FIRE MONITORING PLAN

REDWOOD NATIONAL PARK

 

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CONTENTS

Introduction 4

Redwood Fire Management History 4

Redwood Fire Monitoring History 9

Fire & Fuels Management 11

Ecology & Landscape Management 13

The Bald Hills 15

Coastal Prairies 19

Little Bald Hills 20

Second Growth Forest 22

Boyes Prairie 23

Management Goals & Objectives 25

Fire Management Objectives 25

Monitoring Design 26

Data Management & Analysis 32

Data Management & Quality Control 32

Data Analysis 36

Reporting & Adaptive Management 37

Collaboration 37

Roles & Responsibilities 38

Staff Roles & Responsibilities 38

Work Plans & Prioritization 39

Plan Input and Acknowledgements 40

References 42

Appendices 46

A. Data collection tools and references 46

B. Plant List & Voucher Collection 46

C. Job Hazard Analysis 55

D. Customized Data Sheet Examples 60

E. FFI User Guide 66

F. Maps 75

F. Monitoring Schedule 84
G. Bald Hills "Fir Plots" Methodology 90
I. Bald Hills Oak Woodland (FQUGA1D09) Canopy Cover Protocol 94
J. Bald Hills Oak Woodland (FQUGA1D09) FMH-4 95
K. Bald Hills Mixed Prairie (GMIPR1D03) FMH-4 98
L. FEMO Report Template 100

On the cover: Images from the 2008 Copper Creek prescribed fire in the Bald Hills.

INTRODUCTION

The fire ecology program at Redwood National Park is responsible for providing monitoring and research support to Redwood's fire management program. This ensures that fire management is based upon the best available science and knowledge. The fire ecology program assesses fire management actions through monitoring and evaluation of management objectives. This fire monitoring plan communicates the monitoring and evaluation strategy used to measure fire management program success. It is an appendix to Redwood's Fire Management Plan or RFMP (USDI NPS 2010), and is updated annually by fire ecology program staff.

When Redwood National Park was created in 1968, it included three state park units (Del Norte Redwoods, Jedediah Smith Redwoods, and Prairie Creek Redwoods State Parks) within its boundaries. It was assumed that the state park lands would be donated to the National Park Service (NPS), but this never happened (USDI NPS CDPR 2000). This situation formed an opportunity for a unique partnership between the NPS and California Department of Parks and Recreation (CDPR) to jointly manage these lands for resource protection, visitor experience, and overall efficiency (USDI NPS CDPR 2000). While Redwood's Fire Management Plan is written for the Redwood National and State Park (RNSP) partnership, this Fire Monitoring Plan includes and applies to only NPS lands. The one exception to this is long-term fire effects monitoring in Boyes Prairie of Prairie Creek Redwoods State Park, which is discussed later in this plan. Redwood's fire monitoring program was a consequence of NPS policy such as Director's Order # 18: Wildland Fire Management (USDI NPS 2008a) and its accompanying Reference Manual #18: Wildland Fire Management (USDI NPS 2008b) that mandated monitoring of NPS prescribed fire programs. Integrating the three state parks within the RNSP partnership into Redwood's fire monitoring program is a future possibility.

REDWOOD FIRE MANAGEMENT HISTORY

Early fire management at Redwood was the responsibility of the protection ranger staff. Total fire suppression was the sole fire management objective from the park's inception in 1968 until 1980. Engine stations were established during the early 1980s at Hiouchi and Wolf Creek, and wildland fires were aggressively suppressed.

District Rangers were responsible for each engine, fire equipment, and initial attack response within their assigned areas of the park. They were required to respond to all fires within their district and act as Incident Commander, while permanent and seasonal protection staff was required to respond to fires and assist in a capacity commensurate with their qualifications. Every summer one to three fire control aids were hired for each engine; they were responsible for all of the engine maintenance, prevention and pre-suppression activities. In addition to the protection staff and the seasonal fire control aids, all fireline qualified (e.g., red carded) park personnel were expected to remain fire ready during critical fire danger periods and available for call-out after the ranger staff resources were exhausted (USDI NPS 1985).

Schoolhouse Peak lookout was built in 1940, and was staffed and owned by CAL FIRE (California Department of Forestry). The lookout was staffed seven days a week starting July 1st, unless conditions warranted an earlier season start, until the end of the fire season (USDI NPS 1985). In the late 1990s, the building along with the responsibility of staffing the lookout was transferred from CAL FIRE to the park. In 2005, it was determined that staffing the lookout full-time was no longer necessary. Currently the lookout is staffed only during prescribed fire season and periods of lightning activity within the area (J. McClelland, pers. comm.).

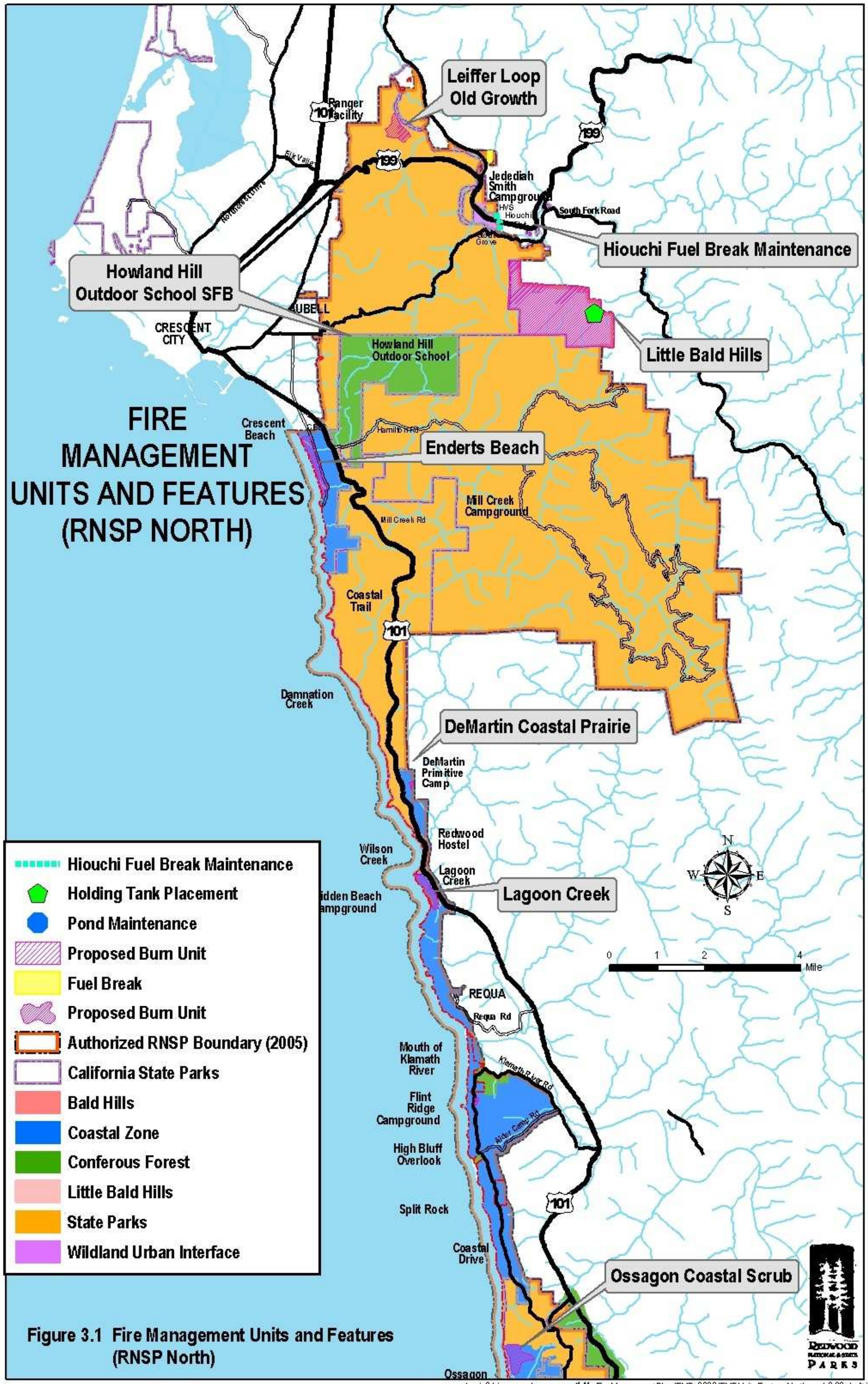


Figure 1. Northern segment of Redwood National and State Parks shown by Fire Management Unit (FMU).

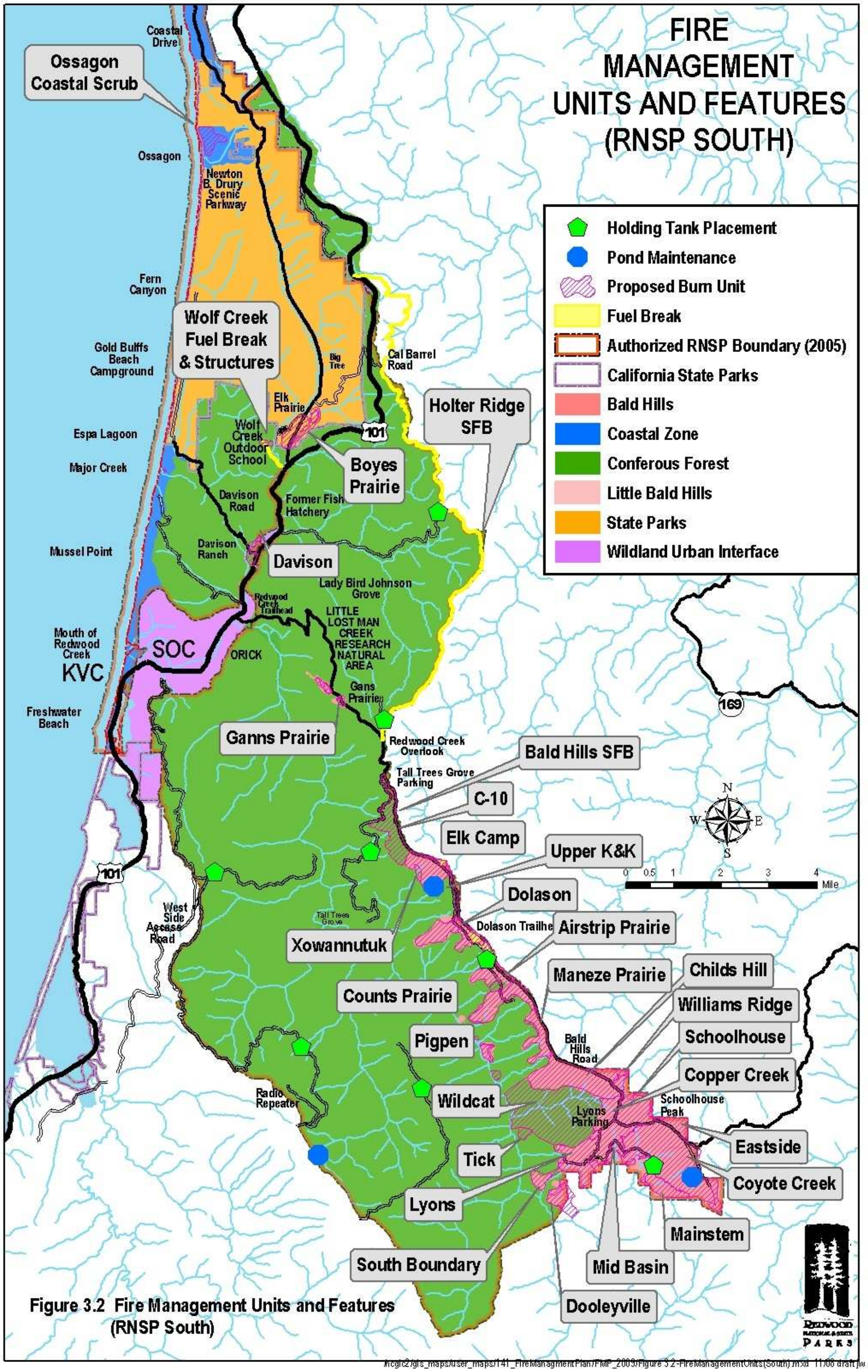


Figure 2. Southern segmnet of Redwood National and State Parks by FMU.

The Bald Hills region was added to the park's land base as part of the 1978 park expansion. The Bald Hills contain 2500 acres of prairie and 1700 acres of Oregon white oak (*Quercus garryana* var. *garryana*) woodland, all of which are fire-dependent and fire-maintained (Sugihara and Reed 1987, USDI NPS 1992). The prairies and oak woodlands are rich in biodiversity and provide habitat for many species (Sugihara and Reed 1987, USDI NPS 1992). Years of fire exclusion, combined with road building, cultivation, and over a century (1864 – 1982) of livestock grazing, facilitated the encroachment of prairies and oak woodlands by Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) and grand fir (*Abies grandis*) (Sugihara and Reed 1987). Some prairies and oak woodlands have experienced advanced encroachment, resulting in total conversion to conifer forest. Redwood resource managers, particularly vegetation management staff, realized the need for prescribed fire to restore and manage these ecosystems. In 1980, the vegetation management staff conducted the park's first prescribed burn in the Bald Hills.

Figure 3. A Bald Hills oak woodland being encroached by young Douglas-fir. Redwood NP photo.

Experimental prescribed burning in the Bald Hills continued through the 1980s on a small scale; by 1992, park staff had implemented fifteen prescribed burns treating a total of 356 acres (USDI NPS 1992). During this time, one small prescribed fire was conducted in the coastal prairie vegetation type at Flint Ridge; additional coastal prairie burns were planned for Enderts and Hidden Beaches but never implemented (L. Arguello, pers. comm.). Fire management at Redwood was a splintered operation, with protection staff covering fire suppression and vegetation management staff conducting prescribed fire management. In 1993, Stephen Underwood joined Redwood's staff as the Chief of Vegetation Management. The prescribed fire program blossomed under Underwood's leadership in the 1990s, and a prescribed fire specialist position was added to the staff in 1998. The prescribed fire program continued to grow and evolve, and many of the Bald Hills' prairies and oak woodlands were treated with prescribed fire. As vegetation management staff turned their focus to redwood forest management (especially second growth management), the need for a comprehensive fire program at Redwood became apparent (L. Arguello, pers. comm.). In 2003, a dedicated Fire Management Officer (FMO) position was added to the staff, and a Fire Management Branch was created to unify both prescribed fire and fire suppression efforts.

