FIRE ECOLOGY and MONITORING

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I. Introduction

This chapter provides policy direction for monitoring of wildland fires, fire effects, and fuels treatments. In addition, this chapter provides direction and guidance relating to adaptive management and general programmatic requirements for the Fire Ecology Program.

The National Park Service's (NPS) Fire Management Program has grown in scope and complexity over the past decade. Changes in federal policy, new political initiatives, and increased planning requirements, have all resulted in a greater need for scientific information that supports fire management activities. In recognition of this need, the NPS made the commitment to fund (within the existing budgetary allocation) national, regional, and field-level fire ecologists and fire effects monitors to provide scientific capabilities for collecting, analyzing, and interpreting fire effects monitoring data and using fire ecology information and monitoring results for adaptive management.

The goals and objectives for wildland fire (wildfire, prescribed fire and wildland fire use) and non-fire fuels treatments can vary widely from park to park as well as from project to project within a park. Monitoring provides management an avenue through which to evaluate whether management goals and objectives are being met and whether undesired effects are occurring. When goals and objectives are not being met, monitoring data can be used to facilitate management changes. This practice is part of the adaptive management cycle that the NPS fire management program uses to improve land management practices.

The National Fire Plan recognizes the need for monitoring as part of adaptive management by including it as one of the guiding principles for restoring fire adapted ecosystems in the 10-Year Comprehensive Strategy. This guiding principle states, "Monitor restoration and rehabilitation projects for effectiveness and share the results in order to facilitate adaptive implementation". *The primary intent of the NPS Fire Ecology Program is to support fuels and fire management by using monitoring data, in conjunction with professional knowledge and judgment, to provide scientific guidance and feedback that supports adaptive management and the assessment of treatment effectiveness.* The information contained within this chapter will evolve as changes in national direction are defined and as new scientific information becomes available.

II. Authorities

The wildland and prescribed fire monitoring program outlined in this chapter is authorized under Director's Order #18 Wildland Fire Management, Section 5.2 Fire Management Plans and Section 5.8 Prescribed Fire Monitoring. One of the fire management goals stated in Reference Manual-18 (RM-18), Chapter 1 is "Continue to evaluate the wildland fire program operations and accomplishments to better meet program goals by refining treatment and monitoring methods, and by integrating applicable technical and scientific advances". Additional support and tasks for monitoring is found in the Wildland Fire Management Strategic Plan sections 1ac,

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1b2, 1b2a-c, and in the National Park Service Fire Ecology Program Strategic Plan: 2004-2008 (http://www.nps.gov/fire/ecology/program_direction/strategic_plan.htm).


III. Monitoring For Adaptive Management

A. Adaptive Management

Adaptive Management is a system of management practices based on clearly identified objectives and monitoring to determine if management actions are meeting these objectives. In cases where objectives are not being met, adaptive management is intended to facilitate management changes that will ensure that desired outcomes are met or to facilitate re-evaluation of the desired outcomes (40 CFR, 516 DM 4.16). Adaptive management is an iterative process, requiring continual evaluation of the results to determine if the ongoing treatments are appropriate, or if they need modification. Monitoring data provides the basis for adaptive management by allowing managers to determine whether or not management objectives are being met, or if undesired effects are occurring.

The adaptive management model *(Figure 1)* illustrates the process of decision making for management actions. Quantitative and measurable management objectives are developed in Resource Management Plans (RMPs) and Fire Management Plans (FMPs), based on Desired Conditions described in the General Management Plan (GMPs), and proposed treatments with specific prescriptions. From the objectives a monitoring design is developed that includes defined monitoring units (what is being monitored and where) monitoring protocols (how and when monitoring is conducted), and monitoring objectives (why). Plots, or the appropriate monitoring technique, are established prior to the proposed treatment and read following the treatment. Analysis of monitoring data provides the means to assess whether management objectives of the treatments are being met. Depending on the monitoring design, statistically significant results may not be available until a number of treatments are conducted across the park. Park resource management staff and fire management staff should meet periodically to assess the progress towards meeting these objectives. If management objectives are being met, then treatments may continue as appropriate to achieve Desired Conditions. If management objectives are not being met, the following questions should be addressed:

- Are the objectives realistic?

- Should there be changes made to the prescribed fire or treatment prescriptions?

- Are there other management actions that should be taken in conjunction with the prescribed fire or treatment?

- Could other management actions be more effective than the use of prescribed fire?

- Is additional research needed?

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Figure 1: Adaptive Management Model
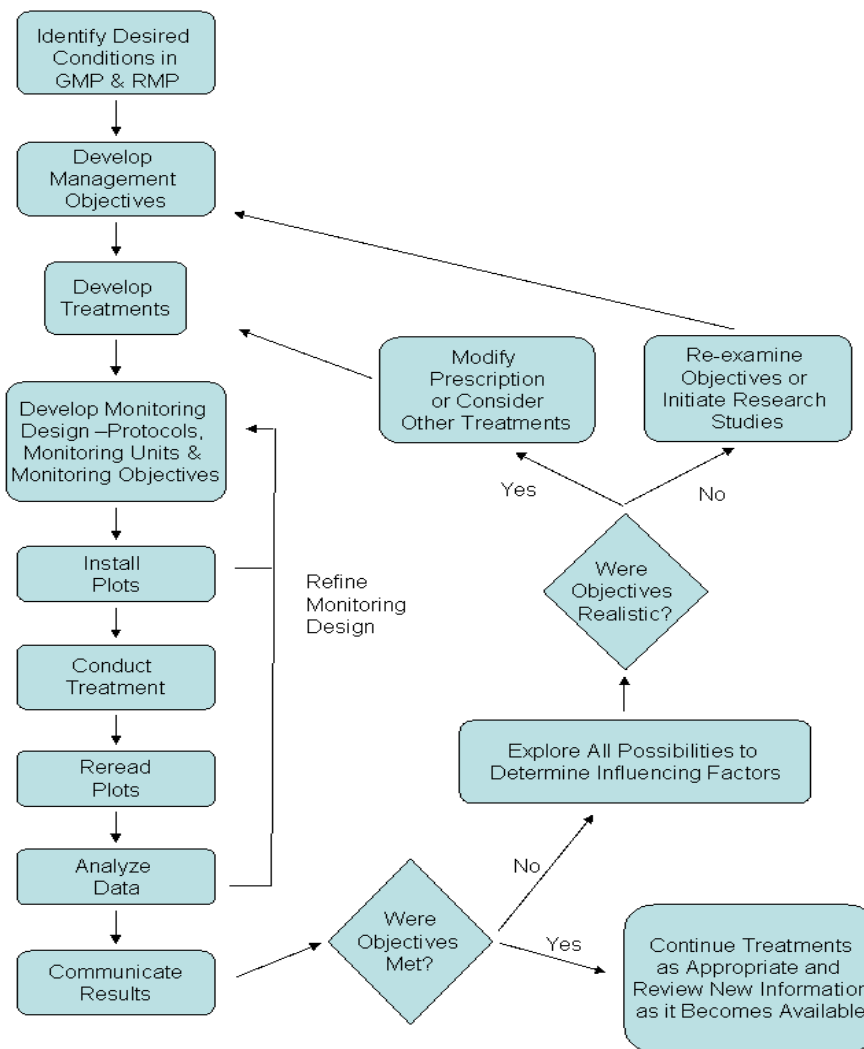
Interdisciplinary task groups may need to be formed to examine the options and determine appropriate actions. As new treatments and new prescriptions are introduced, the monitoring design may need to be modified. If no clear solutions are apparent, this may indicate the need for research studies.

Adaptive management requires continual evaluation. As the monitoring is conducted and data are analyzed, refinements to the monitoring design may need to be made. Results from data analysis should be incorporated into planning documents. Objectives and treatments must also be re-evaluated as new information from research and other sources becomes available.

B. Communication

Communication is critical for adaptive management to work effectively. An important function of the Fire Ecology Program is to communicate with NPS fire staff, other NPS staff, the interagency community, and the general public. Communication is important not only to advertise success stories, but also more importantly to ensure that adaptive management is being implemented effectively. Analysis of monitoring data, and its communication through reports, presentations and informal discussion, is one of the primary means of communication.

