ecological processes in fire-dependent ecosystems; 3) to create and maintain fuel conditions that produce manageable fire behavior and intensity; and 4) to move vegetation and fuel conditions toward their historic condition and ecological

resiliency where feasible, both in the broader landscape and within individual ecological units (USFS 2008).

Project Objectives

Elzinga et al. (1998) defined monitoring as the systematic and repetitive collection of information to evaluate changes in condition and progress toward meeting a management objective. The overall objective for the FireScape Project is to move each Ecological Unit [1] (EU) in the project area toward a "desired vegetative condition" (Huachuca FireScape Project EA, Appendix, part A, Table 20). Specific objectives for some key ecological conditions, such as soil stability, forage production, and wildlife habitat and populations were not established. The implicit assumption is that there is a strong tie between the desired vegetation condition, wildlife habitat quality, and species population levels. Because this assumption has had little testing, and none within the project area, it will need to be validated with monitoring. Agency managers will need to develop specific management objectives to focus monitoring of treatments, evaluation of their success, and subsequent management changes. Well-developed, quality objectives are essential to adaptive management. A good objective meets the criteria of being results oriented, measurable, time limited, specific, and practical (from the *Open Standards for the Practice of Conservation* – www.conservationmeasures.org).

Development of a table of current and desired conditions for each key ecological attribute listed in this monitoring plan will provide the majority of the elements of good quality objectives and the foundation of the monitoring plan. If management objectives stated in the implementation plan differs significantly from what is predicted by the partners, this monitoring plan may need to be revised.

Monitoring Design

Monitoring Objective Setting Process

To effectively monitor the success of proposed fuel treatments, the agency Firescape partners had to devise a way to quantify the management objectives developed by the Huachuca Area Fire Management Plan (HAFP 2005). Although desired vegetative condition statements were defined for each EU (Huachuca FireScape Project EA, Appendix, part A, Table 20), the partners had to describe monitoring indicators–unambiguous and measurable aspects of the desired condition statements. Additionally, it was necessary to develop monitoring indicators for the other desired conditions that are not described in the vegetation descriptions: fire regime, fuels, soils, range, non-vegetative components of wildlife habitat, and wildlife populations.

A process conceived by the Conservation Measures Partnership, a consortium of experts in the field of adaptive management, including representatives from multiple large conservation NGOs, adaptive management consultants, and the IUCN (see www.ConservationMeasures.org), was used. This process is adopted in the Open Standards for the Practice of Conservation, a set of adaptive management standards that are reflected in the work of the participating organizations and that these experts believe are fundamental to effective conservation (Conservation Measures Partnership 2007).

The partners first combined certain EUs with similar characteristics to form eight units for the purposes of monitoring. A set of key ecological attributes was defined for the EUs. Key ecological attributes are critical aspects of the EU that help define and assess its ecological viability and integrity. These attributes, if missing or altered, would lead to continued or further degradation. The "desired vegetative condition" statements identify certain ecological attributes of the vegetation, such

[1] The project area is stratified into fifteen **ecological units** (Appendix; see also EU map in the Environmental Assessment for the project). Ecological mapping units are composites of geology, soils, climate, topography, and vegetation that form a logical basis for fire management. Lang (2005) describes the mapping process.

as plant species composition and canopy cover. Additional attributes, such as fire frequency, soil condition, forage production, and wildlife habitat features (e.g., snags, hiding cover) were added by the partners to more fully evaluate how well the management actions are affecting ecosystem function and other resources of the project area. The list of key ecological attributes was limited to those that are essential to ecosystem function and likely to respond to ecosystem restoration projects.

Because the key ecological attributes are not always concise or measurable, monitoring indicators were then developed; these are measurable parameters that represent the key ecological attributes and are suitable for monitoring. One or more monitoring indicators were defined for each key ecological attribute. While a myriad of indicators can be identified, the number of indicators ultimately selected for monitoring purposes is the minimum required to measure both the effectiveness of management actions, as well as the need to take action where none has yet been proposed. Key ecological attributes and monitoring indicators are described in Table B-1.