Prescribed burning being proposed under the 2010 RFMP continues work in the Bald Hills' prairies and oak woodlands, and expands into second growth redwood forest and coastal prairies. All Bald Hills' prairies and oak woodlands are contained within prescribed burn units and are set to burn on a 3 – 7 year rotation (USDI NPS 2005). Second growth units to be burned under the new plan are the C-10 (339 acres), Upper K&K (40 acres), and Wildcat (1054 acres). The coastal prairie units of DeMartin Prairie (4.7 acres), Enderts (109 acres), Lagoon Creek (68 acres), and Major Creek are slated to burn under the new RFMP.

As management planning in the Bald Hills progressed, it was realized that prescribed burning was not a panacea for restoration of prairies and oak woodlands. Larger Douglas-fir are rarely killed with prescribed fire (Uchytil 1991), and larger grand fir are also moderately resistant to low severity fire (Howard and Aleksoff 2000). In the mid 1980s, experimental girdling of Douglas-fir occurred in oak woodlands in the Copper Creek and Childs Hill areas. In 1991, a conifer cutting program was launched by vegetation management staff to aggressively remove encroaching fir in prairies and oak woodlands (L. Arguello, pers. comm.). Generally fir < 24" diameter were cut or girdled in prairies, oak woodlands, and the prairie/oak woodland ecotone. Isolated, larger fir were occasionally cut or girdled if it was determined they did not provide habitat for threatened, endangered, or sensitive wildlife species. Resulting material from the conifer cutting program was stacked by roadsides for firewood when feasible, lopped and scattered across prairies, or burned in discrete piles that did not impact adjacent oak trees (L. Arguello, pers. comm.). The conifer cutting program's progress slowed in 1999 due to requirements for increased consultations to ensure compliance with protections for threatened, endangered, and sensitive wildlife species and cultural resources. The conifer cutting program in the Bald Hills is still operating on a small scale under the purview of the Vegetation Management branch.

Figure 4. Girdling of Douglas-fir in a Bald Hills' oak woodland/prairie ecotone.

The Fire Management branch routinely performs small-scale cutting and girdling of fir as part of prescribed burn unit preparation. Mechanical fuels reduction occurs along unit boundaries to strengthen the abilities of holding forces during prescribed fire operations, and around historic structures to boost their defensibility. Reducing fuels along the prairie/oak woodland ecotone has additional benefits of drying fuels and allowing fire to spread through this area, potentially killing invading fir (J. McClelland, pers. comm.). The 2010 RFMP proposes to use mechanical thinning to create shaded fuel breaks along portions of park boundaries and around park structures to create defensible space and facilitate control in case of wildfire.

Figure 5. Prescribed burn unit preparation in the Lower Elk Camp unit of the Bald Hills. Thinned materials are scattered across the prairie edge, where many small fir are concentrated.

REDWOOD FIRE MONITORING HISTORY

The Bald Hills are the epicenter of Redwood's prescribed fire program, and this is where fire effects monitoring work has been concentrated. Early efforts in the Bald Hills to monitor the effects of prescribed fire upon oak woodland and prairie vegetation were made by the vegetation management staff. In the early 1980s, four long-term prairie monitoring sites (treatment and control) were established in Childs Hill, Elk Camp, Maneze, and South Pasture prairies (USDI NPS 1992). All sites but Childs Hill had their control plots burned by wildfire, which resulted in these monitoring sites being abandoned. The Childs Hill monitoring plots have been continuously sampled and maintained by vegetation management staff since 1980. Four control and five treatment long-term oak woodland monitoring sites were established in 1985 as part of Sugihara and Reed's (1987) research; this monitoring effort was abandoned in the late 1980s.

Beginning in 1990, Redwood implemented an official long-term fire effects monitoring program based on the Western Region Fire Monitoring Handbook (1990b) protocols. The Western Region Fire Monitoring Handbook morphed into the NPS Fire Monitoring Handbook (2003), and this continues to be Redwood's standard monitoring protocol. The Fire Monitoring Handbook (FMH) includes different levels of monitoring (Levels I – IV) ranging from reconnaissance to long-term. FMH plots have been installed in the prairies and oak woodlands of the Bald Hills, and on a small and experimental scale in old growth redwood forests.

In 2008, the fire ecology program inherited a set of long-term monitoring plots from vegetation management and California State Park staff in Boyes Prairie of Prairie Creek Redwoods State Park. These plots were installed in the 1980s and have been continuously sampled over the years in concert with prescribed fire operations.

The evolution of staffing developments for the fire ecology program is best represented by a timeline:

- 1990 – 1992: Redwood's fire effects monitoring program was staffed by two dedicated seasonal fire effects monitors.
- 1993-1997: One of the seasonal fire effects monitor positions was converted to a permanent, subject-to-furlough lead fire effects monitor position, and the fire effects crew expanded their duties to include work at Lassen Volcanic National Park (LAVO), Lava Beds National Monument (LABE), and Whiskeytown National Recreation Area (WHIS). The fire effects crew was known as the "Northern California Fire Effects Monitoring Team." Student Conservation Association (SCA) volunteers were placed at each park (four total) to assist with field work and complete data entry.
- 1997: Two additional seasonal fire effects monitor positions were added in response to the expanding workload.
- 1998: One permanent, subject-to-furlough assistant lead fire effects monitor position was added to the crew, and Crater Lake National Park (CRLA) and Oregon Caves National Monument (ORCA) were added to the crew's responsibilities. The crew's name changed to the Klamath-Cascades Fire Effects Monitoring Team.
- 2000: One fire ecologist position was created and assigned to oversee the fire effects crew and take responsibility for data management and analysis. This was the inception of the Klamath-Cascades fire ecology program, consisting of the fire ecologist and the fire effects monitoring crew. The fire ecologist position was originally located at Redwood, with responsibilities for all six NPS units (CRLA, LABE, LAVO, ORCA, Redwood, and WHIS) in the Klamath Network (KLMN).
- 2000: The lead fire effects monitor position was converted to permanent full-time, and the crew consisted of the lead fire effects monitor, the assistant lead fire effects monitor, two seasonal fire effects monitors, and four SCA volunteers with responsibilities for fire effects monitoring work in the KLMN.
- 2001: The fire ecologist's duty station moved to WHIS. The supervision of the fire effects crew was transferred to Redwood's Chief of Vegetation Management.
- 2001: The fire effects crew consisted of a permanent, full-time lead fire effects monitor, a permanent, subject-to-furlough assistant lead fire effects monitor, three seasonal fire effects monitors, and one SCA volunteer.
- 2002: The use of SCA volunteers ended. The fire effects crew consisted of a permanent, full-time lead fire effects monitor, a permanent, subject-to-furlough assistant lead fire effects monitor, and four seasonal fire effects monitors. The crew configuration remained this way until 2008.
- 2002: An additional fire ecologist position ("Southern Cascades" fire ecologist) was created for the KLMN, based at CRLA and also covering LAVO and LABE. The "Klamath" fire ecologist continued to be responsible for work at Redwood, WHIS, and ORCA.
- 2003: A Fire Management Officer position was created for Redwood, and the supervision of the fire effects monitoring crew was transferred to this position.
- 2007: The Klamath fire ecologist's duty station returned to Redwood. This position regained the supervisory responsibilities for the fire effects crew.
- 2008: The Klamath-Cascades fire effects crew split into two crews ("Klamath" and "Southern Cascades"), working under the respective fire ecologists. Currently the Klamath fire ecology program consists of a fire ecologist, a permanent, full-time lead fire effects monitor and two seasonal fire effects monitors,

with responsibilities at Redwood, WHIS, and ORCA. The Southern Cascades fire ecology program consists of a fire ecologist, a permanent, subject-to-furlough lead fire effects monitor, and two seasonal fire effects monitors, with responsibilities at CRLA, LABE, and LAVO.

Redwood's long-term fire effects monitoring plot network consists of 26 FMH oak woodland plots, 37 FMH prairie plots, four FMH old growth redwood plots, and seven Boyes Prairie plots. Due to the workload issues faced by fire effects crews of the past, the decision was made in 1998 to reduce the number of oak woodland plots to 14 and the number of prairie plots to 18 (USDI NPS 1998). The excess plots were deemed "inactive" and were maintained as such. This workload reduction also eliminated one recommended FMH plot sampling event: the one year postburn visit. The crew split alleviated some workload issues, and in 2008, the "inactive" plots were re-activated after they were determined necessary for meeting minimum plot numbers for detecting change.

Additional monitoring has occurred, but it has been short-term and experimental in nature, and focused on measuring mortality of encroaching fir (both Douglas-fir and grand fir) in prairies and oak woodlands of the Bald Hills. The first attempt at monitoring fir encroachment utilized "Ecotone" plots and was implemented in 1999. This effort was abandoned in 2001, and no monitoring of prescribed fire induced mortality of encroaching fir occurred until 2008. A short-term monitoring protocol ("Fir Plots") is currently in place. This protocol is simple in nature and monitors fire management objectives from preburn to two years postburn. The current protocol is summarized in Appendix H. Currently 34 "Fir Plots" exist in the Bald Hills.

Limited monitoring of mechanical treatments has occurred. Two monitoring sites were established in 1985 by vegetation management staff to monitor vegetation recovery in areas of Douglas-fir removal; however, this monitoring effort was abandoned in the late 1980s. No monitoring of the conifer cutting program has been conducted by vegetation management staff. To date, the fire ecology program has not monitored any mechanical treatments performed by fire management staff. As mechanical treatments proposed under the 2010 RFMP are applied to park landscapes, monitoring will be conducted by the fire ecology program.

As Redwood's fire management program moves into treating second growth redwood (*Sequoia sempervirens*) forests, serpentine grasslands and Jeffrey pine (*Pinus jeffreyii*) woodlands of the Little Bald Hills, coastal prairies, and eventually old growth redwood forests with prescribed fire, additional monitoring protocols will be developed and implemented as appropriate. Some of these monitoring protocols will be designed at the project-level (especially for second growth forest burns) where burn prescriptions and fire management objectives are tailored to meet site-specific conditions. If existing NPS fire ecology protocols are not used to monitor management objectives, regional approval will be sought for the protocols used, as per direction in Wildland Fire Management: Reference Manual #18 (2008b).

FIRE & FUELS MANAGEMENT

One of the functions of the fire ecology program is to measure fire management objectives expressed as programmatic objectives for prescribed fire and mechanical treatment in the RFMP. The programmatic objectives are fine-tuned in individual prescribed burn plans and tailored to achieve site- and ecosystem-specific management strategies. Fire management objectives have their origins in park planning documents such as the Bald Hills Vegetation Management Plan (1992) or BHVMP, Redwood's Resource Management Plan or RRMP (USDI NPS 1994), and the Redwood National and State Park General Management Plan/General Plan or RNSP GMP/GP (USDI NPS CDPR 2000). The goals stated in park planning documents are provided below to illustrate how fire management objectives are tiered from and closely related to the overall vision for managing park ecosystems.

The RNSP GMP/GP outlines the overall strategy for managing the parks' natural and cultural resources. Those pertinent to the fire management program are listed here:

- Recognize the past and present existence of peoples in the region and the traces of their use as an important part of the environment to be preserved and interpreted
- Ensure that all resource management efforts are consistent with and supportive of the perpetuation of the redwood forest ecosystem as the prime resource of the parks
- Restore and maintain the RNSP ecosystems as they would have evolved without human influences since 1850 and perpetuate ongoing natural processes
- Cooperate with the timber industry, private landowners, and other government agencies to accomplish long-range resource management planning and reduce threats to RNSP resources
- Acquire and analyze baseline inventory data to determine the nature and status of the natural resources under RNSP stewardship
- Monitor selected resources and environmental factors to detect change and to distinguish natural variation from local and bioregional human-induced resource threats

The recognition of fire as a critical process for sustaining ecosystem health is not explicitly stated in the RNSP GMP/GP, but it is singled out as an important natural resource management objective in the RRMP. The RRMP expresses the following resource management objectives that relate to the fire management program:

- Restore and/or maintain the natural ecosystems of the park
- Continue with biological and physical restoration of park lands severely impacted by past land use practices
- Evaluate the changing influence of natural fire on park resources and cooperate with other agencies and landowners in the implementation of the fire management plan and the use of prescribed fire to restore natural fire effects to park ecosystems
- Minimize the impacts on park resources resulting from current human activity outside the park
- Preserve the prehistoric, historic, and contemporary traditional features that trace human use of the redwood region
- Develop basic resource information about the park's cultural resources and manage them in a manner consistent with the natural values for which the park was established

The goals of the fire management program as stated in the RFMP are tiered from the foundation laid in the RNSP GMP/GP and RRMP:

- Ensure firefighter and public safety are the highest priorities in every fire management action
- Protect the public, private property, and the natural and cultural resources of the park utilizing strategies and tactics commensurate with the values at risk
- Use fire as a management tool to meet resource objectives where deemed appropriate and identified risk is both manageable and acceptable
- Manage wildland fire complexes in order to protect resources at risk and minimize unacceptable impacts from fire
- Cooperate with adjacent landowners and land management agencies in the full range of fire management activities, respecting the jurisdiction, interests, and legal mandates of each participant
- Increase the understanding of the role and function of fire in the parks

- Restore fire as an ecosystem process in the parks' biotic communities to the fullest extent practical

Programmatic objectives for Redwood's prescribed fire program are listed in the RFMP and consist of the following:

- Returning fire as an ecological process within the park
- Improving, or at a minimum maintaining, the native plant species within RNSP
- Reducing the conifer encroachment within the grasslands and woodlands within the park

As stated in the RFMP, the programmatic objectives for mechanical thinning conducted by Redwood's fire management program will be modified for each project unit but will generally achieve the following:

- Retain larger trees (dominant and co-dominant tree species > 18" diameter at breast height or DBH)
- Remove tree limbs up to a set height to reduce ladder fuels
- Cut shrub species when present
- Remove intermediate and suppressed trees (< 18" DBH)

The programmatic objectives for the use of prescribed fire and mechanical thinning by the fire management program support overall park management goals and objectives for the judicious use of fire in maintaining and restoring park ecosystems.

ECOLOGY & LANDSCAPE MANAGEMENT

Redwood NP contains a diverse array of ecosystems, each adapted to a suite of natural processes that have shaped them for millennia. Fire is one such process, and defining its contemporary role can be convoluted and complicated. The historic (defined here as pre- EuroAmerican settlement) role of fire differs among park ecosystems, and its contemporary role can vary even within individual park vegetation communities based on factors such as elevation, slope, aspect, fog regime, species composition, historic Native American ignition patterns, and past land use. Most terrestrial park ecosystems have been affected by fire exclusion, which has altered them to varying degrees. Additional anthropogenic disturbances such as logging, livestock grazing, introduction of invasive organisms and pathogens, and climate change have caused and are causing drastic changes in ecosystem structure, function, and composition. Given the inherent complexity of ecosystem management and restoration, it is helpful to comprehend the task at hand by first creating ecological models.