Fire ecologists should work with NPS Fire Communication and Education staff to assist with communication of results and success stories. Articles may be submitted to the fire ecology and fire management newsletters, scientific journals, and "popular" publications. Communication is not limited to written reports and articles, but should include utilization of intranet and internet web sites, presentations at scientific meetings as well as presentations at more informal meetings.

C. After Action Reviews

An After Action Review (AAR) is an assessment conducted after or throughout a treatment or major activity that allows personnel to discover what was planned, what happened, why it happened that way and what could be improved. It is recommended that units develop ecological AARs as a means to discuss monitoring results or trends and management activities following the completion of a project or projects. These reviews may occur immediately following a project, or at the end of a season, depending upon the size of a park's program. They may be an informal or formal meeting that involves the fire ecologist/monitors, fuels specialist, fire management officer, fire education/communication staff, resource staff and key participants involved in planning and implementation of burn. ***The main goal of an ecological AAR is to facilitate communication between the fire and resource management staff, to present findings and provide feedback between fire management and park staff.*** Timing of ecological AARs may range from immediate feedback during an AAR for a prescribed fire to a year end meeting wherein results from a statistical analysis are presented to park staff.

D. Reporting

Official fire monitoring reports are critical not only for adaptive management, but also for a number of other purposes including:

- Communicating results to park fire and resource staff

- Providing accountability to regional and national offices

- Communicating results to scientific community

- Presenting success stories, and failures to NPS staff, interagency community, non-governmental organizations (NGOs) and general public

Two types of annual reports are required for each fire effects monitoring program: park reports and national reports.

One annual monitoring report should be prepared for and presented to each park. The format and timing for such reports is flexible, and should be geared towards the needs of the parks. However, the reports should include a summary of monitoring activities from the year, results from data analysis, interpretation of data in the context of adaptive management, and discussion of the degree to which prescribed fire, wildland fire use and non-fire treatment objectives are being met. The report should also document the results of ecological AARs and any other meetings where feedback was provided. In addition to these written reports, it is encouraged that annual presentations are made to park staff that will allow for open discussion of the results, and possible changes in management based on the data.

A second annual report should be prepared for the regional and national offices. The objective of this report is to provide accountability for funds expended and to keep the regional staff informed regarding programmatic accomplishments. The request for these reports is provided by October 15 of each year to monitoring staff and is due by the end of the calendar year. These reports may be identical to the park reports or regional staff may request additional information.

In addition to annual reports, monitoring staff are encouraged to create informal reports throughout the year summarizing site visits and/or describing individual project implementation evaluations.

E. Internal and External Reviews

Internal and external reviews should be conducted periodically to ensure that fire effects monitoring programs are efficient and effective, and that all aspects of the adaptive management model are fully functional. There are three types of reviews that are conducted.

When FIREPRO program reviews are conducted on a Park's Fire Management program, at least one ecologist should be a member of the review team and the fire ecology/ fire effects monitoring programs should be evaluated along with all other aspects of the fire management program. See Appendix A for the Fire Ecology Program review checklist.

Between FIREPRO reviews, the Regional Fire Ecologist should conduct periodic reviews of fire ecology/ fire effects monitoring programs. This review should focus more closely on collection of monitoring data, data management, monitoring results, and communication of results. A review team consisting of other specialists may be appropriate for these reviews.

Regional Fire Ecology Programs should be reviewed every 5-7 years. These reviews are to be led by the Fire Ecologist at the Fire Management Program Center (FMPC) with an interdisciplinary review team that may consist of at least one of the following: resource manager, fire management officer, superintendent, park fire ecologist, regional fire ecologist, fire researcher.

IV. Fire Ecology Program Roles and Responsibilities

Fire Ecology program personnel consistently collaborate with many other program personnel not only in planning but also in project development, implementation, and evaluation. Specific lists of responsibilities by position are listed in Appendix B. Those lists are not exhaustive but are intended to clarify roles and responsibilities of these various parties in relation to the requirements outlined in this chapter. Responsibilities will vary among parks and unit-level fire management plans that address local definitions of roles and responsibilities should be the first place to seek out clarification.   Fire ecologists and fire effects crews typically provide their services to a number of parks. The group of parks for which a fire management officer is responsible may or may not coincide completely with the areas covered by the fire ecology park groups, although overlap is common.

V. Fire Monitoring

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 of hazardous fuels reduction, ecosystem restoration, and maintenance of ecosystem health. Information gathered during fire monitoring is essential for decision making and 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.

The 2003 NPS Fire Monitoring Handbook (FMH) provides the core background information for fire effects monitoring program sampling, design, and implementation. The handbook can be downloaded at the following website: http://www.nps.gov/fire/fire/fir_eco_firemonitoring.html. Formal handbook updates are approved by the NPS Fire Ecology Steering Committee and posted to this website as needed. Park units starting new fire monitoring programs are encouraged to first consider the FMH standard protocols to see if these protocols meet the needs of the new program before a decision is made to pursue other protocols.

A. Fire Monitoring Level Definitions

The NPS Fire Monitoring Handbook (2003) provides a recommended guideline for monitoring fire or treatment effects within a framework of four monitoring levels:

- Environmental (Level 1)
- Fire Observation (Level 2)
- Short-Term Change (Level 3)
- Long-Term Change (Level 4)

The first two monitoring levels provide information to guide fire management strategies for wildland fire and fuels management. Information collected on environmental conditions and fire observations are generally required for pre-suppression planning and fire reporting, and are usually collected by fire operations or fuels management personnel. This information also provides baseline data necessary to understand fire effects.

Monitoring for short and long-term change is generally confined to fuels and vegetation monitoring, but can be expanded to address other natural or cultural resource concerns. Fire ecology, resource or fuels personnel are responsible for collecting, analyzing and reporting on information for short- and long-term monitoring.

General definitions and overview of the monitoring levels are provided below. The next section provides the recommended level of monitoring based on fire management activities.

Level 1: Environmental Monitoring

This level of monitoring provides baseline data that is collected in preparation for the fire season or prescribed fire projects. Environmental monitoring data provides the background information needed to make fire management decisions. The following are examples of environmental data that may be collected by fire management:

- Local weather data
- Fire Danger Rating
- Fuel Conditions (i.e. fuel type, fuel load, plant phenology, fuel moisture)
- Values at Risk

Level 2: Fire Observations

Fire observation monitoring provides a basic overview of the physical aspects of a fire event or fuels management activity. The following are examples of monitoring variables; the level of data collection may vary with the fire management activity type:

- Fire cause, fire location, fire date
- Fire or project size
- Fuels and vegetation description
- Fire regime and condition class
- Current and predicted fire behavior
- Current and forecasted weather
- Smoke volume and movement

Level 3: Short-Term Change

Monitoring for short-term changes provides information on the immediate or short-term effects of a fire or fire management activity, at a level sufficient to evaluate whether stated program level management objectives are achieved. For example, management objectives may be reducing the fuel load by 20 tons per acre, maintaining mean overstory

tree density to within 10% of pre-burn conditions, or reducing the average total non-native species cover by 50-75%. Monitoring provides information on identified variables of interest either in a specific pre-defined vegetation and fuel complex (monitoring type or monitoring unit) or for a specific project. Data are collected through sampling of permanent monitoring plots, temporary plots, Composite Burn Index (CBI) plots (see burn severity assessment documentation) or photo points. Monitoring is implemented at varying frequencies – pre-burn, during the burn, and immediately post-burn; this continues for up to two years post-burn. Level 3 monitoring requires a data stewardship plan to ensure effective long-term management and use of data (see section I. Data Management for more information).

Level 4: Long-Term Change

Monitoring for long-term change is concerned with identifying the long-term effects of management activities that can be used to guide management decisions. Long-term monitoring of prescribed fire is required to document that overall programmatic objectives are being met and undesired effects are not occurring. It often includes the continuation of level 3 monitoring over a longer period. Monitoring frequency is based on a pre-defined interval appropriate to both the vegetation and fuels complex and the anticipated duration of treatment impacts. Level 4 monitoring requires a data stewardship plan to ensure effective long-term management and use of data (see section I. Data Management for more information).

B. Fire Regime and Condition Class Assessments

At the Departmental level, no clear direction has been defined for the implementation of Fire Regime and Conditions Class (FRCC) Assessments; each DOI agency is developing its own guidance. For the National Park Service, a task group will address this issue. Until the results of the task group are incorporated into RM-18, the current guidance is that each fuels project entered into National Fire Plan Operations and Reporting System (NFPORS) must have an FRCC assessment completed prior to implementation and a post-treatment assessment completed to document any change in FRCC resulting from project implementation.