A simple, but effective, grading scale can be used to assess the current health and desired condition of selected indicators. In other words, if used periodically throughout the project cycle, this grading scale will tell managers if progress is being made toward achieving management objectives. When assessing the condition of indicators, it is important to recognize how they can vary in time and space. Therefore, historic range of variability is incorporated into the ratings. A description of the ratings is as follows:

- **Very Good** -- The factor is functioning at an ecologically desirable status, and requires little human intervention.
- **Good** -- The factor is functioning within its range of acceptable variation; it may require some human intervention.
- **Fair** -- The factor lies outside of its range of acceptable variation & requires human intervention. If unchecked, the target will be vulnerable to serious degradation.
- **Poor** -- Allowing the factor to remain in this condition for an extended period will make restoration or preventing extirpation practically impossible.

Monitoring Objective

The objective of monitoring is to detect a change (positive or negative) in the status of key ecological attributes (e.g., movement from fair to good condition). Initial indicator ratings will be based on peer reviewed literature and expert knowledge. FireScape partners will convene periodically to review the monitoring results and assess their condition and trend. Monitoring may detect a change in indicator ratings that can be reliably linked to the vegetation treatment. However, it is possible that other factors, such as unusual precipitation patterns or the introduction of disease or non-native species, may have played an equal or greater role in altering the condition of one or more key ecological attributes. Therefore, control sites will be necessary to assess the status of indicators and compare with those at treatment sites.

Role of Single Species Survey and Inventory

These indicators might not include parameters measured in pre-project surveys that are required to meet design criteria for protection of threatened and endangered species, cultural sites, and other sensitive resources. Objectives for pre-project surveys are to confirm presence or absence of the sensitive resource so that impacts can be avoided or minimized. Surveys for threatened and endangered species are typically required for consultations with U.S. Fish and Wildlife Service. These surveys differ from the monitoring plan in that they are expected to be completed prior to the project and will not be repeated over time to evaluate project effectiveness. Exceptions are ongoing long-term

monitoring for the following species: Pima pineapple cactus (annual population monitoring at one site on CNF), Huachuca water umbel (bi-annual monitoring of three populations on Forest), Gila topminnow [annual surveys by Arizona Game and Fish Department (ADFD)] Sonoran tiger salamander (annual surveys of stockponds by AGFD), lesser long-nosed bat roosts (several roosts monitored annually) and agave density (five transects read annually on the Forest).

Monitoring Priorities

The number of indicators reflects the choice of indicators that together would provide a means to evaluate the success of the ecosystem restoration project. This number is undoubtedly greater than the capacity of each agency would support. Therefore, the partners ranked the indicators to highlight critical monitoring needs without losing sight of other, equally important parameters. Monitoring priorities (essential, recommended, and opportunistic) are based on a combination of factors, foremost of which are predicted sensitivity to management actions (as documented in peer-reviewed literature), ecological importance, feasibility and cost to monitor, and agency compliance requirements (e.g., Firescape project mitigation measures, species Recovery Plans, Biological Opinions, Forest Plan requirements). Indicators ranked essential are critical to ecosystem function, are sensitive to change and well-tested or simple to monitor at relatively low cost. Indicators that are recommended are also important to monitor but may be more difficult and expensive to measure. With additional partner agency resources (primarily staff) recommended indicators can, and should, be monitored. Opportunistic indicators are not as well-tested and should be monitored if and when outside funding, external researchers, and/or volunteers become available to assist with monitoring. For any specific site and treatment, circumstances may dictate that lower priority indicators are the most appropriate to employ.

Monitoring Methods

Following is a general explanation of the primary methods to be used for monitoring indicators. Some of these methods are currently in use in the project area, while others have not been tested. Adjustments will likely be needed as these methods are applied and new methods and approaches are developed. Sample design, field methods (protocols), and data management analysis will be determined prior to implementation. They will be compliant with the Natural Resource Information System (NRIS) standards and guidelines.