The KLMN Inventory and Monitoring Program has developed multiple versions of ecological models that apply to parks within their network. The overarching model is called the Holistic Conceptual Model of Influences on Klamath Park Ecosystems (Sarr et al. 2007), and is represented by Figure 3 with slight modifications for purposes of this plan. The Holistic Conceptual model synthesizes all influences on park ecosystems into four categories: abiotic, biotic, dynamic, and human; and illustrates how the influences interact with park ecosystems and each other. The KLMN also uses a hierarchical biodiversity model created by Noss (1990); this is depicted in Figure 4. The Noss model defines ecosystems by their structural, functional, and compositional attributes and incorporates scale into this characterization. Despite the complexity involved in synthesizing this information into a coherent fire management strategy, the park has distilled its management concerns into a few key variables that it actively manages and monitors (Figure 5).

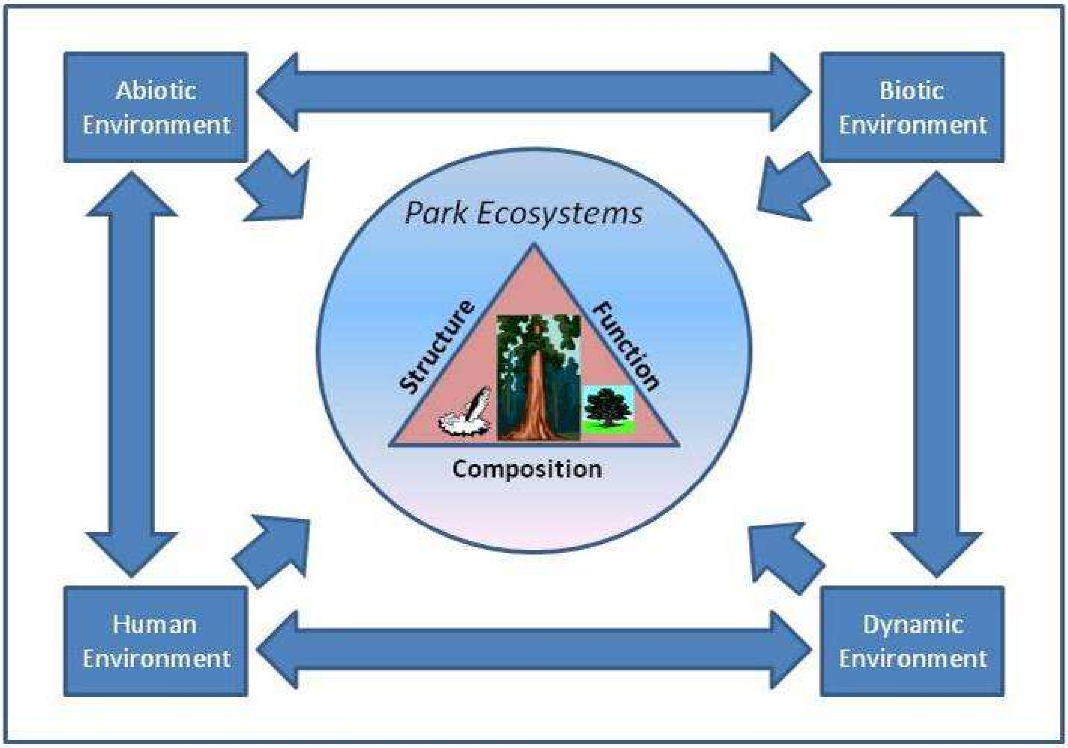


Figure 6. KLMN Holistic Conceptual Ecological Model redrawn from Sarr et al. (2007).

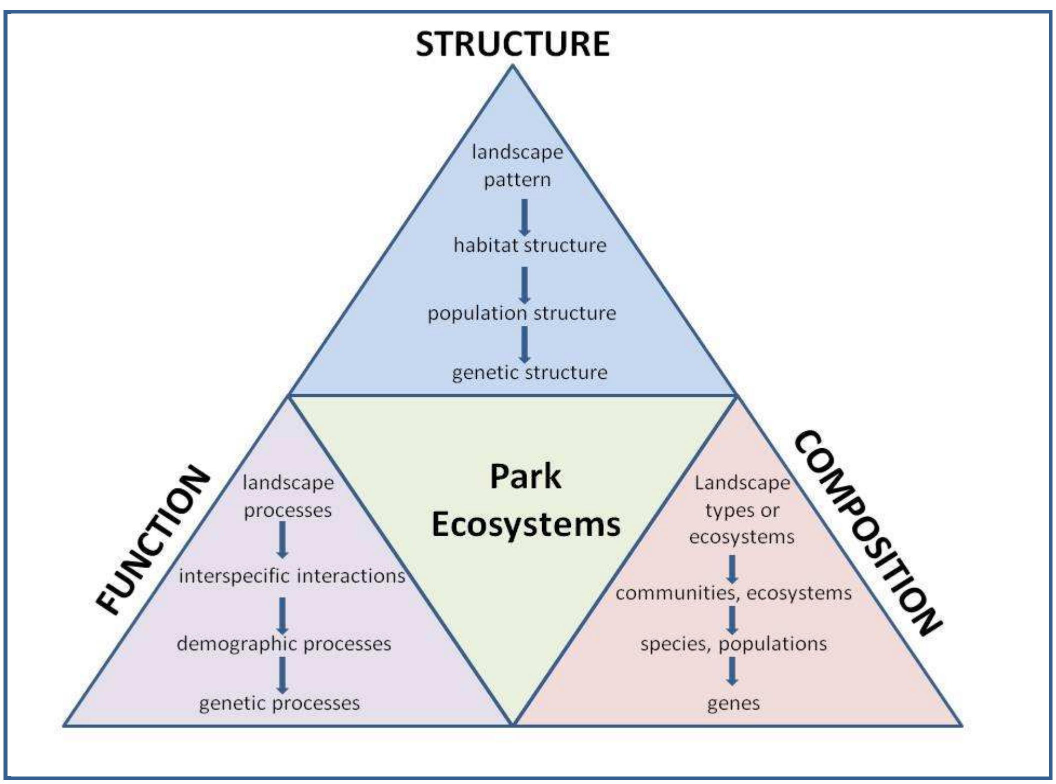


Figure 7. KLMN Hierarchical biodiversity model based on Noss (1990), redrawn from Sarr et al. (2007).

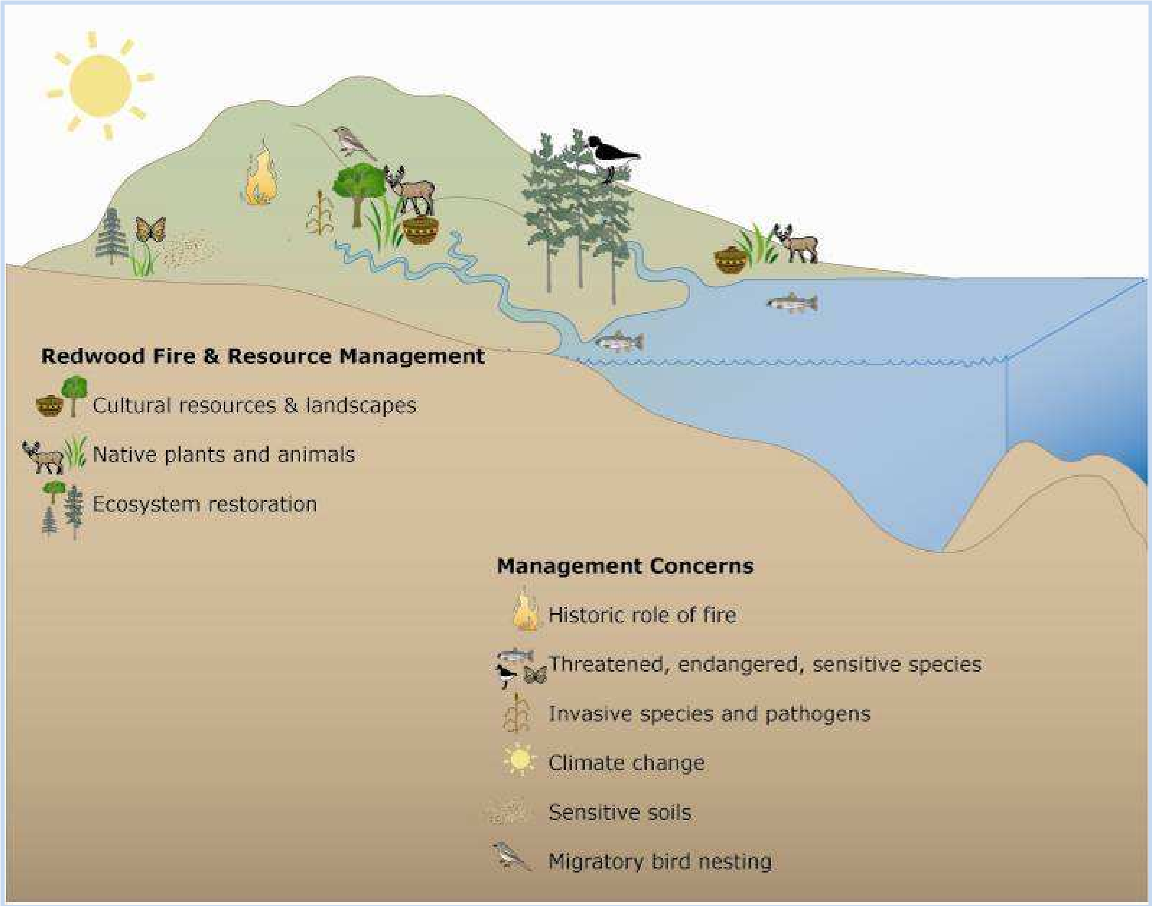


Figure 8. An ecosystem model depicting fire and resource management features and concerns at Redwood. Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science.

The Redwood Fire Management Plan Environmental Assessment (2010b) discusses the vegetation communities, cultural resources, special-status species, and other issues that need to be considered when making fire and resource management decisions. The Affected Environment (pp. 34-67) and Environmental Consequences (pp. 68-143) sections provide a foundation for how park ecosystems have evolved with fire, and describes their resiliency and resistance to fire. That discussion is expanded upon here for the vegetation communities that are scheduled for treatment with prescribed fire under the RFMP.

THE BALD HILLS

Redwood's Bald Hills region encompasses 4200 acres of prairie and Oregon white oak woodland along the eastern edge of the lower Redwood Creek drainage. Interspersed among and adjacent to the oak woodland and prairie include old growth redwood forests; second growth forests of redwood and Douglas-fir; and mixed evergreen-hardwood forests of Douglas-fir, tan oak (*Lithocarpus densiflorus* var. *densiflorus*), California bay (*Umbellularia californica*), and Pacific madrone (*Arbutus menziesii*). Oak woodlands and prairies have experienced varying degrees of encroachment by Douglas-fir and grand fir; grand fir affects areas along the lower slopes of Redwood

Creek that are closer to the ocean and receive much fog. The Bald Hills region supports a large diversity of plant and animal species including two amphibian species, five reptile species, 34 mammal species, 64 bird species, 231 plant species recorded in the oak woodlands, and 284 plant species recorded in the prairies (USDI NPS 1992). The oak woodlands are dominated by Oregon white oak, with occasional black oak (*Quercus kelloggii*), Douglas- and grand fir, tanoak, and Pacific madrone. Their understory consists of native and non-native annual and perennial grasses and forbs, with occasional shrubs present. Common understory vegetation in the oak woodlands includes blue wildrye (*Elymus glaucus*), tall oatgrass (*Arrhenatherum elatius*), hedgehog dogtail (*Cynosurus echinatus*), California brome (*Bromus californicus*), vetch (*Vicia* spp.), bedstraw (*Galium* spp.), and Torilis (*Torilis arvensis*). The prairies are dominated by native and non-native annual and perennial grasses and forbs including tall oatgrass, hedgehog dogtail, sweet vernal grass (*Anthoxanthum odoratum*), California oatgrass (*Danthonia californica*), orchard grass (*Dactylis glomerata*), sedge (*Carex tumulicola*), cat's-ear (*Hypochaeris* spp.), and sheep sorrel (*Rumex acetosella*).

The Bald Hills region was occupied by Native Americans for at least 6000 years prior to their removal in 1864 (Benson 1983, Bickel 1979, and Hayes 1985 in Sugihara and Reed 1987). The 1850s were the beginning of the Bald Hills' ranching era, which was characterized by sheep and cattle grazing, introduction of non-native pasture grasses, cultivation of cereal grains and crops, and selective timber harvest (USDI NPS 1992). Beginning in the 1940s, old growth redwood and Douglas-fir were commercially logged; this resulted in the construction of roads and skid trails (USDI NPS 1992). The Bald Hills region was added to Redwood's land base during the 1978 park expansion; the 2300 acre Coyote Creek (Morganroth/McKee property) addition was acquired in 1991.

The prairies and oak woodlands are fire-maintained; they become choked by encroaching woody species, especially Douglas-fir and grand fir, in the absence of fire (Sugihara and Reed 1987). The lightning regime of coastal Northwestern California consists of few starts in the summer months, and Native Americans are widely considered to be the primary ignition source in this area (Stuart and Stephens 2006). Fire was one of the most important tools used by Native Americans to manage their environment. They burned for many reasons, including facilitating travel; improving the quality and quantity of plants used for food, medicine and materials; driving animals for hunting; enhancing defense and visibility; and preventing catastrophic fire (Anderson 2005, Sawyer 2006). With the absence of fire, woody species (especially Douglas-fir) become established in the prairies and oak woodlands. As canopies of encroaching species close, much herbaceous diversity and wildlife habitat is lost (Sugihara and Reed 1987).

Native Americans regularly and frequently applied fire to the Bald Hills, perhaps as often as every one to two years (Sugihara and Reed 1987). Much is unknown about the timing, placement, specific purpose, and rotation of Native American ignitions, but research (Arguello 1994) has supported fall burning for promoting native plants in the Bald Hills. The current strategy for burning the Bald Hills is on a 3 – 7 year rotation from August – December. Burn units are classified into "early" and "late" units, depending on whether they are burned prior to or after the arrival of fall rains. "Early" burn units contain fireline, mowline, or roads along the entire perimeter to keep the fire contained. "Late" burn units combine human-made fire control lines with forest edge to contain the fire to the lighter, grass-dominated fuels of the prairies and oak woodlands. The forest edge serves as a natural fire barrier due to heavier fuels and closed canopy conditions that hinder fuel moisture loss.