Completion of the on-line or classroom FRCC training (see http://frcc.gov/) is necessary for consistent FRCC implementation. National Park Service fuels, fire ecology, and natural resource staff are strongly encouraged to complete this training. FRCC is a landscape scale planning and monitoring tool and it is most effective when used at the landscape level. Thus, Parks are encouraged to develop FRCC assessments for their entire park working with adjacent land managers to broaden the development and application of the assessment.

C. Burn Severity Assessments

Initial and extended burn severity assessments are a nationally approved NPS fire effects monitoring protocol.   The information these assessments provide can meet the criteria defined

by levels 2, 3, or 4 monitoring depending upon the extent to which the assessments are conducted.   The Joint NPS-U.S. Geological Survey (USGS) National Burn Severity Mapping Project addresses the need to quantify fire effects on NPS lands in order to develop an archive of fire history. This archive includes all fire types: wildfire, prescribed and wildland fire use. The goal is to monitor by means of standardized geographic databases employing consistent measures of "burn severity", defined as the magnitude of ecological change caused by fire.

Remotely sensed burn severity data should be requested for all wildland fires exceeding 500 acres on National Park Service lands as part of the NPS-USGS Burn Severity Mapping Project (see Appendix C for procedures on how to complete burn severity requests). Remote sensing and field methods for burn severity and a general overview of burn severity mapping are available at the NPS-USGS National Burn Severity Mapping Project website: http://burnseverity.cr.usgs.gov/.

D. Fire Monitoring Requirements by Fire Management Activity

The following section specifically lists the requirements for monitoring activities for all fire management activity types. Table 1 outlines the minimum required monitoring level for each type of fire management activity.

Table 1. Minimum required monitoring level for each fire management activity.

Management Activity	*Minimum Required* Monitoring Level and Activities
Wildfire	Levels 1, 2 Request burn severity assessments for fires > 500 acres
Wildland Fire Use	Levels 1, 2 Request burn severity assessments for fires > 500 acres
Prescribed Fire	Levels 1, 2, 3, 4[1] Request burn severity assessments for fires > 500 acres
Non-Fire Treatments	Documentation of treatment prescription, location and objectives of activity

[1] Long-term monitoring is required if monitoring addresses prescribed fire programmatic objectives.

1. Wildfire (suppression fires) and Wildland Fire Use

Requirements
Levels 1 and 2:
- Data necessary to satisfactorily complete a Wildland Fire Report for Type 1 (suppression), Type 2 (natural out) fires or Type 4 (Wildland Fire Use and Prescribed) fires.
- Data necessary for a Wildland Fire Situation Analysis (WFSA) and/or Wildland Fire Implementation Plan Stage I – III (WIFP).

- Request Burn Severity Assessments for single fires exceeding 500 acres. Consider requesting burn severity assessment for forested and shrub dominated areas with fires between 300 - 500 acres.

Recommendations
- CBI plots for field validation of burn severity mapping.
- Post-burn survey to inspect for exotic plant species invasion.
- Post-burn short- or long-term monitoring plots in areas of sensitive species, rare/unique vegetation types, or vegetation types where the effects of fire are not well known.
- Consultation with cultural resources staff evaluating the need for post burn surveys.
- Determination if any non-fire (research, resources management) program plots or projects were impacted.
- Re-measurement of any previously established plots as necessary.
- Data necessary to satisfactorily complete pre and post FRCC assessment

2. Prescribed Fire

Requirements
Levels 1 and 2:
- Data necessary to satisfactorily complete a Wildland Fire Report for Type 4 (Wildland Fire Use and Prescribed) fires.
- Data necessary to satisfactorily complete a Prescribed Fire Plan and immediate Post Fire Report.
- Request Burn Severity Assessments for single fires exceeding 500 acres. Consider requesting burn severity for forested and shrub dominated areas with fires between 300 - 500 acres.
- Data necessary to satisfactorily complete pre and post FRCC assessment

Level 3:
- Data collected to determine the immediate or short-term effects of a fire or fire management activity, at a level sufficient to evaluate whether stated management objectives are achieved.

- Data are collected through sampling of permanent monitoring plots, temporary plots, CBI plots, or photo points.

- Permanent plot program establishment using protocols defined in FMH or other protocols approved at the Regional Level (see Protocol Approval discussion below).
  Note: Plots are not required in each specific project but the monitoring program should include representative data for each key vegetation/fuel complex with specific objectives (monitoring type) in the park prescribed fire program.

Level 4:
> This level of monitoring is concerned with identifying the long-term effects of management activities that can be used to guide management decisions. The decision to continue long-term monitoring is dependent on whether the monitoring will document that overall programmatic objectives are being met and undesired effects are not occurring.
> - Continuation of level 3 monitoring activities at a frequency appropriate to both the vegetation and fuels complex and the anticipated duration of treatment impacts.

Recommendations
- Post-burn ocular evaluation to inspect for exotic species invasion.
- CBI plots for field validation of burn severity mapping.

3. Non-Fire Treatments

> Increased emphasis on fuel reduction in the Wildland Urban Interface (WUI) has resulted in an increasing number of non-fire treatment projects within the NPS. Non-fire treatments include manual, mechanical, chemical, and biological controls to manipulate vegetation and/or remove fuels to change fire behavior and/or reduce the likelihood of ignition or fire spread. RM-18 Chapter 10 describes the process for planning and implementing non-fire treatments. Documentation of non-fire treatment activities is required in NFPORS. The minimum required data for monitoring non-fire treatments (and needed for NFPORS) is treatment type, project initiation and completion dates, location, objectives, and FRCC pre- and post-treatment.

> It is recommended that non-fire fuels treatments be monitored for pre- and post-treatment conditions, at a level sufficient to determine whether the objectives of the treatment were met. Examples could include photo point documentation or establishment of pre- and post-treatment monitoring plots. The fuels specialist or fire management officer (FMO), fire ecologist and resource staff should determine the level and type of monitoring needed based on the scope, complexity, and size of each treatment or combination of treatments. Non-fire treatment monitoring must be included in the Park Fire Monitoring Plan. Fire Ecology and fuels program staff are creating a task group that will develop standard monitoring protocols for non-fire treatments in the future.

Requirements
- Documentation of treatment prescription.
- Documentation of treatment location by developing geographic information systems (GIS) layers or maps.
- Data necessary to fill out NFPORS documentation, including FRCC for the project area pre and post-treatment.
- Photo point documentation pre- and post-treatment.

Recommendations
- Post-treatment survey to inspect for exotic plant species invasion.
- Pre-and post-treatment short or long-term monitoring plots to determine if the management objectives were met, resulting in a desired outcome.

E. Protocol Development and Approval

Monitoring protocols document the sampling design, methods, frequency, and analysis for a monitoring method. Descriptions of all monitoring protocols in a park are documented in the park's fire monitoring plan. A single protocol or sets of protocols are necessary for the Fire Monitoring Plan.   Currently, the only nationally approved NPS Fire Ecology Program protocols are FMH protocols and burn severity mapping protocols. Additionally, the NPS Inventory and Monitoring Programs are developing standard protocols for monitoring, which may include protocols for monitoring fire effects.

Park units are encouraged to first consider the FMH standard protocols, since these protocols were developed for use in many vegetation types and to address a wide range of fire and resource management objectives. However, the use of FMH protocols is not mandatory for Level 3 and 4, and new protocols can be developed and utilized if they better meet the program's objectives. Determination of appropriate protocols or the use of new protocols should be included in the development or revision of the Fire Monitoring Plan.

A list of monitoring protocols is maintained on the NPS Fire Ecology Program intranet site (http://www.nps.gov/fire/ecology/science/protocols.htm) and the NPS Inventory and Monitoring Program Protocol Database website (http://science.nature.nps.gov/im/monitor/protocoldb.cfm). If additional national protocols are developed and approved, they will be listed on the NPS fire ecology website under Approved NPS Fire Ecology Program Protocols. This list will also include protocols that are not nationally approved but are being used at the regional level; they will be listed under Regionally Used Protocols.