Fire Seasonality, Frequency, Severity and Risk Monitoring

Indicators for these attributes include treatment time of year (season), percent of EU in desired fire frequency, percent of plan area with very high severity fires per year, percent bare ground and canopy kill, and fuel load arrangement, alignment and values at risk (Table B-1).

Range transects and line intercepts (explained below) are used to measure ground cover and tree canopy kill. Fuel load and fire risk is evaluated from photo guides and field observations documented by fuels and fire experts. Photo points are used to document pre-treatment fuel conditions, including fuel load and arrangement, as well as risk from fire. Burn boundaries (prescribed and wildfire) are monitored with a global positioning system (GPS) and analyzed with a geographic information system (GIS). Fuel load will be evaluated prior to treatment and 5 years following treatment. Taken together, these data are used to help determine the fire regime condition class (FRCC). Fire behavior modeling is used to demonstrate treatment effectiveness in reducing risk.

Vegetation and Habitat Monitoring

Indicators in this group include 1) tree composition, size class distribution, and density; 2) canopy cover; 3) snag, nest cavity and bark roost availability; 4) shrub composition and structure;

Table B-1. Huachuca FireScape monitoring indicators and priorities

No.	Attribute	Indicator	Ecological Unit and Monitoring Priority							
			1	2	3, 14	5 - 8	9	15	10 - 12	13
1	Fire seasonality	Time of year	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**
2	Fire frequency	% of EU in desired frequency	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**
3	Fire severity	3.1 % bare ground over time	**H**	**L**	**L**	**H**	**H**	**H**	**H**	**H**
		3.2 % of planning area with very high severity fires per year	**H**	**L**	**L**	**H**	**H**	**H**	**H**	**H**
		3.3 % canopy kill	**H**	**M**	**M**	**H**	**H**	**H**	**H**	**H**
4	Fire risk to life, property, and ecosystem	Fuel load, arrangement, alignment, values at risk	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**
5	Tree composition and structure; snag and bark availability; Mexican spotted owl "micro-habitat"	5.1. Density of fire adapted species	**M**		**H**	**H**	**H**	**H**	**H**	**M**
		5.2. Density of juniper by size class			**H**	**H**	**H**	**H**	**H**	
		5.3. Density of other species that would increase with lack of fire (particularly in smaller size classes)	**M**		**H**	**H**	**H**	**H**	**H**	**M**
		5.4. Number of trees per size class w/in Protected Activity Center (PAC)				**H**			**H**	**H**
		5.6. Total basal area of trees >5 inches diameter-at-root-collar (w/in PAC)				**H**			**H**	**H**
		5.7. % canopy cover (w/in PAC)				**H**			**H**	**H**
		5.8. Oak canopy cover by size class				**H**	**H**			
		5.9. Number of snags by size class per hectare	**H**			**H**			**H**	**H**
		5.10. Number of trees with suitable nesting cavities	**L**		**L**	**H**	**L**	**L**	**H**	**L**
		5.11. Bark availability	**L**		**L**	**H**	**L**	**L**	**H**	**L**