Livestock grazing, cultivation, road building, and timber harvest have facilitated the introduction of many non-native plant species to the Bald Hills, including highly invasive species such as Scotch broom (*Cytisus scoparius*), Himalayan blackberry (*Rubus discolor*), tall oatgrass, and Harding grass (*Phalaris aquatica*). Redwood fire and resource managers are concerned not only with the restoration of fire as an ecosystem process, but also with maintaining the integrity of native plant species that comprise park vegetation communities. Disturbances such as fire can promote and facilitate the spread and dispersal of non-native plants, and in some situations exacerbate the balance between native and non-native plant species (Agee 1996, Tveten and Fonda 1999, Maret and Wilson 2000, Wilson et al. 2004, Maret and Wilson 2005).

Two threatened species, the northern spotted owl (*Strix occidentalis caurina*) and the marbled murrelet (*Brachyramphus marmoratus*), and one candidate species for listing, the Pacific fisher (*Martes pennanti*) are found in old growth forests within the Bald Hills region. Protections for these species affect preparation and ignition of prescribed fire units that contain, adjoin, or are within 500' of threatened and endangered species habitat. These protections limit the use of mechanized equipment and prescribed fire ignitions to outside the nesting, denning, and breeding period of February 1 – September 15, unless immediately adjacent to a well-traveled road (Bensen 2009). This period may be adjusted based on recent wildlife survey findings. Protections for migratory bird nesting habitat are also considered when preparing prescribed fire units for treatment. These include limiting the cutting of brush to outside the May 31 - July 31 nesting window. Additionally, large snags (> 36" DBH) and large downed logs (>36" diameter on long end and > 10' long) are retained when possible during prescribed fire operations to protect mammal, bat, and cavity nesting bird habitat.

Figure 9. Prescribed fire in the Bald Hills.

Two types of protocols are utilized to monitor fire management objectives in the Bald Hills: FMH and "Fir Plot." FMH monitoring is long-term in nature and focuses on the prairies and oak woodlands. Two FMH monitoring types are established in the Bald Hills: Mixed Prairie – GMIPR1D03, and Oregon White Oak – FQUGA1D09. FMH plots have been monitoring changes in the vegetation community in these two monitoring types since the early 1990s. Data show that fire management objectives are generally being achieved, even after multiple treatments (Figure 8). The number of plots (n) decreases as the number of burn cycles increase; this is due to some burn units being treated more frequently than others and also due to the 1998 inactivation of plots for workload management. As time passes and all units are treated multiple times with prescribed fire and re-activated plots are sampled, plot numbers should equalize among burn cycles.

Fire Management Objective	FQUGA1D09 – Change in native plant relative cover from original preburn conditions	GMIPR1D03 – Change in native plant relative cover from original preburn conditions
Do not reduce the relative cover of native plants by ≥ 10% two years postburn as measured from original preburn conditions	01YR02 (n = 17): +0.4% 02YR02 (n = 8): +5.1% 03YR02 (n = 7): +2.2% 04YR02 (n = 4): -6.5%	01YR02 (n = 27): +11.6% 02YR02 (n = 16): +5.6% 03YR02 (n = 13): +26.0% 04YR02 (n = 5): -0.2% 05YR02 (n = 2): +21.0%

Table 1. Fire management objective vs. FMH plot results for oak woodland (FQUGA1D09) and mixed prairie (GMIPR1D03) monitoring types. 01YR02 indicates two years after the first prescribed burn; 02YR02 means two years after the second prescribed burn; etc.

Fir Plots measure prescribed fire-induced mortality on small (< 3' tall) encroaching fir in prairies and oak woodlands. The protocol was implemented in 2008, and preliminary results suggest that fire management objectives are close to being achieved (Figure 7); additional plots are needed for a complete assessment. Fir Plot monitoring is short-term in nature, spanning from preburn to two years postburn. To date, 34 Fir Plots have been installed in three monitoring types: 16 plots in open prairie (5 have burned), 13 plots in "early" oak woodland units (5 have burned), and 5 plots in "late" oak woodland units (1 has burned). Fir Plots will be accompanied by an upcoming landscape-level assessment of fire and vegetation management success at meeting management targets for the Bald Hills established in the BHVMP.

Fire Management Objective	Change in live fir (< 3' tall) density immediately after the burn from preburn conditions
In open prairie, reduce density of live fir, < 3' tall, by ≥ 80% within two years of the burn	01 POST (n = 5): -76%
In "early" oak woodland units, reduce density of live fir, < 3' tall, by ≥ 70% within two years of the burn	01POST (n = 5): -66%
In "late" oak woodland units, reduce density of live fir, < 3' tall, by ≥ 50% within two years of the burn	01POST (n = 1): -100%

Table 2. Fire management objectives vs. Fir Plot monitoring results for prairie, "early" oak woodland, and "late" oak woodland monitoring types. 01POST indicates plots were sampled immediately (within 2 weeks - 2 months of the burn) postburn.

Reference conditions exist for the Bald Hills and are summarized in Sugihara and Reed (1987) and the BHVMP. These reference conditions are spatial (mapped in 1983) and delineate the extent of prairie and oak woodland as they existed in 1850.   The BHVMP classifies the prairies and oak woodlands into four categories:

1. Little Encroachment: Fir exist as seedlings or large individuals
2. Moderate Encroachment: Fir exist as dense thickets of saplings; fir occupy a subcanopy position in the oak woodlands
3. Heavy Encroachment: Prairie has been usurped by fir; fir is co-dominant with the oaks
4. Advanced Conversion to Conifer Forest: prairie is lost; fir is the dominant species in the oak woodland canopy and oaks are dead

Under the BHVMP, no action is proposed for Category 4 prairies and oak woodlands. Category 1 areas are maintained with prescribed fire on a regular frequency (every 5 – 10 years in the BHVMP; this has since been truncated to 3 – 7 years) with selected fir removal. Category 2 areas are regularly prescribed burned and treated by the conifer cutting program. Category 3 areas are first treated by the conifer cutting program, and then followed up with regular prescribed burning. Desired future conditions as expressed in the BHVMP are to restore Category 1 – 3 prairies and oak woodlands and maintain them with prescribed fire and conifer cutting. The previously mentioned landscape assessment will measure management success and progress with meeting this target.

COASTAL PRAIRIES

Coastal prairies are open areas dominated by perennial grasses and forbs in close proximity to the ocean. The coastal prairies may harbor the greatest plant diversity of any grassland in North America (Stromberg et al. 2001 in Stuart and Stephens 2006). The historic coastal prairie extent is thought to be created and maintained by Native American fire use (Veirs 1987). Coastal prairies are diminishing in size due to encroachment by woody species and are considered to be rare and endangered (Ford and Hayes 2007). In the absence of fire, coastal prairies are lost via succession to shrubland then forest dominated by species such as Sitka spruce (*Picea sitchensis*) and red alder (*Alnus rubra*) (Nuckols 2002).

Figure 10. Typical coastal prairie vegetation. Redwood NP photo.

Lightning-caused ignitions in and near the coastal prairies are rare (Kay 2007, van Wagtendonk and Cayan 2008). Native American population density along the coast was high (Sawyer 2006, Kay 2007), and coastal prairies were shaped by frequent Native American ignitions (Lewis 1973, Heady et al. 1977, Veirs 1987, Keeley 2002, Zobel 2002, Anderson 2005, Kay 2007). The frequency and timing of coastal prairie burning is unknown, although regional historic accounts indicate burning occurred during the fall and fairly often, perhaps even annually (Veirs 1987).

Coastal prairies are extremely productive grasslands, and early settlers capitalized on this by subjecting them to livestock grazing (Ford and Hayes 2007). Early accounts describe coastal prairies as dominated by native perennial grasses; today coastal prairies are heavily impacted by non-native plant species (Ford and Hayes 2007).

The 2010 RFMP proposes to burn four coastal prairie units, DeMartin (4.7 acres), Enderts (109 acres), Lagoon Creek (68 acres) and Major Creek (7 acres). No fire effects monitoring of the coastal prairies has occurred to date, although vegetation management staff installed 80 long-term monitoring plots at DeMartin prairie in 1982. These plots were last sampled in 1989 and may be difficult to relocate, especially since additional prairie has experienced encroachment since 1989. Reference conditions and desired future conditions have not yet been defined for the coastal prairies. Only one prescribed burn (1980) has been conducted within Redwood's coastal prairies. After this burn, cover of the dominant preburn species, orchard grass, was reduced, while cover of hairy cat's ear (*Hypochaeris radicata*) and lupine (*Lupinus* spp.) increased (USDI NPS 1995). After the burn, cover of pioneering non-native plant species increased, but then decreased over time as preburn vegetation recovered (USDI NPS 1995).

The Enderts prescribed fire unit may harbor the threatened Oregon silverspot butterfly (*Speyeria zerene hippolyta*). It has not been detected in the park to date, but it will be surveyed for prior to ignition (Bensen 2009).

LITTLE BALD HILLS

The Little Bald Hills (LBH) comprise approximately 1500 acres in the northeast corner of the park. The LBH are underlain by two unique soil assemblages: one of ultramafic origin (derived from serpentine, peridotite, and dunite parent materials), and one sedimentary soil high in clay and containing a shallow hardpan (Goforth and Veirs 1989). The ultramafic, or serpentine, soils are high in some elements considered toxic for plant life such as nickel, chromium, and magnesium, and contain low amounts of essential plant nutrients such as nitrogen, calcium, potassium, and phosphorus (Goforth and Veirs 1989, Harrison et al. 2004, Harrison et al. 2006). This combination of soil types results in a diverse suite of vegetation able to tolerate harsh growing conditions. Serpentine soils have been recognized as harboring a high amount of endemism by and diversity of native plants (Whittaker 1960, Goforth and Veirs 1989, Harrison et al. 2006a, 2006b). Twenty one plant species considered to be rare or uncommon by the California Native Plant Society are found within the LBH, primarily within the Jeffrey pine woodland.

Redwood's LBH are a matrix of Jeffrey pine woodland; knobcone pine (*Pinus attenuata*) woodland; chaparral/pygmy forest; Douglas-fir forest; Douglas-fir/Port Orford cedar (*Chamaecyparis lawsoniana*) forest; and Douglas-fir, redwood, and western hemlock (*Tsuga heterophylla*) forest (Goforth and Veirs 1989). Vegetation community descriptions are summarized from Goforth and Veirs (1989). The Jeffrey pine woodland comprises 360 acres and contains an abundant herbaceous understory dominated by Idaho fescue (*Festuca idahoensis*). Knobcone pine woodland has a shrub understory of primarily huckleberry oak (*Quercus vaccinifolia*) and tan oak

(*Lithocarpus densiflorus* var. *echinoides*). Chaparral occupies the sedimentary soils and consists of chinquapin (*Chrysolepis chrysophylla* var. *minor*), manzanita (*Arctostaphylos columbiana* and *A. viscida*), evergreen huckleberry (*Vaccinium ovatum*), rhododendron (*Rhododendron macrophyllum*), and salal (*Gaultheria shallon*) with diminutive Douglas-fir and knobcone pine trees interspersed within the shrubs. The Douglas-fir dominated forests are believed to exist on deeper serpentine soils with greater moisture-holding capacities (Goforth and Veirs 1989).

The fire history of the LBH is unknown beyond a large fire recorded in 1940 affecting knobcone pine woodland. A research project is underway that is investigating stand dynamics and fire history within the Jeffrey pine and knobcone pine woodlands of the LBH. Jeffrey pine woodlands are being encroached by Douglas-fir, which is due to fire exclusion (Goforth and Veirs 1989). Throughout its range, Jeffrey pine has been shown to decline without fire as it is replaced by more shade-tolerant and closed canopy creating species (Gucker 2007). Jeffrey pine is a fire-adapted species able to withstand or resist most fires due to its thick bark, self-pruning crown, protective bud scales, and mineral soil/high light requirements for seedling germination (Gucker 2007). Knobcone pine is also a fire-adapted species, but where Jeffrey pine adopts a "resister" life history strategy to survive low to medium intensity fires, knobcone pine shows an "evader" life history strategy to ensure it remains on site after fire (Agee 1993). Knobcone pine's fire "evading" adaptation is bearing serotinous cones that are sealed by resin and open only after exposure to heat (Howard 1992). Knobcone pine's regeneration requirements mirror the postfire environment, with abundant mineral soil and high light conditions necessary for seedling germination (Howard 1992). Knobcone pines are easily killed by even low-intensity fires due to their thin bark (Howard 1992). Fire maintains the knobcone pine woodlands within the LBH, and without recurring fire, the species could not persist (Goforth and Veirs 1989).

Figure 11. 2007 experimental prescribed burn in the Little Bald Hills' Jeffrey pine woodland.

One species of concern, the Mardon skipper (*Polites mardon*), is found within the Jeffrey pine woodlands and grasslands of the LBH. The Mardon skipper is a candidate for listing as a federally threatened or endangered species. Prescribed fire planning in the LBH involves Redwood's Fish & Wildlife staff to ensure that burn timing, size, frequency, and rotation are adequate for sustaining Mardon skipper populations. The size of a single burn in one calendar year within Mardon skipper habitat will be limited to 50 acres to ensure population viability (Bensen 2009). Prescribed fire will enhance and potentially expand Mardon skipper habitat by killing small fir encroaching upon Jeffrey pine woodlands and grasslands.

Only one small prescribed burn has been conducted in the LBH; this occurred in 2007 and treated three acres within the Jeffrey pine woodland. Reference conditions and desired future conditions for the LBH have not yet been developed. No fire effects monitoring has occurred in the LBH to date; although vegetation management has installed 270 monitoring plots in the LBH that were last sampled in 1984.

SECOND GROWTH FOREST

Almost 50,000 acres of old-growth redwood forest were logged between 1950 and 1978 in what is now Redwood National Park (USDI NPS 2008c). Stand development and recovery in these logged areas have taken many different trajectories based on the old growth stand composition, timber harvest techniques used (clearcutting vs. selective harvest), the type of equipment used to harvest trees, site characteristics (slope, aspect, elevation, soil type), and the reforestation technique used (aerial seeding, planting), if any (USDI NPS 2008c). Some of Redwood's second growth stands are in severe need of management, as many have little redwood dominance, very high stand densities, small diameters in relation to height, depauperate understories, and even tree canopies with very little diversity (USDI NPS 2008c).