Parks that choose to develop or use protocols not found in FMH need to document the protocol and receive approval at the regional level. The decision to use other documented monitoring protocols or to develop new protocols should be conducted with input from park fire and resource managers, park scientists, regional fire ecologist, regional vegetation specialist, interagency or academic scientists, and other local experts. A written protocol proposal is required to be developed as outlined below and submitted to the Regional Fire Ecologist for approval. When regional approval is received, the monitoring plan must be updated to include the new protocol. Protocol requests should include the following:
- Justification of need for new protocol and description of how the new protocol meets the monitoring objectives.
- List of target variables identified that directly measure objectives described in park fire and/or resource management plans.
- Detailed description of field methods utilized.

- Description of statistical tests to be used to analyze the data and determine minimum sample size needed to measure whether objectives are being met.
- Description of repeatable plot location process and location documentation for permanent plots.

There are two levels of approval for new protocols. At the regional level, approval is performed by the regional fire ecologist either through the signing of the monitoring plan or through a written protocol proposal that is approved and then incorporated into the monitoring plan. Approval at this level signifies acceptance of the protocol for use at the park, cluster, or regional level.

The second level is national approval by the NPS Fire Ecology Steering Committee. The committee may approve the protocols themselves or may form task groups that include outside reviewers to provide recommendations to the committee. Once protocols are approved at this level, they are considered accepted protocols available for use by programs nationwide.

F. Project Level Monitoring

The monitoring methodology outlined in FMH relies on the monitoring of vegetation across Monitoring Types. Monitoring Types are areas of the landscape defined by similar vegetation, treatments and objectives that often encompass multiple prescribed fire units. A limitation of this methodology is that it was not designed to provide immediate answers as to whether the short-term management objectives identified in a prescribed fire plan were achieved by a single treatment.

In instances where immediate results are needed to evaluate the effectiveness of a treatment, it is desirable to develop monitoring protocols that specifically answer whether treatment objectives are being achieved. It must be recognized that time and energy spent on answering short-term treatment level questions, will detract from addressing longer term park-wide objectives. The fire ecologist will work with fire management staff in determining the appropriateness of project level monitoring.

G. Coordination with Park and Network Monitoring Efforts

Fire effects monitoring is one of numerous monitoring activities that may occur within a park. The NPS Inventory and Monitoring (I&M) program consists of networks that monitor a wide range of natural resources within parks Moreover, resource management staff in individual parks may conduct specific types of monitoring.

It is critical that fire ecologists coordinate with park/network staffs who are conducting monitoring. The degree of coordination will vary by program but at a minimum, the different monitoring programs should communicate with one another to ensure that there are not potential conflicts in their monitoring activities or treatments. More intensive coordination may entail the sharing of data or even the sharing of personnel and resources.

Coordination is also necessary to avoid potential conflicts with treatments. For example, fire ecologists should work with Exotic Plant Management Teams to coordinate timing of prescribed fire and mechanical treatments to maximize effectiveness of treatments.

H. Fire Monitoring Plans

Fire monitoring plans are required for all units using prescribed fire or wildland fire use in order to ensure that treatments are effective and that management goals and objectives are met. Monitoring plans are also recommended where any long-term or moderately intensive non-fire treatments are occurring. The fire monitoring plan is an appendix to the Fire Management Plan, which is tiered to the Resource Management Plan, which in turn is tiered to the General Management Plan.

For units without wildland fire use and prescribed fire programs, the decision regarding whether a fire monitoring plan is necessary should be made collaboratively by the regional office fire staff, the unit fire staff and the unit resource management staff. This decision should be revisited over time as the program evolves. The Fire Monitoring Plan should work in concert with monitoring plans that are developed by the NPS Inventory and Monitoring (I&M) program, as well as with any other monitoring occurring in the park.

The fire monitoring plan describes in detail how fire monitoring will be conducted (see Appendix D for a detailed outline for developing the fire monitoring plan). Peer review of fire monitoring plans by NPS, Interagency NGOs and academic scientists in the disciplines of vegetation, fire ecology and monitoring is strongly recommended. The fire monitoring plan should be viewed as a living document. It should be updated regularly, as new information becomes available through analysis of data and research

The current outline in Appendix D is extensive and may not fully meet the needs of many small parks or parks with low to moderately complex fire management programs. A future task group will work to develop more specific planning guidance for fire monitoring plans that will more fully address a broader range of monitoring complexity within NPS. The task group's results will be included in the next update of Chapter 11.

I. Data Management

NPS Fire Ecologists and Fire Effects Monitors will primarily use the Fire Ecology Assessment Tool (FEAT) software to collect, store, and analyze fire effects monitoring plot data.

Park level fire ecologists are responsible for developing a data stewardship plan for fire effects plot data (level 3 and 4 monitoring data). The data stewardship plan, at a minimum, should address the critical elements listed below. Data stewardship plans should be reviewed annually and updated as needed. Regional Fire Ecologists will ensure that data stewardship plans are completed for parks that are not covered by a park level fire ecologist.

The data stewardship plan will be referenced or included in the fire monitoring plan. The NPS I&M Program website is an excellent reference to use when developing the data stewardship plan: http://www1.nrintra.nps.gov/im/datamgmt/dmplanning.htm

Addressing level 1 and 2 monitoring data in the data stewardship plan is optional. Level 1 and 2 data (i.e. smoke, fire weather, fire behavior) are included in the Wildland Fire Report, WFIP Stage 1, and prescribed burn summary report. At a minimum, on-site fire weather and behavior data should be archived (electronically or as a hard copy) with the other information pertaining to the fire, i.e., Wildland Fire Report, WFIP, prescribed burn report. Fire management staff must make sure adequate mechanisms are in place to ensure long-term protection of this data. To ensure long-term protection and use of burn severity assessments completed by the NPS/USGS National Burn Severity Mapping Project, all assessments are archived and available on its website: http://burnseverity.cr.usgs.gov/.

Data Stewardship Plan Critical Elements

- Number, location, and type of monitoring plots

- Location of databases and type of databases that store fire effects monitoring data

- Location of hard copies of data

- Status of metadata

- Quality Assurance / Quality Control (QA/QC) processing

- Type of quality control completed

- Quality control issues encountered in the data

- Changes made to the data

- Process and procedures that ensure long-term protection of data

- Procedures for backing-up data that will minimize potential for data loss

- General procedures for addressing requests for data from stakeholders, management and the public

- List species of concern that need to be flagged because location of these species cannot be released to the public (e.g., rare species, threatened and endangered (T&E) species, and culturally significant species).

- Data analysis completed and location of results or summaries

VI. Fire Ecology Program Safety

Employee and public safety is the first priority in every fire management activity. RM-18, Chapter 3 deals specifically with safety and health related to wildland fire activities. This chapter does not address fire monitoring activities specifically.

The Interagency Standards for Fire and Aviation Operations (Redbook) Chapter 6 (Safety) identifies safety items that should be considered for safe fire monitoring activities. Two of the

primary sections in this chapter are risk management and job hazard analysis (JHA). The risk management process ensures that critical factors and risks associated with operations are considered during decision making. This process must be applied to all fire operations prior to taking action. This process includes gathering information, estimating/identifying hazards, identifying controls for hazards, and evaluating personnel. Job hazard analyses information is available at the following web sites:

www.fs.fed.us/r1/people/jha/jha_index_www.html

www.osha.gov/Publications/osha3071.pdf

Parks and fire effects monitoring teams should review the above documents to determine if they meet their local programmatic needs. For those job aspects unique to local Fire Ecology Programs, each fire effects monitoring crew should develop JHAs for their long-term monitoring activities. The JHAs may apply to an individual park or cluster of parks.

VII. Fire Ecology Program Funding

Funding for the Fire Ecology Program is included under the overall NPS Non-Wildland Urban Interface and Wildland Urban Interface Program Budget. Permanent and seasonal staffing levels are determined by FIREPRO analysis. Project level and supplemental travel funding are requested through NFPORS. Fire ecologists should play an active role in developing and overseeing the budget of their program.

A.   Fire Effects Business Rules

Specific information on staffing levels and budget is contained within the "NPS Wildland Fire Management Business Rules" which are updated periodically and can be downloaded from the following internal website:
http://inside.nps.gov/documents/FMLBFinalBusRules_TOC_030606.doc.

The following topics of interest to the Fire Ecology Program are covered in the business rules:

- Park and Cluster Fire Ecology Program staffing level definitions

- Fire effects clusters: definitions, development, and modification processes

- Management Override Rules

- Fire Effects travel funding calculations and request processes

- Reporting Requirements for regional and national program managers

B. Supplemental Travel Funds

Programmatic support funding should be used for general program functions including supplies and equipment, and travel for fire ecology training, workshops and conferences.