Table B-1. Huachuca FireScape monitoring indicators and priorities

No.	Attribute	Indicator	Ecological Unit and Monitoring Priority							
			1	2	3, 14	5 - 8	9	15	10 - 12	13
6	Shrub composition and structure; browse	6.1 Shrub density/cover by size class, particularly manzanita and mesquite in smaller size classes		H	H	H	H	H	L	
		6.2 Browse availability, composition, age class		L			M	M		
7	Understory plant species composition; ground cover; MSO "micro-habitat"	7.1. % cover native perennial grasses	H	H	H	H	H	H	L	L
		7.2. Native grass species composition	H	H	H	H	H	H	L	L
		7.3. % cover native/nonnative forbs	H	H	H	H	H	H	L	L
		7.4. Abundance and distribution of special status species	H	H	H	H	H	H	H	H
		7.5. Agave abundance	L	M	M	M	M	L	L	L
		7.6. Number of logs >12 inches (w/in PAC)				H			H	H
		7.7. Large woody debris cover	H			H			H	H
		7.8. Litter cover		H	H	H	H	H	H	
8	Livestock forage production	Pounds per acre (over 3+ years)	L	L	M	H	H	H	L	L
9	Ecological condition	National Resources Conservation Service ecological site guide	H	H	H	H	H	H	O	O
10	Livestock distribution	% of pasture where utilization is >10%	O	O	M	H	H	H	O	O
11	Bark and cavity users	Pick one based on EU, $, frequency, etc								
		11.1. Breeding success of cavity nesters (e.g., clutch size, offspring condition)	O		O	H	O	O	H	O
		11.2. Distribution and habitat use of bark-roosting bat species	O		O	M	O	O	M	O
		11.3. Distribution and habitat use of bark-nesting bird species	O		O	M	O	O	M	O

Table B-1. Huachuca FireScape monitoring indicators and priorities

No.	Attribute	Indicator	Ecological Unit and Monitoring Priority							
			1	2	3, 14	5 - 8	9	15	10 - 12	13
12	Insect abundance or availability	Insect density or biomass				M	M	M	M	
13	Insectivorous species	Pick one based on EU, $, personnel, etc:								
		13.1. Breeding bird abundance	M	O	O	H	H	H	H	M
		13.2. Bat distribution and habitat use	M	O	O	M	O	O	M	M
		13.3. Lizard abundance	O	O	O	M	O	O	M	O
14	Ground dwelling species	Distribution & abundance (pick one)								
		14.1 lizards	M	M	M	M	M	M	M	M
		14.2 snakes	O	O	M	M	M	M	M	O
		14.3 small mammals	O	O	M	M	M	M	M	O
		14.4 breeding bird density	M	O	O	H	H	H	H	M
15	Aquatic habitat	Amount of ash that enters occupied aquatic habitat	H		H	H	H	H	H	H
16	Watershed stability	16.1. Ground cover (rock, litter, plant)	M	M	M	M	M	M	M	M
		16.2. Channel stability	M							M

1 Ecological Units (Cleland et al. 2008): 1 = Low Gradient Riparian; 2 = Chihuahuan Desert Scrub; 3 and 14 = Grasslands; 5 and 8 = Oak Savanna and Open Woodlands; 9 = Grass-Chaparral and Oak Savanna; 15 = Grass-Chaparral and Oak Woodland; 10, 11, and 12 = Oak-Pine Woodland and Mixed Conifer; 13 = High Gradient Riparian

2 Monitoring Priorities'- H= High, M- Medium, L – Low

5) understory plant species composition; 6) ground cover; and 7) forage production for livestock (Table B-1).

A suite of vegetation indicators is measured along the same transects, increasing sampling efficiency and reducing costs. Paced frequency, dry weight rank, and Fetch transects (per 1996 Interagency Technical References: Sampling Vegetation Attributes, and Utilization Studies and Residual Measurements) currently in use by the Forest Service Range Program will be used to measure 1) bare soil, rock, gravel and litter cover, 2) perennial plant basal cover, 3) plant species composition (from dry weight rank), 4) plant species frequency and 5) plant distribution (= Fetch). Fetch can be used to assess soil stability. Ecological site guides are applied to the range transect area. The Sierra Vista Ranger District has established about 200 of these range transects. Additional range transects may be necessary if the number of existing transects in a treatment area is inadequate. Livestock forage production will be determined by clipping and weighing perennial grasses or by ocular estimate.

Line intercept is used to measure tree and shrub density and canopy cover. Browse is measured using the Cole Browse Method. Agave encountered along transects are also recorded.

The availability and suitability of snags and cavities for primary and secondary cavity nesting birds and bat roosts is measured in fixed area plots (see breeding bird monitoring below).

Aquatic habitat is monitored immediately following treatment and 1 year later. Visual survey of aquatic sites and upstream habitat is done to assess the amount of ash that has potential to enter aquatic habitats for T&E species.