Thinning is the primary means for restoring Redwood's second growth forests. Another tool for managing second growth redwood forests is prescribed fire. This has been used on a small scale within the park in recent years. The 17 acre D-A second growth prescribed burn unit was treated in 2007. Vegetation management staff installed 21 monitoring plots before the fire, and these plots were sampled one year postburn in 2008. Plot data indicate that large overstory trees (> 20 cm DBH) experienced a 3.6% reduction in density (from 577 trees/ha to 556 trees/ha) and a 2.1% reduction in basal area (from 67.9 m^2/ha to 66.5 m^2/ha) one year postburn. Smaller trees (< 20 cm DBH) experienced a 54.8% reduction in density (from 1052 trees/ha to 476 trees/ha) and a 22.4% reduction in basal area (from 8.5 m^2/ha to 6.6 m^2/ha) one year postburn. These results suggest that prescribed fire can be a very effective tool for causing mortality to smaller-diameter trees while favoring the retention of larger diameter trees, which is in line with management efforts to promote the development of old-growth forest characteristics in these stands.

No fire effects monitoring has occurred in second growth forests to date. In addition to the D-A plots, vegetation management staff manages 8 long-term monitoring plots in the Dolason Trailhead area that were treated with prescribed fire in 2003. Desired future conditions will be developed for each project unit due to the varied nature of second growth stands, and monitoring will be designed at the project level rather than developing a comprehensive second growth forest monitoring type. The 2010 RFMP proposes to burn three second growth units, the Upper K & K (40 acres), Wildcat (1054 acres), and the C-10 (339 acres). Burn severity data will be requested for the C-10 and Wildcat projects through the NPS-USGS Burn Severity Mapping program.

Figure 12. Prescribed burn in the Douglas-fir dominated D-A second growth unit, 2007.

BOYES PRAIRIE

The 125-acre Boyes Prairie in Prairie Creek Redwoods State Park is the only prescribed burn unit proposed for the state parks under the 2010 RFMP. This prairie has been treated with prescribed fire every two to five years since 1983. Boyes Prairie represents a transition zone between the coastal prairies next to the ocean and the upland interior prairies of the Bald Hills (L. Arguello, pers. comm.). Boyes Prairie's origins result from soil properties favoring herbaceous vegetation, and the historic prairie extent was created and maintained through regular Native American burning (Veirs 1987). Boyes Prairie is dominated by non-native and native perennial grasses and sedges such as sweet vernal grass, creeping bent (*Agrostis stolonifera*), California oat grass, Kentucky bluegrass (*Poa pratensis* ssp. *pratensis*), slough sedge (*Carex obnupta*), and common velvet grass (*Holcus lanatus*) (Veirs 1987).

Boyes Prairie has been heavily impacted since EuroAmerican settlement by activities such as livestock grazing, production of crops, tilling, drainage to improve agricultural pursuits, and various developments including a Civilian Conservation Corps (CCC) headquarters, a gift shop, and the construction of Highway 101 (now the Newton B. Drury Scenic Parkway) that bisects the prairie (Veirs 1987). As a result, the native plant assemblages and drainage patterns have been significantly altered.

In the absence of fire, the prairie becomes choked with invading species such as cascara (*Rhamnus purshiana*) and Himalayan blackberry, and especially the eastern margin becomes encroached by young redwood, Douglas-fir, western hemlock (*Tsuga heterophylla*), and Sitka spruce (Veirs 1987, CDPR 2009). Management objectives for burning include maintaining and restoring the prairie extent, improving elk habitat by decreasing cover of the unpalatable slough sedge, and increasing the cover of native plant species. The prairie is immediately adjacent to marbled murrelet and spotted owl habitat, so preparation and burning activities occur outside of the breeding and noise restriction periods. Prescribed fire preparation and ignition also occur outside the migratory bird nesting period, and snags are protected as much as possible during operations to protect wildlife habitat.

Fifteen long-term monitoring transects were established in 1986 to monitor the vegetation of Boyes Prairie. They have been sampled over time in coordination with prescribed fire treatments. Seven of these transects were taken over by the fire ecology program in 2008.

Figure 13. A postburn image of Boyes Prairie with a long-term monitoring plot stake in the foreground. Newton B. Drury Scenic Parkway bisects the prairie along the fence line. Redwood NP photo.

MANAGEMENT GOALS & OBJECTIVES

Evaluation of fire management actions is the primary purpose of Redwood's fire ecology program. Crafting fire management objectives is a task shared by Redwood's fire and resource management staff. The foundation of the objectives lies in previously mentioned park planning documents. Since prescribed fire has been one of Redwood's resource management tools since the 1980s, fire management objectives have evolved throughout the years. The general direction of park management with respect to prescribed fire has not changed much over the years; semantical changes have been made to fire management objectives and management targets have been revised over time. The fire management objectives stated here resulted from an interdisciplinary meeting of Redwood fire and resource managers in April 2009, and they were subsequently fine-tuned by the Chief of Vegetation Management and the fire ecologist. As the prescribed fire program is periodically assessed and evaluated, management objectives may again be revised as needed.

FIRE MANAGEMENT OBJECTIVES

The programmatic fire management objectives stated in the 2010 RFMP are expanded upon in individual prescribed burn plans to explicitly state the intended management target, the desired effect, and the timeframe for achieving management success. The fire management objectives provided here are the ones measured by Redwood's fire ecology program and the ones expressed in prescribed burn plans. They are organized by Fire Management Unit (FMU), and sometimes address specific vegetation communities.

Bald Hills:

- In open grassland, reduce density of live fir, < 3′ tall, by ≥ 80% within two years of the burn.
- Early Season Burns: In oak woodlands with conifer encroachment, reduce density of live fir, < 3′ tall, by ≥ 70% within two years of the burn.
- Late Season Burns: In oak woodlands with conifer encroachment, reduce density of live fir, < 3′ tall, by ≥ 50% within two years of the burn.
- Do not reduce the relative cover of native plants in oak woodlands by ≥ 10% two years postburn as measured from original preburn conditions.
- Do not reduce the relative cover of native plants in prairies by ≥ 10% two years postburn as measured from original preburn conditions.
- Do not reduce overall oak woodland canopy cover by ≥ 10% two years postburn as measured from original preburn conditions.

Coastal Prairie:

- Do not reduce native plant species diversity (alpha diversity or number of native plant species) by ≥ 10% two years postburn as measured from original preburn conditions.
- Do not reduce the relative cover of native plants by ≥ 10% two years postburn as measured from original preburn conditions.
- Reduce small (< 3′ tall) tree density and shrub cover by > 20% with two years of the burn.

Little Bald Hills:

- Do not reduce native plant species diversity (alpha diversity or number of native plant species) by ≥ 10% two years postburn as measured from original preburn conditions.
- Do not reduce the relative cover of native plants by ≥ 10% two years postburn as measured from original preburn conditions.
- Reduce density of small (< 3′ tall) conifers in prairies and woodlands by > 50% within two years of the burn.
- Reduce dead & down fuel loading in prairies by > 40% immediately postburn.

Second Growth Forests:

- Create ≤ ½ acre gaps (dead/dying trees with < 5% live crowns) in the second growth forest at an average rate of one gap per five acres, two years postburn.
- Increase mean stem diameter of residual mixed conifer stand by at least 10% two years postburn.
- Increase shrub and herbaceous cover by ≥ 25% two years postburn.
- Retain ≥ 50% of forest canopy throughout the unit with the same gap distribution as desired above two years postburn.

Boyes Prairie (Prairie Creek Redwoods State Park):

- Reduce cover of slough sedge (*Carex obnupta*) by any amount within two years of the burn.
- Increase diversity (alpha diversity or species richness; the total number of native plant species) of native plants by any amount within two years of the burn.
- Increase the relative cover of native plant species by any amount within two years of the burn.
- Reduce shrub cover and encroaching tree density by any amount within two years of the burn.

MONITORING DESIGN

Four levels of monitoring are ongoing at Redwood to support the fire management program. The Fire Monitoring Handbook (USDI NPS 2003) describes these levels in detail, and they are summarized here.

Level I: Environmental Monitoring

Level I environmental monitoring at Redwood consists of collecting data on weather, fire danger rating, fuel conditions, resource availability, and concerns and values to be protected (USDI NPS 2003). These monitoring data are used for both wildland and prescribed fires. There are two Remote Automated Weather Stations (RAWS) within the park maintained and operated by fire management staff; the Schoolhouse RAWS is located on Schoolhouse Peak in the Bald Hills, and the Westside RAWS is located on the A-9 Deck off the Westside Access Road. Fire danger and fuel conditions are tracked using National Fire Danger Rating System (NFDRS) indices available from the Weather Information Management System (WIMS) and the local dispatch office. Park staffing is outlined in the park preparedness plan and is linked to the NFDRS energy release component (ERC), while concerns and values to be protected are addressed in the RMFP. Monitoring of fire danger rating, fuel conditions, and resource availability occurs primarily during fire season at Redwood.

Level II: Fire Observations

This level of monitoring involves direct observations of wildland and prescribed fire at Redwood. It is divided into two parts: reconnaissance monitoring and fire conditions monitoring. Reconnaissance monitoring occurs on all wildland fires and is included in a fire "size-up" performed by the Incident Commander of the incident. The size-up consists of the following information and is delivered to the park Duty Officer: fire cause and ignition point, fire location and size, logistical information, fuels and vegetation description, topographic variables (slope, aspect, elevation), current and predicted fire behavior, fuel model, potential for further spread, current and forecasted weather, resource or safety threats or constraints, and smoke volume and movement (USDI NPS 2003). This information is also documented in a "Fire Report" form that is completed for each incident. Data from reconnaissance monitoring are updated and reported as needed for each incident.

Fire observation monitoring occurs on all prescribed fires and wildland fires that go into extended attack, and consists of collecting data on the following: ambient conditions (current and forecasted weather, seasonal outlooks, fire weather watches and warnings), fuel moisture, fire characteristics (fire behavior, fire size, spotting potential), smoke characteristics, holding options, and resource advisor concerns (USDI NPS 2003). Data from fire observation monitoring is updated and reported as needed for each prescribed burn or wildland fire, and may be included in the Wildland Fire Decision Support System (WFDSS) planning process for unplanned ignitions. One or more Resource Advisors will be assigned to any wildland fire that goes into extended attack at Redwood; the Resource Advisor Guide outlines natural and cultural resource concerns and issues related to managing wildland fires.

Many of these Level II variables are incorporated into modeling fire behavior and effects, identifying holding concerns and resource needs, and in the development of smoke management plans, individual prescribed burn plans and multi-year prescribed fire treatment plans. The Fire Monitor(s) or FEMO(s) assigned to individual prescribed burns are responsible for preparing a postburn report within one month of the burn to be filed with the prescribed burn plan. Many Level II monitoring variables are documented in the FEMO report; a FEMO report template for Redwood can be found in Appendix L.

Level III: Short-Term Change in Vegetation and Fuels

This level of monitoring occurs at Redwood to assess prescribed fire and mechanical treatment objectives that can best be addressed with a temporary, short-term approach. To date, Level III monitoring has been used only in assessing the effectiveness of using prescribed fire to kill encroaching fir seedlings (< 3' tall) in the Bald Hills' prairies and oak woodlands through the use of "Fir Plots." The complete Fir Plot methodology can be found in Appendix H. Other Level III monitoring protocols that will be used on larger wildland and prescribed fires at Redwood are the Composite Burn Index and Normalized Burn Ratio (Key and Benson 2006). Additional Level III monitoring will be used to assess mechanical treatment success through repeat photography at established photo points.

Level IV: Long-Term Change in Vegetation and Fuels

Long-term monitoring is the standard for assessing prescribed fire objectives at Redwood. FMH protocols have been utilized to monitor the Bald Hills' oak woodlands and prairies since 1990; almost twenty years of monitoring data exist that cover as many as six burning cycles. FMH methodology has also been used in a very limited and experimental fashion in the old growth redwood forest. Level IV monitoring has been used since 1986 in Boyes Prairie of Prairie Creek Redwoods State Park. Level IV monitoring will be used to assess management success at treating second growth forests, coastal prairies, the Little Bald Hills, and eventually old growth redwood forests.

As park managers prepare to treat these areas with prescribed fire, target conditions and desired future conditions will be developed by park staff, and a monitoring design will be developed by the fire ecologist.

Minimum Plot Determinations for Monitoring Levels III and IV

Minimum plot numbers are not calculated for certain Level III monitoring such as photo points and Composite Burn Index plots. Minimum plot numbers have not and will not be calculated for the Boyes Prairie plots due to their purpose to track vegetative trends rather than rigorously detect change after treatment with prescribed fire. To date, all of the prescribed fire objectives measured by the fire ecology program are "change" objectives, meaning that they seek to cause some change in target variables within a set timeframe through management action (USDI NPS 2003). Minimum plot numbers for short and long-term monitoring of "change" objectives are determined using a sample size equation described in Elzinga et al. (1998) to detect the difference between two means using paired sampling units. The equation is summarized here:

$$n = (s)^2(Z_\alpha + Z_\beta)^2/(MDC)^2$$

where: s = standard deviation of the difference between paired samples

Z_α = Z-coefficient for the false-change error rate

$Z\beta$ = Z-coefficient for the missed-change error rate

MDC = Minimum detectable change size expressed in absolute terms

Redwood's fire monitoring objectives are to monitor change objectives at the following levels:

- Confidence level = 80%
- Statistical power = 80%
- False-change error rate, α = 20%
- Missed-change error rate, β = 20%

Monitoring Design: Bald Hills Oak Woodland (FQUGA1D09)

The FQUGA1D09 monitoring type is based upon standard FMH forest plot protocol, described in detail in the Fire Monitoring Handbook (2003). Within each 50 m x 20 m plot, the following data are collected:

- <u>Overstory Trees (> 15 cm DBH)</u>: species, live/dead status, DBH, crown position code, damage, scorch height, char height, percent of canopy scorched; trees are mapped and tagged
- <u>Pole-Size Trees (< 15 cm DBH and > 2.5 cm DBH)</u>: species, live/dead status, DBH, height; trees are mapped and tagged
- <u>Seedling Trees (< 2.5 cm DBH)</u>: species, live/dead status, height, whether seedling originates from seed or sprouting

- Understory Vegetation: species, height of tallest vegetation, live/dead status, invasive plant species of concern

- Dead & Down Fuel Loading: litter depth; duff depth; loading of 1, 10, 100, and 1000 (sound & rotten) fuels

- Burn severity: quantitative estimate of burn severity to substrate and vegetation

- Photos: repeat photography documents changes over time on eight permanent photo points per plot

- Physical data: slope, aspect, UTM coordinate location, plot location

Very little documentation exists to explain how plots were installed during the early years of FMH monitoring other than that they were located in a random fashion (USDI NPS 1990a). Plots are typically sampled from July through September. During years with heavy workloads, often the vegetation transects of oak plots are read during their phenological peak (July – mid August), and the rest of the plot is completed when time allows to ensure seasonally-affected vegetation is sampled during its prime.