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Fire Ecologists need to track NFPORS project entry deadlines for requesting funds for travel support for fuels monitoring projects. These additional travel funding requests should be coordinated with regional ecologists. See NPS Wildland Fire Management Budget Business Rules for guidance on using support funding and requesting additional travel funding.

C. Additional Funding and Staffing Sources

In addition to FIREPRO funding for staffing and projects, other sources of funding may be available to enhance or supplement existing fire ecology programs. These sources include:

- Interagency Positions and partnerships

- Student Conservation Association Positions

- Collaborative partnerships with the NPS Inventory and Monitoring program

Proposals to create these types of positions should be coordinated with the regional Fire Ecologist and regional Fire Management Officer.

D. Budget Planning Cycle and Deadlines

Fire Ecology program staff should monitor FIREPRO and Fuels Management Program annual budgetary planning cycles. Checklists for both of these cycles can be found as appendices in NPS Wildland Fire Management Budget Business Rules.

Park Fire Ecologists need to consult with their regional Fire Ecologist when changing cluster configurations and for the annual deadline to submit these changes.

E. Research Funding Sources

The Joint Fire Science Program (JFSP) was established in 1998 to fill gaps in knowledge about wildland fire and fuels. It's a partnership of six federal agencies – the Forest Service, in the Department of Agriculture; and the Bureau of Indian Affairs, Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service and the U.S. Geological Survey, all in the Department of the Interior. The purpose of the Program is to provide wildland fire and fuels information and tools to specialists and managers who make wildland fuels management decisions. The information and tools will also help agencies develop sound, scientifically based land use and activity plans. The program does this primarily by soliciting proposals for science projects that are designed to answer specific questions or solve specific problems related to wildland fuels issues. Requests for Proposals (RFPs) are issued periodically as funding is available. The latest information, RFP and summaries of completed and ongoing research can be found at http://www.jfsp.org.

The NPS Servicewide Comprehensive Call (SCC) identifies all National Park Service (NPS) funding programs that target natural resource issues. The Fire Ecologist should work with the park's chief of resource management to coordinate submissions. There are several different

funding sources that have different requirements. Parks may only be able to submit a limited number of proposals in each category. Coordination with your park's resource staff is critical to using this as a funding source. The latest information, including deadlines and funding sources can be found at Inside NPS – Programs – Natural Resources Stewardship and Science or
http://inside.nps.gov/waso/waso.cfm?prg=4&lv=1

There are a number of other possible funding sources for research, including the National Science Foundation as well as state and county grants. Contact your Regional Fire Ecologist for more information.

VIII. Appendices

A. Program Review Standards

The following questions and issues are suggested topics for a review of a park's fire ecology program. Every question is not applicable to all programs. Many questions are intended to be asked directly to various pertinent park staff: Fire Ecologist, Lead Fire Effects Monitor, Resource Management, Fire Management Officer and Prescribed Fire Specialist. Other questions address issues that may require a more thorough investigation by the reviewers. Portions of the Monitoring Program section are appropriate for an in-depth review of a monitoring program, a level that may not be feasible for all program reviews. For programs where fire ecology staff serve multiple parks, the reviewers should consider how the fire ecology program functions for all the parks that it serves.

After completion, findings and recommendations are to be discussed with the park managers and then summarized in a written report. If this review is done concurrently with a fuels program review, then the findings and recommendations should be included as part of that report.

Fire Ecology Program

Staffing
- Is funding for fire monitoring staff adequate: crew size, travel budgets, supplies, and training?
- If fire ecologist staff serve more than one park, do park staff feel they receive an equitable share of their time?
- Are annual work plans developed for fire ecology staff? What is the process?
- Is available training adequate?
- Does fire ecology staff have employee development plans?
- Does fire ecologist have opportunities to maintain scientific currency?
- Does fire ecology staff receive adequate support from regional office?
- Is supervision adequate? Do fire ecology staff perform excessive duties not found in job description?
- Has a Job Hazard Analysis been developed for fire ecology staff?

Planning

- Does fire have a relevant ecological purpose?
- Are vegetation maps available?
- Has the park developed and used the following in their management planning:
    - ➢ Reference Conditions,
    - ➢ Desired Future Conditions,
    - ➢ Ecological Models,
    - ➢ The most recent pertinent research,

> ➢ Risk Assessment,
> ➢ Successional Modeling and
> ➢ Monitoring Data

Integration of Fire Ecology and Fire Operations

- Does ecologist provide input for the Fire Management Plans (FMP), Prescribed Fire Plans, and Long-Term Fuels Treatment Plan?
- Who develops the Long-Term Fuels Treatment Plan? Who provides input? Is the Long-Term Treatment Plan updated annually? Do planned treatments follow the plan? Are fire effects crews given sufficient time to install plots?
- What roles do fire ecology staff play in wildland fires: monitors, resource advisors, firefighter type 2 (FFT2), Burned Area Emergency Rehabilitation (BAER) team member, Geographical Information specialist, Fire Effects Monitor (FEMO), etc?
- How is Fire Regime Conditions Class (FRCC) being addressed?

Integration of Fire Management and Resource Management

- Do resource managers (natural and cultural) communicate regularly with fire ecologist and lead monitor?
- To what extent are resource managers involved in developing Long-Term Fuels Treatment Plan, and Fire Management Objectives?
- Does the fire ecologist sit on the Exotic Plant Management Team's Steering Committee?

Reporting and Communication

- Are annual reports written? Who receives them?
- Are monitoring data presented to fire management staff, parks, public, and/or scientific community through presentations, web sites, publications, etc.?

Adaptive Management

- Is there a defined procedure outlined in the Monitoring Plan or FMP that documents how results will be used to influence future management actions?
- Is monitoring data currently influencing management decisions, being incorporated into the FMP, and inspiring research?
- Are ecological After Action Reviews (AARs) or meetings being held to present findings and provide feedback among fire management and park staff?
- Is monitoring addressing the needs of the park, or is research necessary to answer the questions?
- To what extent is fire research being conducted in the park?

Monitoring Program

Fire Behavior Monitoring

The following should be considered in programs that have monitoring activities during prescribed fires and/or wildfires:

- What types of quality control are used in data collection, entry, and management?
- Is the fire crew aware of what monitors are doing and why?
- Do monitors regularly make presentations at morning briefings?
- Are the data being used to help make decisions?
- Is burning occurring outside the prescription window?
- Are there tendencies to burn on the cool or the hot end of the prescription?

Monitoring Design
- Does monitoring take place for prescribed fires, mechanical treatments and wildland fire use fires?
- Are appropriate methods being utilized to determine whether objectives are being met? What resources are being used to assess appropriate methodologies?
- Are monitoring type descriptions, objectives and protocols documented?
- Are the objectives viable and measurable?
- Has the sampling design been customized (pilot sampling) to meet the park's needs?
- Are modifications in methodology well-documented?
- Is the frequency of monitoring appropriate?
- Are control plots necessary or utilized?
- Is burn severity mapping being conducted?
- Is there a signed monitoring plan? If not, are the components of a monitoring plan available (e.g. monitoring unit descriptions, monitoring objectives, stewardship plan)?

Field Sampling
- It is critical to spend at least a day in the field with the crews in order to see how they function with each other, with the methods, and with the resource.
- It is also advised to spend some time with individual crewmembers to determine what the field folks feel is really happening.
- What actions are undertaken to ensure quality control?
- Allow managers to provide a full assessment of prescribed fire units, including a thorough tour of the burn units if time allows. Discuss objectives, and timing/seasonality of fires.

Data Entry
- Do data sheets match what is in the computer? Spot checking usually reveals some discrepancies.
- Look for a variety of data entry errors, including those that are indicators of field crew quality from year to year.

Data Management
- Are the files orderly and easy to use?
- Are plants identified correctly?
- Slides and photo documentation useful?
- Are plot locations well documented? Are they available in GIS?

Data Analysis
- Assess past data analysis
- Ask if the data were presented, discussed, and what happened after those discussions.

Collaboration
- Is there any communication or collaboration between the Fire Effects Monitoring Program and the Inventory and Monitoring (I&M) Program?
- Is there any communication or coordination with other park-based monitoring efforts?
- Are there opportunities for coordination with interagency partners?