Permanent photo points are established and mapped before treatment. Location for photo points typically will be the range transects, line intercepts, and/or wildlife study plots (explained below). Additional photo points may be needed to document fuel load and arrangement. In some situations, photo points are the primary monitoring tool. Comparing pictures of the same site taken over a period of years furnishes visual evidence of vegetation, fuel and soil changes.

Range transects are read 1 year prior to the treatment, 1 to 3 growing seasons after treatment, and every 5 years after treatment. Shrub and tree cover are measured prior to the project and 1, 2, 5, and 10 years after treatment. All other vegetation indicators are measured immediately prior to treatment and 1 year after treatment.

Some indicators are measured only for treatments in protected and restricted forest types, as defined in the Recovery Plan for the Mexican Spotted Owl (e.g., tree basal area, number of trees per size class, percent canopy cover). The Region 3 Mexican Spotted Owl Microhabitat Protocol (USDA Forest Service 1998) applies to silvicultural thinning, management-ignited fire, and other activities directed at modifying forests and woodlands (excluding prescribed natural fire). Indicators are measured in plots (fixed- and variable-radius) at a fixed distance along a transect. Monitoring is required pre-treatment and post-treatment after most of the treatment effects have occurred but no longer than 3 years.

Wildlife Monitoring

Wildlife monitoring is coordinated with existing external monitoring programs, principally AGFD but also with academic institutions and NGOs, for greater efficiency and to ensure best monitoring practices are implemented. Monitoring methods are designed to record species occurrence, distribution and abundance. Habitat use information is collected opportunistically.

Breeding birds are monitored in area-constrained plots (15 hectare) consistent with a coordinated State-wide approach to bird monitoring that is being developed and tested by the Arizona Bird Conservation

Initiative (ABCI). The approach provides opportunities for the input of "citizen science." This is a rapid survey (4-5 hours), followed with a more intensive survey of selected sites for protocol validation. A minimum of one plot is strategically located in treatment areas and recorded prior to treatment and 1-year after treatment. Birds are monitored a minimum of twice per year: once in spring and once in summer rainy season. When funding and/or volunteers are available, birds are monitored a third time, post-monsoon. A subset of the breeding bird monitoring plots is retained for long-term effectiveness monitoring, with plots stratified by EU. Available funding and available work force determines the frequency of long-term monitoring.

In the same bird monitoring plots, nest cavities and trees with loose bark are inspected for occupancy. An optional nest box study can provide additional data to evaluate nesting dates, clutch size and nestling condition. These parameters are highly sensitive to vegetation and prey (insect) conditions.

Bat, small mammal, and lizard monitoring is recommended or opportunistic (i.e., when funding and volunteer labor is available). Bat monitoring is coordinated with the Arizona Bat Conservation Strategic Plan, which calls for Statewide species and habitat monitoring. Species diversity is measured with one or more of the following: mist net, harp trap, and acoustic monitoring, depending on the target species. For these surveys, riparian species (e.g., red bat and yellow bat) are targeted. Monitoring methods for small mammals is species-specific but typically involves live traps (Sherman and pitfall traps). Monitoring for lizards is typically done with a belt transect (Visual Encounter Survey) but other methods (e.g., time-limited search) work equally well for certain species.

Watershed Condition Monitoring

Channel stability is evaluated through measurement of channel width: depth, bank cover and pebble counts. These data are compared with the baseline condition determined at least 1 year prior to treatment. Existing data can be used, with an immediate post-treatment evaluation.

Partner Coordination

One goal of FireScape is to increase efficiency of treatments by coordinating across land management jurisdictions. The EUs are mapped without regard to jurisdiction. Monitoring will be coordinated across EUs to maximize agency resources and prevent over-sampling, under-sampling, or poor sampling design.

Based on monitoring results or information needs identified during monitoring or project planning, FireScape partners might recommend research studies and seek partnerships and funding to facilitate their implementation