FMH protocols are adhered to for sampling oak plots with a few exceptions. A canopy cover protocol (Appendix I) was added in 2008 to address the canopy cover fire management objective. It is hoped that this objective can be assessed using a combination of canopy cover data with overstory oak tree mortality data. The collection of shrub density data was suspended in 2008. This is due to inconsistency and gaps in data collection of this protocol from 2003 – 2007. The sampling schedule for the oak plots excludes the one year postburn (YR01) sampling event; plots are sampled preburn, two years postburn (YR02), five years postburn (YR05), and every subsequent five years thereafter. Canopy cover is sampled immediately before the burn (and before any oak leaves have fallen for the season) and two years postburn. The "Species seen within 5 meters of the transect" component of the herbaceous transect has been eliminated and replaced by an "Invasive plant species of concern seen within 5 meters of the transect" effort. More details specific to the oak plots are discussed in the following "Data Management" and "Quality Control" sections. The FMH-4, or Monitoring Type Description Sheet, is attached as Appendix J, and outlines specifics for the oak plot protocol.

The minimum desired change for relative native plant cover in the oak woodlands is stated to be 10%, or 5.5% (preburn relative native plant cover is 55.05%). Minimum plot numbers have been calculated for the Bald Hills FQUGA1D09 monitoring type using the previously stated sample size equation. 24 plots are needed to detect change with the confidence and power stated above, and 26 plots are currently active in this monitoring type.

Monitoring Design: Bald Hills Prairie (GMIPR1D03)

The GMIPR1D03 monitoring type is based upon standard FMH grass plot protocol, described in detail in the Fire Monitoring Handbook (2003). For each 30 m transect, the following data are collected:

- Understory Vegetation: species, height of tallest vegetation, live/dead status; invasive plant species of concern

- Burn severity: quantitative estimate of burn severity to substrate and vegetation

- Photos: repeat photography documents changes over time on two permanent photo points per plot

- Physical data: slope, aspect, UTM coordinate location, plot location

Very little documentation exists to explain how plots were installed during the early years of FMH monitoring other than that they were located in a random fashion (USDI NPS 1990a). Plots have been sampled from June through late July, although it is preferred to complete sampling by the end of June.

FMH protocols are adhered to with the following exception: the "Species seen within 5 meters" sampling effort has been replaced by a "Invasive plant species of concern seen within 5 meters of the transect" belt. More details specific to the grass plots are discussed in the following "Data Management" and "Quality Control" sections. The FMH-4, or Monitoring Type Description Sheet, is attached as Appendix K, and outlines specifics for the grass plot protocol.

The minimum desired change for relative native plant cover in the prairies is stated to be 10%. Minimum plot numbers are currently being re-calculated for the GMIPR1D03 monitoring type and are pending rectification of recently identified errors in the database and data entry of newly installed plots. These calculations should be completed prior to the dissemination of the 2009 Fire Ecology Annual Report. During previous minimum plot calculations, a high number (> 80) of plots were needed to detect change. If plot numbers are still prohibitively high after database corrections have been made, then a new strategy will be developed for dealing with sampling relative native plant cover in the grass plot network, and may involve splitting the monitoring type into two types or increasing the level of minimum detectable change.

Monitoring Design: Fir Plots (FIRG, FIROE, FIROL)

Please refer to Appendix H for a full account of Fir Plot methodology. Minimum plot numbers have not been calculated for the Fir Plots; this is due to not enough plots being treated with prescribed fire at the time of this writing. Fir Plot minimum plot calculations are scheduled to occur over the winter of 2010.

Monitoring Design: Old Growth Redwood (FSESE1D08)

Only four plots exist in this monitoring type, and only one has been treated with prescribed fire. The FSESE1D08 type utilizes standard FMH forest plot methodology. Due to the relatively small size of the standard FMH forest plot and the low density of old growth redwood trees, additional overstory tree sampling was identified as being needed to augment standard FMH protocols. An experimental approach was used for additional overstory sampling, and all four old growth plots have four different additional overstory sampling protocols. This monitoring type is currently inactive; the one plot that has been treated with prescribed fire will be sampled every five years to track trends in forest structure and composition.

The role of fire in old growth redwood forests needs to be further investigated, and research on the effects of prescribed fire on the northern spotted owl and marbled murrelet needs to occur before any prescribed burning or fire effects monitoring occurs in this vegetation type. If or when prescribed burning is proposed for old growth redwood forests, a new monitoring design will be created.

Monitoring Design: Little Bald Hills

No monitoring design exists; this section is a work in progress. Monitoring design will be developed by the fire ecologist and lead fire effects monitor in consultation with park fire and resource managers and the regional fire ecologist.

Monitoring Design: Coastal Prairie

No monitoring design exists; this section is a work in progress. Monitoring design will be developed by the fire ecologist and lead fire effects monitor in consultation with park fire and resource managers (especially cultural resource managers) and the regional fire ecologist.

Monitoring Design: Second Growth Forests

No monitoring design exists; this section is a work in progress. Monitoring design will be developed by the fire ecologist and lead fire effects monitor in consultation with park fire and resource managers (especially the park forester) and the regional fire ecologist.

Monitoring Design: Boyes Prairie

The purpose of the Boyes Prairie sampling is to track changes in vegetation cover and detect trends in the vegetation community. These plots were installed in 1986 and were not linked to any specific objective for prescribed fire management, so no minimum number plots has or will be determined. The current plot network consists of seven transects (the original number was 15), and each transect is a 200' long point-intercept transect with vegetation sampled every 1' (100 points total per transect). Plots are sampled two years after each prescribed burn.

Monitoring Design: Burn Severity Assessments

Burn severity data will be requested for single fires (planned and unplanned) that exceed 300 acres or multiple fires that exceed 500 acres in areas of shrub or forest-dominated vegetation. Data will be requested by the fire ecologist through the NPS-USGS Burn Severity Mapping Program (http://burnseverity.cr.usgs.gov/). These requests will be made annually within two months of the end of fire season. Remotely sensed burn severity data in the form of the differenced Normalized Burn Ratio (dNBR) or the relative differenced Normalized Burn Ratio (RdNBR) will be field verified using the Composite Burn Index (CBI) methodology (Key and Benson 2006). Prescribed burn units proposed under the 2010 FMP that will be especially targeted for burn severity assessment are the C-10 (339 acres) and Wildcat (1054 acres) second growth forest burns.

Monitoring Design: Mechanical Treatments

Mechanical treatments conducted by Redwood's fire management program will be monitored using permanent photo points and repeat photography. Specific protocol has yet to be developed.

DATA MANAGEMENT & ANALYSIS

The Redwood fire ecology program is responsible for managing almost 20 years worth of fire effects monitoring data. A major challenge of any long-term monitoring program is maintaining consistency and accuracy in data collection and management over time. The fire ecology program takes this challenge seriously, and is constantly evolving its data management and analysis strategy to ensure the collection, management, and analysis of meaningful, high quality data.

DATA MANAGEMENT & QUALITY CONTROL

The highest standards for data management and quality control are upheld within the Klamath Fire Ecology Program. Throughout the years, many different strategies have been developed to ensure that high quality field data are collected, entered and analyzed. Listed below are some of the methods and standards developed for data management and quality control.

Data Management

- The "matrix" for Redwood is a master list of all plots located within the park, organized by monitoring type and burn unit. It also lists Universal Transverse Mercator (UTM) coordinates in North American Datum 27 (NAD27) and North American Datum (NAD83) if available, along with a date for every time the plot has burned, and every data collection event. The matrix is updated as often as possible throughout the year, and if major changes occur, a new matrix is saved with the date the changes occur. The current matrix is attached as Appendix G, while all previous matrices can be found here: S:\team\shdata\Fire\Fire Effects Team\Parks\REDW\Matrix
- Each plot has its own archival binder and field folder. The original data sheets are kept in the archival binder and copies are made for the field folder. This ensures that original data sheets are not compromised by inclement weather or human error. Digital pictures for each sampling event are printed and filed within the field folder so plot pictures can be replicated as closely as possible through time. A plot history and plot maintenance log is located within each field folder; all burn and data collection dates are recorded in the plot history log, while plot maintenance activities are recorded on the plot maintenance sheet. The plot maintenance sheet is referenced before traveling to a plot in the event that tags need to be made, or rebar stakes need to be replaced.
- Inactive and rejected plot folders are kept in a separate file cabinet drawer within the field folder file cabinet. Rejected plots are placed within the "busy work" section until there is time to pull rebar stakes. Once rebar has been pulled, archival and field folders for the rejected plot are moved to the "deceased plot" section of the file cabinet drawer. Inactive plot field folders and archival binders are placed in the "inactive plot" section of the drawer. These changes should also be documented on the matrix in the "inactive" and "deceased" worksheets of the Microsoft Excel workbook.

- Plot slides are located within archival slide binders. Each slide is labeled as per instructions on the sign hanging above the light table in the fire effects office. If signs are unreadable on the slide, the photo log notebook is used to help determine where the picture was taken. Slide film can be purchased from Swanlund's Camera on F Street in Eureka. Slide film is commonly taken to a local drug store (e.g., Rite Aid) to be developed. This process usually takes at least two weeks before slides are ready to be picked up.
- Every time a picture is taken, either digital or slide, it should be recorded within the appropriate camera's photo log notebook, located in the camera bags. Each roll of slide film is labeled before placing it into the camera. A document providing more details on these subjects is located here: S:\team\shdata\Fire\Fire Effects Team\Data Mgmt\Film Protocols
- Before the start of field season, the lead fire effects monitor and fire ecologist meet to discuss the upcoming field season and develop a work plan. Based on this meeting, a list of field work and a travel schedule are compiled by the lead fire effects monitor. A master list of all field work needing to be completed is created and includes important information such as burn unit, plot name, sampling event, and estimated amount of time needed to complete each burn unit's plots. The travel schedule includes the crew's location, holidays and training throughout the months of May, June, July and August. In addition, it is important to send a copy of this schedule to all pertinent fire and resource management staffs at all parks and effects crew members for planning purposes. Examples of these are located here: S:\team\shdata\Fire\Fire Effects Team\09 Season\2009 Season Stuff
- Pre-season meetings with the lead fire effects monitor, fire ecologist, and pertinent fire and resource management staff at each park are held to discuss the 5-year burn plan (especially revisions) and the scheduling of upcoming burns. This is especially important to help define priority units for plot installation efforts and to address any of the fire and resource management staff's questions.
- A document has been produced that details the ins-and-outs of fire effects life. It discusses topics such as crew travel, per diem, vehicle maintenance, time reporting, and what is expected of seasonal staff. A copy is given to all crew members at the start of the season and it is discussed with them. Crew members are also provided with a pocket card-size list of important Redwood fire management staff phone numbers, and a Klamath Network contact list that is kept current for reference by the fire effects crew. Again, examples of these can be found here: S:\team\shdata\Fire\Fire Effects Team\09 Season\2009 Season Stuff
- All field data are entered into the database and software program specifically designed to house federal fire effects monitoring data, FFI. FFI is an acronym that stands for FEAT FIREMON Integrated, revealing its legacy as a new database and analysis tool to replace the National Park Service's fire effects database, FEAT (Fire Ecology and Assessment Tool), and the U.S. Forest Service's fire effects database, FIREMON (Fire Effects Monitoring and Inventory System). FFI data are backed up in triplicate regularly to the hard drive of the "master" FFI fire effects computer, to an external hard drive attached to previously named computer, and to Redwood's network (S:drive).
- Spatial data for Redwood are found on the N:drive. Helpful locations on the N:drive include the fire history geodatabase (N:\geodatabase\001_SOC_FIRE_FirePerimeter), vector data (N:\GIS_Data\Agency\rnsp), raster data (N:\GIS_Data\Raster), 2010 RFMP files (N:\GIS_Maps\user_maps\141_FireManagmentPlan\FMP_2009), layer files associated with the 2010 RFMP and fire history data (N:\GIS_Custom\Layers\agency\rnsp\fireandfuels), and the RNSP Atlas topographic version (N:\GIS_Maps\share_maps\PDF\RNSP_Atlas-07_23_06) and NAIP imagery version (N:\GIS_Maps\share_maps\PDF\RNSP_Atlas_Imagery_CurrentVersion). Maps of prescribed burn units in .pdf format are found on the network: S:\team\shdata\Fire\BurnUnitAtlas. Projects created and managed by the fire ecology program are stored on the network: S:\team\Fire\Fire

Ecology\REDW\GIS\Projects and any maps created are exported to this folder: S:\team\Fire\Fire Ecology\REDW\GIS\Maps.