B. Fire Ecology Program Roles and Responsibilities

General responsibilities for program personnel are given below. The information below is meant
to serve as a general guideline, as responsibilities may vary according from park to park.

A. Agency Administrator

The park's Superintendent functions as the Agency Administrator for all ecology and monitoring
program activities.

- Ensures that the Fire Management Plan meets RM-18 Chapter 4 policy standards
  including clear articulation of programmatic fire management goals and objectives

- Ensures that required Fire Monitoring Plans are completed according to policy guidelines

- Ensures that all monitoring program activities are conducted in accordance with
  established standards and guidelines

B. Park Fire Management Officer

The Fire Management Officer (FMO) is responsible to the Agency Administrator for overall
planning, implementation, and monitoring of the fuels program.

- Ensures that every fire ecology and fuels program employee emphasizes safe work
  practices

- Ensures that the fire ecology and fuels program is well-integrated with the overall fire
  management program

- Hires, trains, and supervises cluster/park fire ecologist

- Collaborates with pertinent personnel to ensure that all prescribed fire, wildland fire use
  and non-fire treatments undertaken meet planning requirements for both implementation
  and monitoring

- Provides opportunities for training and employee development as outlined in approved
  employee development plans

- Creates and maintains the unit Fire Management Plan

C. Park Fire Ecologist

The fire ecologist is intended to serve as the program expert in fire ecology, and coordinates with
other resource managers to achieve scientific information regarding long- and short-term effects
of fire and fuels management activities. Individual parks and clusters delegate the following
responsibilities according to local needs and resources:

- Analyzes, reports, and interprets fire effects data for managers

- Manages and refines monitoring program, including the communication of measurable objectives, monitoring schedules, protocols, and data analysis procedures

- Manages fire monitoring database

- As qualified, may act as a resource advisor

- Hires, trains and supervises fire effects monitors

- Prepares fire effects monitoring annual report and disseminates results to fire managers

- Serves as a liaison between fire managers and resource management at host and cluster parks

- Coordinates with resource management and fuels staff to assist with the development of prescribed fire and other fuels management objectives and prescriptions

- Provides expertise on the role of fire in ecosystems and advice on how fire can be used to accomplish management objectives

- Writes and maintains Fire Monitoring Plan for host and cluster parks

- Contributes to and reviews compliance and other management documents

- Identifies research needs, solicits researchers, writes proposals, and applies for funding for research projects

- Conducts literature reviews into fire ecology questions; interprets and presents results

- Manipulates/presents spatial monitoring data using ArcGis

- Coordinates monitoring with the Inventory and Monitoring program to minimize duplication of efforts

- Has budget and fiscal responsibility for program

- Serves as a member of the Exotic Plant Management Team as per the Strategic Plan

- Coordinates with the Regional and National Fire Ecologists

- May review prescribed burn plans

- Assists with implementation of treatments as needed and as available

- May provide ecological expertise, in conjunction with regional fire ecologist, on fire effects and vegetation for Burned Area Emergency Rehabilitation (BAER) teams

- Collaborates with Fire Education, Prevention, and Information Specialists and Regional Ecologists to assemble success stories and lessons learned in order to promote acceptance and support for the role of fire in ecosystems

D. Lead Fire Effects Monitor

The Lead Monitor collects and stores vegetative monitoring data at host and cluster parks needed to determine the effectiveness of the fire program in meeting objectives.

- Assists with hiring and training of the monitoring field crew

- Leads field crew in collection and entry of vegetation monitoring data according to standard protocols at host and cluster parks

- Directs/oversees daily operations of fire effects monitors in the field and office

- Assures data quality and management

- Sets monitoring schedule and communicates schedule with host parks

- Identifies plants to the species level in a variety of ecosystems and resolves unknown species

- Creates and maintains voucher specimens

- Assists with implementation of treatments as needed and as available

- Assists fire ecologist with budget and fiscal activities

- Collects and manages spatial data relating to monitoring plot locations

- Collaborates with fire ecologist on planning and annual reporting documents

E. Assistant Lead Fire Effects Monitor

The Assistant Lead Monitor performs field and laboratory work associated with the collection and storage of fire effects monitoring data at host and cluster parks in order to determine the effectiveness in meeting prescribed fire objectives. The assistant lead is able to lead the crew in the absence of the lead monitor (see lead monitor duties).

F. Prescribed Fire Specialist or Fuels Specialist

The Prescribed Fire Specialist position serves as the primary contact person between fuels/prescribed fire personnel and the fire ecology program. Specific roles may be addressed in the respective Fire Management Plan.

- Collaborates to ensure that annual and five year prescribed fire work plans are developed with input from the fire ecologist

- Communicates with fire ecologist to provide the opportunity for input into prescribed fire plan development

- Collaborates to ensure that prescribed fire plan goals and objectives are consistent with those outlined in the Fire Management and Fire Monitoring plans

- Coordinates with fire ecology program so that staff is given the most up to date information regarding project and treatment status in terms of both planning and implementation

- Works with fire ecologist and/or fire effects monitors to articulate measurable fuels treatment objectives

- Collaborates on the fuels and fire effects monitoring plan

G. Prescribed Fire Burn Boss

The Prescribed Fire Burn Boss is responsible to the Agency Administrator or Prescribed Fire Manager for implementing the Prescribed Fire Burn Plan.

- Reviews the prescribed fire burn plan prior to implementation and ensuring all the objectives and prescriptions are compatible and that monitoring has been addressed

- Collaborates with pertinent personnel to determine that all monitoring requirements outlined in the prescribed fire plan are met during burn plan development

- Determines when the prescribed fire is not within prescription parameters or is not meeting objectives

- Coordinates with ecology program personnel to ensure that the applicable postburn reports (as determined by the Fire Management Plan) are completed

H. Fuels Technician

The Fuels Technician performs a variety of fire management support functions, including aiding in the implementation and monitoring of wildland fire and non-fire treatment projects.

- Leads and participates in the monitoring, collation, and reporting of specified fuel monitoring data

- Works in conjunction with fire effects monitors as needed

- Establishes fuel monitoring plots in a variety of fuel models

- Enters natural resource field data using available support software

- Performs analyses of fire weather, behavior, fire history; works with fire behavior models such as BEHAVE

- Collects GPS information for field plots; prepares field maps

I. Fire Education, Prevention, and Information Specialist

The Fire Education, Prevention, and Information Specialist (FEPIS) is responsible for facilitating communications about the NPS Wildland Fire Management Program with the internal and external audiences. This program is interdisciplinary in nature, and is based on the best available science.

- Collaborates with regional ecologists to assemble success stories and lessons learned in order to promote acceptance and support for the role of fire in ecosystems

- Develop credible fire management messages by working with the fire ecology staff

- Aid in the determination of the most appropriate outlets for information dissemination

- As appropriate, participates in information-sharing meetings dealing with fire effects results

J. GIS Specialist

The GIS Specialist provides a variety of support functions, such as geospatial expertise, data layers, and map products. Responsibilities of the GIS specialist vary throughout the program.

- Supports the GIS needs of the wildland fire management program; may provide GIS data layers, map products and data analysis as requested

- Ensures that fire management staff has access to current data, software versions, training and assistance

- Facilitates the wildland fire management program's utilization of existing GIS capability

- May represent the wildland fire management program on NPS/interagency committees and task groups related to fire management and GIS

K. Resource Management Specialist

The Resource Management Specialist provides guidance in determining monitoring objectives related to resource management objectives for fire. As applicable, resource management specialists provide input in the fire management and prescribed fire plans. Additional responsibilities may include consultation in the development, completion, and evaluation of research projects and compliance documentation.

- Identifies projects where fire is an appropriate resource management tool; helps identify monitoring objectives related to resource management objectives for fire

- Aids in completion of environmental compliance

- Reviews fire management and prescribed fire plans

- Provides input into the development, completion, and evaluation of research projects

L. Regional Fire Ecologist

The Regional Fire Ecologist serves as the coordinator and administrative lead for fire ecology and monitoring related activities throughout the region. Communication and coordination are critical components of these positions.

- Coordinates with other regional fire, resource management, and Inventory and Monitoring staff to ensure fire ecology program is recognized and considered in programmatic decisions

- Assists with preparation and review of Fire Management and Fire Monitoring plans for parks and clusters

- Coordinates with parks regarding monitoring funding request requirements and reviews and approves park National Fire Plan Operations and Reporting System (NFPORS) monitoring request entries

- In association with appropriate personnel, the regional fire ecologist ensures that Fire Effects Teams serving cluster parks are provided with the most current project list information available

- Coordinates research needs at the regional level and assists with prioritization of park level research requests.

- Compiles park level annual reports into annual regional Fire Ecology program report

- Participates in site visits and programmatic reviews

- Determines cluster configuration, in conjunction with parks

- Provides technical advice and oversight to parks not covered by a park Fire Ecologist

- Approves fire monitoring plans

- Serves on the Fire Ecology Steering Committee

- Approves other monitoring protocols at the regional level

- Assess and prioritizes overall programmatic staffing and budget needs

- Coordinates with resource management and fuels staff to assist with the development of prescribed fire and other fuels management objectives and prescriptions

- Provide ecological expertise on fire effects and vegetation for Burned Area Emergency Rehabilitation (BAER) teams as needed; may approve BAER plans

- Works in conjunction with park ecologists to coordinate fire effects monitoring training

- Collaborates with Fire Education, Prevention, and Information Specialists and Park Ecologists to assemble success stories and lessons learned in order to promote acceptance and support for the role of fire in ecosystems

C. Steps for Completing Burn Severity Assessment Requests

Overview
National Park Service (NPS) units in which a single fire exceeded 500 acres will request an assessment of burn severity through the NPS-U.S. Geological Survey (USGS) National Burn Severity Mapping Project website. NPS units should also consider requesting burn severity assessments for single fires 300 to 500 acres in size, or multiple fires that exceed 500 acres (but no single fire that is larger than 300 acres). An on-line request form has been developed to facilitate this requesting process (described in detail in step 2 below). The requesting unit does **not** have to pay for the assessment.

Park and cluster level Fire Management Officers (FMOs) should identify an individual to complete the on-line request form with input from fire management staff. Currently, in many parks, the fire ecologist or fire GIS specialist has taken on this role. Before completion of any requested assessment, National Burn Severity Mapping Project staff will first evaluate potential quality of requested assessments. If quality of assessment is questionable they will work with park staff to determine whether to proceed with the assessment. Cloudiness, size of burn, vegetation type, and availability of Landsat scenes can all impact assessment quality.

The initial and extended burn severity assessments are a nationally approved NPS fire effects monitoring protocol. The Joint NPS-USGS National Burn Severity Mapping Project addresses the need to quantify fire effects on NPS lands in order to develop an archive of fire history. This archive includes all fire types: wildfire, prescribed and wildland fire use. The goal is to monitor by means of standardized geographic databases employing consistent measures of "burn severity", defined as the magnitude of ecological change caused by fire. Burn Severity Assessments use Landsat 30-meter data and a derived radiometric value called the Normalized Burn Ratio (NBR). The difference between pre-and post-fire NBR datasets is computed to determine the extent and degree of landscape change resulting from fire. Remote sensing and field methods for burn severity and a general overview of burn severity mapping are available at the NPS-USGS National Burn Severity Mapping Project website:
http://burnseverity.cr.usgs.gov/.

The GIS and cartographic products that the National Burn Severity Mapping Project produces delineate fire perimeter and provide information on the range of effects within the burn. These products help to define lasting impacts and environmental responses from fire and to prepare for long-term management of burned areas. Because many fires cannot be closely monitored while active, post-fire evaluations also yield insight into fire behavior across varying topography and vegetation, thus contributing basic information for research and modeling.

Request Deadlines
All requests should be completed within a few months after the end of the local NPS unit's primary fire season.

Burn Severity Assessment Types
Requests may include Extended Assessments, Initial Assessments, or both. Please review the
descriptions below to determine which is appropriate for your area.

Rapid Assessments are assessments specifically completed for Burned Area Emergency
Rehabilitation (BAER). These assessments are not requested through the NPS-USGS National
Burn Severity Mapping Project website (see Rapid Assessment for more information).

- *Extended Assessment (EA)*:   Generally completed on all large burns. Post-fire Landsat
  scenes are acquired during the first growing season after the fire. Timing varies with
  geographic region; it may be 8-11 months post-fire in the northwest, while only 1-4 months
  post-fire in the southeast. The EA provides a final complete view of the burn, including the
  ability to capture delayed mortality and survivorship of burned vegetation. For this reason,
  it tends to be a better indicator of severity than the Initial Assessment by offering a means
  to evaluate the full range of first-order ecological effects. In most cases, it also provides a
  good delineation of the burned area and fire perimeter. By waiting until the next growing
  season, the opportunity to acquire optimal remote sensing data is also greater than with
  Initial Assessments. The EA is important for long-term management, ecological
  understanding and study of burns.

- *Initial Assessment (IA)*: The IA is generally done within one week to two months after the
  fire. It *may* fall within the timeframe of rapid response by BAER teams. There are two
  triggers for IA: 1) when the fire stops growing significantly, or preferably when the fire is
  completely out, and 2) when acceptable Landsat data is available. Because of data timing
  and quality issues, it may not be possible to do an IA on all burns. The IA usually cannot
  capture both delayed mortality and regrowth or survivorship of burned vegetation
  especially in western coniferous systems. Thus, IA normally misses some important
  factors for gauging burn severity, and may tend to overestimate severity. Moreover, in
  some cases, the fire may still be active after the last Landsat scene suitable for IA, so the IA
  may not show the final area or composition of the burn. Depending on how late in the year
  burning concludes, snow and low sun angles may also reduce the quality of results.

- *Rapid Assessment:* BAER teams often conduct rapid assessments of fires using remote
  sensing products. This post-fire emergency assessment can include requesting a Burned
  Area Reflectance Classification (BARC). BAER teams complete this request immediately
  prior to or after arriving on the fire; the product needs to be delivered to the team as soon as
  possible, often less than a week after the request. The intent of the BARC map is to
  provide the BAER teams with a product to assist in determining emergency stabilization
  needs; it may or may not meet the objectives for fuels monitoring or vegetative fire effects
  analysis. The incident pays for BARC maps. To request Burned Area Emergency
  Response (BAER) Imagery Support go to: http://www.fs.fed.us/eng/rsac/baer/.

STEP 1: Determine the Type of Burn Severity Assessment Needed

Extended Assessments are recommended in all cases with the following exceptions:
- All of the burn occurs within ecotypes that respond quickly after fire, and first-order effects are ephemeral. This includes many grasslands, mesic shrub and herbaceous communities. Often in these cases, just knowing whether or not an area burned is sufficient, because severity is uniformly low and homogeneous. We can review available post-fire data in these cases to help determine whether it would be productive to proceed with an EA.
- The burn is small (<300 acres), and it did not produce sufficient area representing a range of effects, e.g. it was mostly low to moderate severity. Such burns may be more cost effectively characterized by other means.

Initial Assessments may be warranted under one or more of the following conditions:
- The burn is large and has significant socio-economic impacts, or when there is an urgent need for public information and/or emergency response.
- Significant portions of the burn occur within ecotypes that respond quickly after fire, or where first-order effects are ephemeral, as in many grasslands, or mesic shrub and herbaceous communities.
- The burn is in deciduous forest and/or it is a fall burn after leaves have fallen, such that, the next season's growth is likely to completely obscure the burn.
- The burn is the subject of study, with objectives to compare burn responses over time.

Both Initial and Extended Assessments may be useful in some circumstances for full information on the extent and composition of burns:
- Low severity fires that occur in high-density, closed-canopy forest (deciduous or coniferous), to better delineate the burn scar as well as the severity mosaic.
- Where burns are exceedingly complex involving several different ecotypes, again, using the IA to distinguish burned and unburned areas, and to delineate the perimeter, while capturing additional burn severity information with the EA.
- If there is uncertainty about the need for either an IA or EA, seek assistance through the contact information on the web site. It is possible, for example, to complete the EA and then determine the need for an IA after looking at the results. Since all Landsat scenes are archived, the ability always exists to go back and complete any assessment type at a later date.

Additional Guidelines:
- For most solitary fires, only burns greater than 300 acres should be mapped. Smaller fires can be mapped when there is solid justification.
- A Landsat scene covers 180km by 180 km, and all fires within that scene will be captured, so there is no need to submit multiple requests for all fires covered within the same scene area and timeframe. Complete a request for the largest fire, and make note of the additional fires on the on-line request form.
- EA can effectively map burn severity in forest or shrub communities when burns are mixed severity and greater than 100 acres. However, when fires are low

severity and/or homogeneous in those communities, consider an assessment only when fires are greater than 300 acres.