Quality Control

- A field calibration session is conducted by the lead fire effects monitor at the beginning of each season with all members of the fire effects crew to ensure all field measurements are conducted in an accurate and consistent manner. Activities such as compass use, laying out measuring tapes, filling out data sheets correctly, taking plot photos, and data collection techniques for each plot variable sampled are discussed to ensure that all crew members are aware of the proper methodology and operating procedures. A document with all of the field calibration talking points and exercises is located here: S:\team\shdata\Fire\Fire Effects Team\Data Mgmt
- A blank, unknown species master list is created at the beginning of each season. This includes pages for individually numbered unknown forb (FUNK) and unknown grass (GUNK) species. Each new unknown species receives the next consecutive number, which is recorded on data sheets and ensures that all species are tracked from collection to identification. An example of this master list can be found here: S:\team\shdata\Fire\Fire Effects Team\Data Mgmt This blank, unknown species master list is used only for purposes of managing and tracking unknowns. A separate protocol for recording unknown species is utilized for data entry and inclusion on the species list.
- If a species is not able to be identified to the genus level, it will be entered into FFI using a generic family (e.g., LILIA for unknown Liliaceae), genus (e.g., IRISX for unknown Iris), or life form (e.g., FUNK1 for unknown forbs; GUNK1 for unknown grasses) code. Duplicate generic unknown codes should be utilized for two or more unknown but different species found on a single plot during one sampling event (e.g., IRISX1 for unknown Iris species 1; IRISX2 for unknown Iris species 2).
- Digital pictures are downloaded and labeled within a reasonable amount of time after being taken. Digital pictures are labeled as follows: Plot name (e.g., QUGA04)_location (e.g., Q4-Q1)_sampling event (e.g., 05YR02). All digital pictures are stored on the external hard drive attached to the desktop computer in the fire effects cubicle. No unlabeled photos are stored here. The photos on the external hard drive are backed up once a year onto CDs, which are then stored above the desktop computer.
- A document has been created to assist with data entry and general use of the fire effects database and analysis tool, Ecological Monitoring Utilities or FEAT FIREMON Integrated (FFI). It includes step-by-step directions for entering data for each protocol, creating plot species lists and lists of trees, and quality checking data with certain issues to keep in mind. It is called "FFI Mumblings" and is included as Appendix E. It is also located here: S:\team\shdata\Fire\Fire Effects Team\Data Mgmt
- New data sheets have been created to assist with data entry in FFI. While continuing to use original FMH data sheets is still acceptable, the new FFI data sheets arrange the data variables by the order they are presented in FFI. This enables the crew to cut back on data entry mistakes and save on optometry bills from having to squint at data sheets to find the next column of data to enter. The new "Overstory Tagged Tree" (FMH-8) data sheet includes extra columns for previous (most recent sampling event) DBH, previous live or dead status, and previous crown position code. For each plot, data from the previous sampling event is queried from FFI and imported into an Excel spreadsheet, and then arranged into a new data sheet allowing comparisons of previous and current measurements. The new "Pole-Size Tree" (FMH-9) data sheet is similar, as it has extra columns for previous DBH, previous live or dead status, and previous tree height. The new "Forest Plot Fuels Inventory" (FMH-19) data sheet contains columns for

previous 1000 hour logs, and the foot mark where the log was found. This ensures that logs can be tracked throughout the years. The new "Tree Postburn Assessment" (FMH-20) data sheet includes a column for quarter where the tree is located, previous live or dead status, new DBH and previous DBH. The new "Overstory Tagged Tree," "Pole-Size Tree," "Forest Plot Fuels Inventory," "30 Meter Transect" (FMH-16), and "Tree Postburn Assessment" data sheets are in Excel format to enable the import of FFI data. The data sheets are found here: S:\team\shdata\Fire\Fire Effects Team\FFI\Data Sheets\Excel Datasheets

- Each year, a master list of sampled plots is created to track data through the collection, entry, quality checking and filing phases. Once one of the steps of the data's "life" is completed, the master list hanging on the file cabinet in the fire effects office should be checked in the appropriate box for the completed phase. Completed data sheets are not allowed in the "data entry" bins until all unknowns are identified and every header of the data sheet is filled out. After data are entered into FFI, the data sheets for the plot move to the "quality checking" bin. After the quality checking is complete, the data sheets move to the "data to copy" bin. Data sheets are photocopied dark enough to be legible, and the copies and original data sheets are placed in the "data to file" bin. Lastly, the data sheets are filed in their appropriate archival binder and field folder.
- All data are quality checked for errors after they are entered. It is important that quality data go into FFI and that quality data come out of FFI. The individual who performed data entry is discouraged from quality checking that same data. By using two separate crewmembers for each process, fewer mistakes are made in the quality checking effort. Every line of data entry should be quality checked for errors, along with the data sheet headers for each protocol within FFI. The "FFI Mumblings" document explains in detail common errors within the database to watch out for.
- Over time, there have been issues with the FQUGA1D09 monitoring type and measuring multi-stemmed oaks. During plot installation in the 1990s, there was inconsistency with the definition of an "overstory oak tree." Some plots were installed with only the largest overstory tree bole being tagged within a clump of oaks, while other plots were installed with every overstory tree bole in a clump of oaks being tagged within the plot. Over the years, changes have been made in data collection protocol for multiple-stemmed oaks, such as removing tree tags from multiple-stemmed individuals and retaining the tag for only the largest stem, measuring diameter at root crown of oak clumps, and measuring the DBH of all stems and then calculating the average or "composite" DBH for the clump. Unfortunately, there is little or no documentation to accompany not only the actual changes made through time, but also the reasoning behind the changes. It has been determined that current and future protocol will be to maintain consistency with original (preburn) data collection efforts. For example, when a plot is sampled that has only the largest stem of an individual clump tagged, the trees will continue to be sampled this way, and good documentation will be made of how many 'extra' stems exist, and if they are live or dead. These data are entered into the Tree protocol form in FFI under the "Num. Live Stems" column and "Num. Dead Stems" column. If a plot has all overstory tree multiple stems tagged, the plot should again continue to be sampled this way, with good documentation made that every stem is tagged. The collection of diameter at root crown data and calculation of average or composite DBH has been discontinued.

DATA ANALYSIS

Monitoring data will be analyzed in a timely manner, and results will be disseminated to fire and resource managers as available. Intended data analyses are listed below, organized by FMU or monitoring type. Bold type indicates that analysis measures a stated fire management objective. Data analysis is listed here for only monitoring types with sufficient sample size to support such analyses.

FQUGA1D09 MONITORING TYPE:

- **Overall oak woodland canopy cover**
- Overstory tree density and basal area (total, by species, by live/dead, by crown position code, by diameter class)
- Overstory tree damage
- Average overstory tree scorch and char height and average percent canopy scorched (also by species, crown position code, diameter)
- Pole size tree density and basal area (total, by species, by live/dead, by height)
- Fuel loading (total, by size class, litter and duff depth)
- Seedling tree density (total, by species, by live/dead)
- **Relative cover of native plants**
- Understory vegetation cover (by species, by life form, by life cycle, by live/dead, by any combination of previously stated variables)
- Understory vegetation community analysis

GMIPR1D03 MONITORING TYPE:

- **Relative cover of native plants**
- Understory vegetation cover (by species, by life form, by life cycle, by live/dead, by any combination of previously stated variables)
- Understory vegetation community analysis

FIR PLOTS:

- **Density of live small (< 3' tall) fir (by species) in grasslands**
- **Density of live small (< 3' tall) fir (by species) in early burn unit oak woodlands**
- **Density of live small (< 3' tall) fir (by species) in late burn unit oak woodlands**

BOYES PRAIRIE PLOTS:

- Relative cover of native plants
- Vegetation cover (by species, by life form, by life cycle, by live/dead, by any combination of previously stated variables)
- Vegetation community analysis

REPORTING & ADAPTIVE MANAGEMENT

The fire ecologist and lead fire effects monitor will prepare an annual report of monitoring findings and disseminate it to interested parties and post it on the Redwood intranet. This report will also be sent to Regional and National Fire Ecology offices and posted on the NPS intranet. The fire ecologist and lead fire effects monitor will present annual findings to Redwood staff at a "Brown Bag" luncheon, and may publish monitoring results in Redwood's Resource Management and Science newsletter, *Redwood Currents*. At minimum, the fire ecologist, lead fire effects monitor, FMO, lead fuels technician, Chief of Vegetation Management, and supervisory forestry technician will gather at the end of the fire season for a review of the season's progress, success, and issues and to conduct an Ecological After Action Review (EAAR). The fire ecologist will generate monitoring results for each prescribed burn or mechanical treatment plan, with an assessment of whether management objectives were achieved or not. This report will be provided to the FMO and burn boss prior to the annual FMP update, and will be added as an appendix to the prescribed burn or mechanical treatment plan.

Monitoring results, plot data, and photos will be made available to park interpretive staff for their use in sharing this information with park visitors and the general public. The fire ecologist will work with the FMO to ensure programmatic accomplishments are summarized into "fire success stories" and shared as appropriate with NPS fire communication and education staff.

If monitoring results indicate that management objectives are not being achieved, then the fire ecologist will alert Redwood fire and resource managers as soon as possible, and a discussion will ensue to determine the next course of action. Adaptive Management will be practiced regularly, and feedback will be delivered in a timely manner to fire and resource managers.

Periodic fire ecology program reviews will be conducted by the Regional Fire Ecologist and his team. The last program review was conducted in 2005.

Monitoring results and findings may also be summarized into posters, presentations, or papers to share with the scientific community at conferences, symposia, or in the technical literature.

COLLABORATION

The fire ecology program believes that its strength lies in its ability to collaborate with other resource managers, scientists, and interpreters and educators. Redwood has a strong natural and cultural resource staff, and fire management has been and will continue to be an interdisciplinary effort. Fire management and fire monitoring objectives are developed with the input of many park specialists. The fire management program works closely with the vegetation management staff to coordinate prescribed fire and mechanical treatments with exotic plant management efforts, the conifer cutting program, and second growth forest management. The program works closely with the fish & wildlife staff to ensure that protections and considerations for threatened, endangered, and sensitive species, migratory birds, and wildlife habitat are abided by and incorporated into all aspects of fire management planning and implementation. The fire management staff also works closely with the cultural resource program to ensure that all steps are taken to protect cultural resources to the highest degree possible during fire management planning and operations, and to maintain and restore cultural landscapes as appropriate through the use of fire. A Resource Advisor program (managed by the fire ecologist) has recently been created at Redwood that unites park scientists and managers in an effort to protect park natural and cultural resources through preparing for unplanned wildland fire events. The fire ecology program intends to take an active role in sharing monitoring data and results with interpretive and education staff. The fire ecology staff also intends to collaborate with scientists from the KLMN Inventory and Monitoring program, local USGS research stations (Western Ecological Research Stations in CA and Forest and Rangeland Ecosystem Science Center in OR), and local universities (e.g., Humboldt State University) to address fire research needs.

ROLES & RESPONSIBILITIES

The fire ecology program is nested within the Redwood fire management program, which is a branch within the Resource Management division. The fire ecology program consists of the Fire Ecologist, the Lead Fire Effects Monitor, and seasonal Fire Effects Monitors. Many additional people work directly with the fire ecology program and are jointly responsible for its success.

STAFF ROLES & RESPONSIBILITIES

The roles and responsibilities of individuals closely connected to the fire ecology program are defined here. These definitions are based upon those outlined in the RFMP (2010) and RM-18 (DOI NPS 2008b) and summarized:

The Regional Fire Ecologist (RFE) reviews and approves the Fire Monitoring plan and provides monitoring and research guidance and support to the Fire Ecologist. The RFE also approves funding requests for monitoring and is the point of contact for additional funding needs. The RFE organizes regional ecologist meetings and communicates direction from the regional and national offices to park fire ecology programs. Fire ecology program reviews and site visits are completed by the RFE. The RFE coordinates and prioritizes research needs and requests.

The Chief of Resource Management and Science (CRMS) is responsible for ensuring that fire management program goals and objectives are clearly stated. The CRMS also ensures that the fire monitoring plan reflects the goals and objectives stated in related park management documents. The CRMS supervises the Fire Management Officer and has overall responsibility for the fire management program. The CRMS approves prescribed fire and mechanical treatment plans and communicates programmatic activity and success to the park Superintendent.

The Chief of Vegetation Management (CVM) communicates and coordinates frequently with the Fire Management Officer and the Fire Ecologist to ensure the efficient management of park vegetation communities. The CVM collaborates with the Fire Ecologist to identify and manage fire research needs and ensure vegetation management objectives are being appropriately monitored. The CVM participates in the park Resource Advisor program and collaborates with the Fire Ecologist on fire rehabilitation needs and management. The CVM reviews the fire management plan and prescribed burn and mechanical treatment plans, and provides vegetation management objectives to the fire program.

The Fire Management Officer (FMO) maintains overall responsibility for Redwood's fire program. The FMO provides supervision to the Fire Ecologist and provides training and development opportunities to this position. The FMO ensures that the fire management program complies with policy directives for monitoring of fire management activities. The FMO maintains a cohesive fire management staff and ensures that the fire ecology program is involved with and integrated into fire management planning, operations, and activities. The FMO writes and maintains the Fire Management Plan.

The Lead Fuels Technician (LFT) ensures that fire ecology personnel are kept abreast of prescribed fire and mechanical treatment planning. The LFT collaborates with fire ecology staff to ensure objectives are reflected in treatment plans and that monitoring is implemented prior to treatment.

The Fire Ecologist directs and manages the park fire ecology program and serves as the staff specialist in fire ecology. The Fire Ecologist supervises the Lead Fire Effects Monitor and provides training and development opportunities to this position, and provides direction and support to the Fire Effects Monitoring crew. The Fire Ecologist helps develop fire management and monitoring objectives. The Fire Ecologist retains overall responsibility for the Fire Effects Monitoring program and maintains the fire monitoring plan. The Fire Ecologist reviews prescribed fire and mechanical treatment plans and assists with setting schedules for prescribed fire and mechanical treatment. The Fire Ecologist analyzes monitoring data and shares results and findings with interested parties. The Fire Ecologist identifies fire research needs and pursues efforts to have fire research conducted. The Fire Ecologist manages the Resource Advisor program. The Fire Ecologist also acts as the fire ecologist for ORCA and WHIS.

The Lead Fire Effects Monitor (LFEM) supervises, trains, and provides development opportunities for the fire effects monitoring crew. The LFEM leads and organizes the collection, entry, and management of fire effects data and ensures that protocol is followed accurately and correctly. The LFEM assists the fire ecologist with developing new monitoring protocols, writing plans and reports, and communicating results of the fire ecology program with interested parties. The LFEM upholds a high standard for data quality and management and passes this along to crew members. The LFEM maintains voucher collections, plot spatial data, and electronic and hard copy monitoring data. The LFEM also leads fire effects monitoring efforts at ORCA and WHIS.

The Fire Effects Monitors (FEMs) collect, enter, and quality check fire effects monitoring data. The FEMs follow established protocol for maintaining high levels of data quality. The FEMs also conduct fire effects monitoring work at ORCA and WHIS.