➢ In grasslands or other communities where first-order effects are short lived, consider burn severity assessments only when a fire is greater than 300 acres. When fire effects are ephemeral, an IA may provide all the information necessary to capture the burn and unburned mosaic. An EA may not contribute much about severity, except perhaps that productivity was actually enhanced by the fire.

➢ There often are unique circumstances and uncertainties about completing a burn severity assessment. Feel free to contact the NPS Fire Ecology Program Lead with any questions about the need or type of assessment.

STEP 2: Complete On-line Request for Burn Severity Assessment:

1. Go to http://burnseverity.cr.usgs.gov/fire_main.asp
2. Click on "Request Data"
3. Click "NPS Burn Severity Mapping Requests"
4. Fill out form:
    - Under "Type of Analysis" enter the assessment type. The options are Extended, Initial, or Both. Your default selection should not be "both". If you request an Initial or both (initial and extended assessment), you will need to write a brief justification on why the IA is needed.
    - Make sure to list smaller secondary fires in the request. Burn severity assessments can detect fires that are around ten acres; if these fires are included in the request, USGS EROS Data Center (EDC) will map their perimeters when feasible. Also, inclusion of these fires may influence what pre- and post-fire scenes that EDC selects for the assessment.
    - If there is urgency, please state that in the comment section of the request form and EDC will try to complete the assessment as soon as EDC acquires acceptable Landsat scenes.

Timeframe and Products

Once the request is submitted, EDC will begin selecting and processing Landsat data. Scene selection for extended assessment depends on when green up occurs and in high elevation fires this may not happen until late summer. For extended assessment there is usually no urgency in completing the assessment, however, EDC will try to have most assessments completed by fall.

When the assessment has been completed, EDC will post the results on the National Burn Severity Mapping Project website under the *Data Archive* link, and will send the primary contact person, identified in the on-line request form, three cds:

- One cd will have an ArcView project with a full Landsat scene dNBR, a rescaled first draft of burn severity classes, the fire perimeter, and metadata.
- The other two cds will have the pre- and post-fire Landsat scenes in the park's designated projections and in the Geo-tiff format, (see *Data Contents* link for further details).

If you have any questions regarding completion of the burn severity assessment request form, or what type of assessment to request, contact USGS EDC or NPS Fire Ecology Program Lead:

- Stephen Howard, EDC, 605-594-6027, smhoward@usgs.gov

- Don Ohlen, EDC, 605-594-6026, ohlen@usgs.gov
- Nate Benson, NPS, 208-387-5219, nate_benson@nps.gov

D. Fire Monitoring Plan Outline

The following outline is recommended as a format for the Fire Monitoring Plan.

Title Page with signatures (Submitted by Fire Ecologist: Reviewed by Chief of Resource Management, Fire Management Officer; Approved by Regional Fire Ecologist).

Table of Contents

I. Introduction
> Provide a brief overview and history of unit's Fire Management Program and Fire Monitoring Program.

II. Model
> This section is the biological basis for the development of objectives. If an adequate model exists in the Fire Management Plan, Resource Management Plan, Inventory and Monitoring Plan, or elsewhere, it could be referenced and summarized. If cultural landscapes are present, describe how fire and fuels treatments are used to restore or maintain these landscapes.
> A. There should be ecological descriptions of the plant communities that may include:
>> - dominant species
>> - T&E and other species of management concern
>> - ecological descriptions of dominant and important species
>> - summary of relevant fire effects monitoring data
>> - environmental determinants and stressors
>> - historical role of fire
>> - alteration of fire regimes
>> - other disturbance regimes, and how they interact with fire
>> - successional trajectories
>> - assumptions made to create the model
> B. Consider including box-and-arrow diagrams illustrating:
>> - functional relationships between communities
>> - successional trajectories associated with various fire regimes
>> - environmental influences and impacts of stressors
> C. Discuss how these vegetation communities relate to monitoring units.
> D. Discuss other factors that may necessitate monitoring (e.g. fauna, air quality, reference conditions).
> E. Include references.

III. Management Objectives
> A. Desired Future Conditions (from Resource Management Plan and Fire Management Plan). Include desired vegetation structure and desired disturbance regimes.
> B. Fire Management Objectives (Prescribed Fire, Wildland Fire Use, Mechanical Treatments) by monitoring unit. Refer to Chapter 3 of FMH.

    C. Rationale for choice of attributes to be measured, amount of change, and Desired Future Conditions.

IV. Monitoring Design
    A. Monitoring levels – Describe the four levels of monitoring and discuss which management activities will be monitored at what levels.
    B. Environmental and Fire Observation
- Environmental Monitoring (Level 1) -variables to be monitored.
- Fire Observation Monitoring (Level 2) -variables to be monitored.

    C. Short (Level 3) and Long (Level 4)Term Monitoring
- Monitoring Units
  - Describe all current and potential monitoring units, including those for burn severity, and photopoints.
  - Discuss potential monitoring units that likely to be monitored in the future.
  - Provide rationale for not monitoring specific treatments.
- Monitoring Objectives – Discuss the precision required (Refer to Chapter 3 of FMH).
- Sampling Design
  - Describe sampling methods for each monitoring unit in detail.
  - Cite the FMH when pertinent, and include all other protocols used.
  - Provide justification of protocols. Describe monitoring frequency, pilot sampling and the randomization process.
  - Discuss methodology for post-wildland fire monitoring as would occur under a BAER plan, CBI, or in the event that other established plots are burned.
- Field Measurements – Describe how plots are marked, location of maps, and timing of monitoring (phenologically and by calendar).

    D. Monitoring of Non-Fire treatment
- Monitoring Units – Describe all current and potential monitoring units.
- Monitoring Objectives – Discuss the precision required (refer to Chapter 3 of FMH).
- Sampling Design
  - Describe sampling methods for each monitoring unit and provide justification.
  - Discuss results of pilot sampling.
  - Describe monitoring frequency.
  - Describe randomization process.
  - Provide justification of methodology.
  - Cite FMH (if pertinent), and describe any other methods used.
- Field Measurements – Describe how plots are marked, location of maps, timing of monitoring (phenologically and by calendar), and frequency of monitoring.

V. Data Management & Analysis
    A. Describe the data management system, location of data (hardcopies and electronic), GIS layers and photos, and who has access to database. Describe process for backing

up data and quality control or refer to data stewardship plan if completed (see RM-18, chapter 11, section III D- Data Management).
B. Describe intended analysis of data, including timing of analysis and minimum plot calculations if pertinent.

VI. Roles and Responsibilities
A. Describe the roles and responsibilities of Fire Ecologist, Lead and Assistant Lead Fire Effects Monitors, FMO, Chief of Resources, Prescribed Fire Specialist, Regional Fire Ecologist and others.
B. Discuss the process for development of annual work plans and work prioritization.
C. Discuss collaboration with NPS Inventory and Monitoring program, Exotic Plant Management Teams, and Interagency groups.

VII. Reporting and Adaptive Management
A. Describe the methods by which fire effects and all other monitoring information will be communicated to park staff (fire, resource and park management) e.g. prescribed fire reports, annual park reports, presentations at annual meetings. Mention annual reports to be sent to the Regional and National office.
B. Discuss how the fire effects data will be used to effect adaptive management. Discuss the possible management actions that should be considered if treatment (prescribed fire, wildland fire use and nonfire treatment) objectives are not being met. Describe how monitoring data will be incorporated in the annual update of the fire management plan.
C. Discuss any publications that include monitoring data.

VIII. Consultation and Review
List all people who provided input to the plan, including cooperators providing a reference(s) to each person's contributions. It is recommended that three peer reviews are conducted.

IX. References – provide citations for scientific literature and policy documents.

X. Appendices
A. Monitoring Unit Descriptions
B. Maps- Monitoring Units, Vegetation and Fuels, Fire Management Units, Plot Location, Fuels, FRCC
C. Monitoring Schedule (to be updated annually). Reference Long-Term Fuels Treatment Plan
D. Plant specimen voucher collection/plant list
E. Data Sheet Examples, if non-FMH data sheets are used
F. Job Hazard Analysis