WORK PLANS & PRIORITIZATION

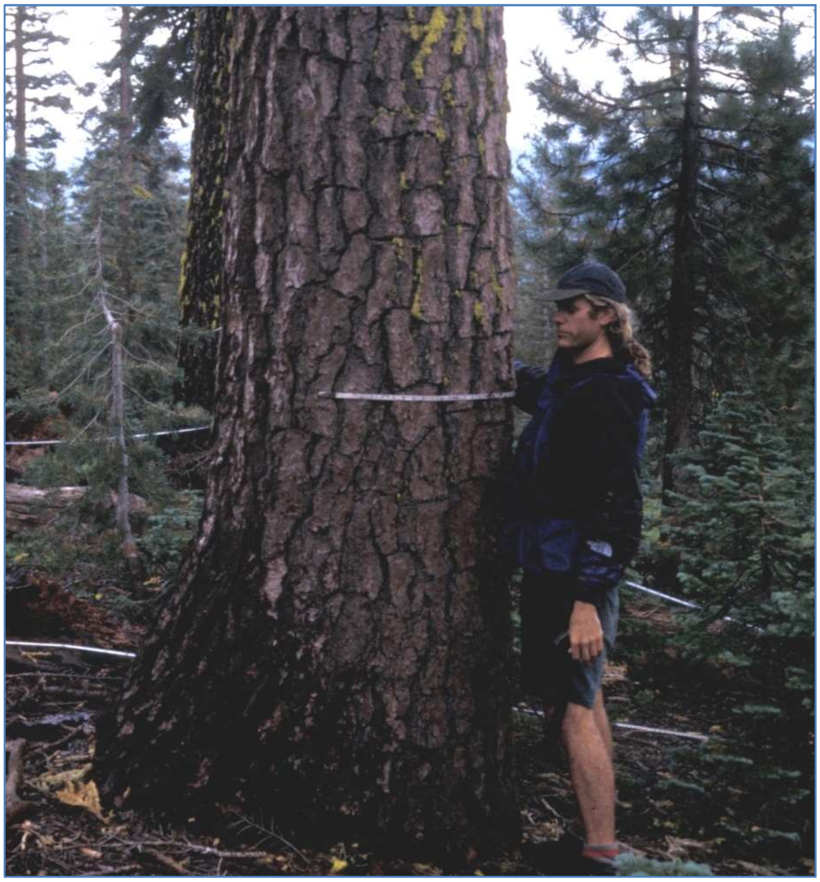
Annual work plans are prepared at the beginning of each calendar year after the previous year's reporting and presentation is completed. Recurring field work is organized and scheduled by the Lead Fire Effects Monitor, which is then approved by the Fire Ecologist. New field work is identified by the Fire Ecologist after holding pre-season meetings with Redwood's fire and resource management staff to discuss upcoming projects, priorities, and activities. Ongoing field work is always a high priority, and installation of new plots is accommodated as much as possible. In years with unusually heavy workloads, assistance is requested in the National Fire Plan

Operations and Reporting System (NFPORS) and from the Regional office via additional funds to either hire one or more Redwood seasonal monitors or gain assistance from nearby fire effects crews (especially the Southern Cascades fire effects team). Assistance can also be solicited from Redwood fire and resource management staff. If the annual monitoring workload exceeds staff capabilities, triage is performed by the fire ecologist and lead fire effects monitor to ensure the highest priority work is completed.

PLAN INPUT AND ACKNOWLEDGEMENTS

This monitoring plan is a revision of the 2005 Redwood Fire Monitoring Plan written by Tim Bradley (previous Fire Ecologist) and Jennifer Gibson (Ecologist, Whiskeytown National Recreation Area). The 2010 Redwood Fire Monitoring Plan was written by Jen Beck (Fire Ecologist) and Becky Smith (Lead Fire Effects Monitor). Historical information on the fire management and fire monitoring programs were gleaned from discussions with Leonel Arguello (Chief, Vegetation Management) and John McClelland (Lead Fuels Technician and Battalion Chief). Leonel Arguello also helped refine fire management and monitoring objectives. The current set of fire management objectives were crafted in a April 15, 2009 meeting with Karin Anderson (Chief, Cultural Resources), Leonel Arguello, Jeff Ayers (Supervisory Forestry Technician and Engine Captain 30), Jen Beck, Keith Benson (Fish & Wildlife Biologist), Terry Hofstra (Chief, Resource Management and Science Division), John McClelland, Aida Parkinson (Chief, Fish & Wildlife Branch and Environmental Specialist), Becky Smith, Jason Teraoka (Forester), Jim Wheeler (Interpretive Specialist), and Rick Young (Fire Management Officer). Jason Teraoka generously provided access to data and results from vegetation monitoring in the D-A second growth prescribed burn unit. Julie Dubose initiated the "Data Management and Quality Control" section. Leonel Arguello and Robin Wills (Regional Fire Ecologist, Pacific West Region) reviewed the draft of this plan and provided suggestions that greatly improved the final version.

We would like to honor the memory of past (1998 – 2000) Assistant Lead Fire Effects Monitor Dale Haskamp, who passed away in August 2009 after a long battle with cancer. His creative uses for the U-Dig-It tool remain a Fire Effects legacy, and his laughter echoes among tagged oaks and rebar-studded prairies in the Bald Hills. He is greatly missed.



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APPENDICES

A. DATA COLLECTION TOOLS AND REFERENCES

All field reference guides, plant identification books and taxonomic keys are located at the South Operations Center (SOC) in the Fire Effects office. Redwood's herbarium is located on the second floor of the building in the museum collection; James (Bow) O'Barr (Park Curator) and Stassia Samuels (Plant Ecologist) can grant access and provide further information.

Field equipment is stored within the Fire Effects vehicle, and excess field gear is stored within the Fire Effects/Vegetation Management cage area in the SOC building.

B. PLANT LIST & VOUCHER COLLECTION

The Fire Ecology program's voucher collection is located within the Fire Effects office at SOC. The voucher specimens are split into three binders: dicots, monocots (except Poaceae) and Poaceae. Each voucher specimen is pressed between two pieces of self sealing adhesive sheets and is arranged alphabetically by family within each binder.

The Jepson Manual (Hickman 1993) and the Jepson Flora Project's Jepson Online Interchange (http://ucjeps.berkeley.edu/interchange/about_interchange.html) are used for naming standards. Each species has a designated species symbol within FFI, usually a four letter code consisting of the first two letters of the genus and the first two letters of the species. If there is a subspecies, first letter of the subspecies is added for the fifth letter in the species symbol. Some species have a number fixed to the end of their species symbol; this number originates from the USDA Plants Database (http://plants.usda.gov/).

A plant list is compiled from the Redwood FFI database at the beginning of each field season to represent all species that have been found or observed within plots throughout the years. This list includes the species symbol used in FFI, family name, common name, scientific name and nativity. An example of the list is included below.

Redwood FFI Species List

*exotics highlighted in gray

Species Symbol	Family	Common Name	Scientific Name	Native Species
ABGR	Pinaceae	grand fir	Abies grandis	TRUE
ACMA3	Aceraceae	bigleaf maple	Acer macrophyllum	TRUE
ACMI2	Asteraceae	common yarrow	Achillea millefolium	TRUE
ACTR	Berberidaceae	deer foot	Achlys triphylla ssp. tryphylla	TRUE
ADBI	Asteraceae	American trailplant	Adenocaulon bicolor	TRUE
AGCA5	Poaceae	colonial bent; colonial bentgrass	Agrostis capillaris	FALSE
AGGR	Asteraceae	bigflower agoseris; shortbeak agoseris	Agoseris grandiflora	TRUE
AGHA2	Poaceae	Hall's bentgrass	Agrostis hallii	TRUE
AGID	Poaceae	Idaho bentgrass; Idaho redtop	Agrostis idahoensis	TRUE
AGROS	Poaceae	Agrostis unknown	Agrostis unknown	FALSE
AGST2	Poaceae	creeping bentgrass	Agrostis stolonifera	FALSE
AICA	Poaceae	silver hairgrass	Aira caryophyllea	FALSE
AMALS	Rosaceae	Pacific serviceberry; Saskatoon serviceberry	Amelanchier alnifolia var. semiintegrifolia	TRUE
AMUT	Rosaceae	Utah serviceberry	Amelanchier utahensis	TRUE
ANAR7	Poaceae	annual vernalgrass	Anthoxanthum aristatum	FALSE
ANMA	Asteraceae	pearly everlasting	Anaphalis margaritacea	TRUE
ANOD	Poaceae	sweet vernalgrass	Anthoxanthum odoratum	FALSE
ANTO	Apiaceae	woolly angelica	Angelica tomentosa	TRUE
APAN2	Apocynaceae	bitterroot; flytrap dogbane; spreading dogbane	Apocynum androsaemifolium	TRUE
APIAC	Apiaceae	Apiaceae unknown	Apiaceae unknown	FALSE
AQFO	Ranunculaceae	crimson columbine; western columbine	Aquilegia formosa	TRUE
AREL3	Poaceae	tall oatgrass	Arrhenatherum elatius	FALSE
ARHIG	Brassicaceae	mountain rockcress	Arabis hirsuta var. glabrata	TRUE
ARME	Ericaceae	pacific madrone	Arbutus menziesii	TRUE
ASCA2	Aristolochiaceae	British Columbia wildginger	Asarum caudatum	TRUE
AVBA	Poaceae	slender oat; slender wildoat	Avena barbata	FALSE
AVFA	Poaceae	flaxgrass; wild oats	Avena fatua	FALSE
BAPI	Asteraceae	coyotebrush	Baccharis pilularis	TRUE
BEAQ2	Berberidaceae	mountain grape	Berberis aquifolium	TRUE
BRCA5	Poaceae	California brome; mountain brome	Bromus carinatus	TRUE

BRDI3	Poaceae	ripgut brome	Bromus diandrus	FALSE
BREL	Liliaceae	harvest brodiaea	Brodiaea elegans	TRUE
BRHO2	Poaceae	soft brome; soft chess	Bromus hordeaceus	FALSE
BRINI	Poaceae	smooth brome	Bromus inermis ssp. inermis	FALSE
BRMA	Poaceae	big quakinggrass	Briza maxima	FALSE
BRMI2	Poaceae	little quakinggrass	Briza minor	FALSE
BROMU	Poaceae	Bromus unknown	Bromus unknown	FALSE
BRST2	Poaceae	barren bromegrass; poverty brome; sterile brome	Bromus sterilis	FALSE
BRTE	Poaceae	cheatgrass; early chess; military grass; wild oats	Bromus tectorum	FALSE
BRVU	Poaceae	Columbia brome	Bromus vulgaris	TRUE
CAAF	Scrophulariaceae	coast Indian paintbrush	Castilleja affinis	TRUE
CAAT25	Scrophulariaceae	Indian paintbrush	Castilleja attenuata	TRUE
CACA39	Brassicaceae	milkmaids	Cardamine californica	TRUE
CAGL7	Cyperaceae	roundfruit sedge	Carex globosa	TRUE
CAOL	Brassicaceae	Idaho bittercress; little western bittercress	Cardamine oligosperma	TRUE
CAPR5	Cyperaceae	clustered field sedge; slim sedge	Carex praegracilis	TRUE
CAPR10	Campunulaceae		Campanula prenanthoides	TRUE
CAREX	Cyperaceae	Carex unknown	Carex unknown	TRUE
CARYO	Caryophyllaceae	Caryophyllaceae unknown	Caryophyllaceae unknown	??
CATO	Liliaceae	Tolmie star-tulip	Calochortus tolmiei	TRUE
CATU3	Cyperaceae	splitawn sedge	Carex tumulicola	TRUE
CEAR4	Caryophyllaceae	field chickweed	Cerastium arvense	TRUE
CHME	Pyrolaceae	little prince's pine	Chimaphila menziesii	TRUE
CHPOP4	Liliaceae	wavyleaf soap plant	Chlorogalum pomeridianum var. pomeridianum	TRUE
CIALP2	Onagraceae	small enchanter nightshade	Circaea alpina ssp. pacifica	TRUE
CIBR2	Asteraceae	clustered thistle	Cirsium brevistylum	TRUE
CIRSI	Asteraceae	Cirsium unknown	Cirsium unknown	??
CIVU	Asteraceae	bull thistle; common thistle; spear thistle	Cirsium vulgare	FALSE
CLPE	Portulacaceae	miner's lettuce	Claytonia perfoliata	TRUE
CLPUQ	Onagraceae	winecup clarkia; winecup fairyfan	Clarkia purpurea ssp. quadrivulnera	TRUE
CLSI2	Portulacaceae	Siberian springbeauty	Claytonia sibirica	TRUE
COCOC	Betulaceae	California hazel	Corylus cornuta var. californica	TRUE
COMA4	Orchidaceae	spotted coralroot; summer coralroot	Corallorrhiza maculata	TRUE
COMPO	Asteraceae	Asteraceae unknown	Asteraceae unknown	??
CYEC	Poaceae	bristly dogstail grass	Cynosurus echinatus	FALSE

CYGR	Boraginaceae	Pacific hound's tongue	Cynoglossum grande	TRUE
CYSC4	Fabaceae	English broom; scotchbroom	Cytisus scoparius	FALSE
DACA3	Poaceae	California oatgrass	Danthonia californica	TRUE
DAGL	Poaceae	cocksfoot; orchard grass	Dactylis glomerata	FALSE
DAPU3	Apiaceae	American wild carrot	Daucus pusillus	TRUE
DELPH	Ranunculaceae	Delphinium unknown	Delphinium unknown	TRUE
DENU	Ranunculaceae	red larkspur	Delphinium nudicaule	TRUE
DETR2	Ranunculaceae	Columbian larkspur	Delphinium trolliifolium	TRUE
DICA14	Liliaceae	bluedicks	Dichelostemma capitatum	TRUE
DICO19	Liliaceae	ookow	Dichelostemma congestum	TRUE
DIFO	Fumariaceae	Pacific bleeding heart	Dicentra formosa	TRUE
DIHO3	Liliaceae	drops of gold	Disporum hookeri	TRUE
DIID	Liliaceae	firecracker flower	Dichelostemma ida-maia	TRUE
DISM2	Liliaceae	largeflower fairybells	Disporum smithii	TRUE
DOHE	Primulaceae	mosquito bills	Dodecatheon hendersonii	TRUE
ELGL	Poaceae	blue wild rye	Elymus glaucus	TRUE
EPBR3	Onagraceae	autumn willowherb	Epilobium brachycarpum	TRUE
EPILO	Onagraceae	Epilobium unknown	Epilobium unknown	TRUE
EPMI	Onagraceae	chaparral willowherb; minute willowweed	Epilobium minutum	TRUE
ERBO	Geraniaceae	longbeak stork's bill	Erodium botrys	FALSE
ERCI6	Geraniaceae	red-stem stork's-bill	Erodium cicutarium	FALSE
ESCA2	Papaveraceae	California poppy	Eschscholzia californica	TRUE
EUCR2	Euphorbiaceae	Chinese caps	Euphorbia crenulata	TRUE
EURA11	Asteraceae	roughleaf aster	Eurybia radulina	TRUE
FABAC	Fabaceae	Fabaceae unknown	Fabaceae unknown	??
FECA	Poaceae	California fescue	Festuca californica	TRUE
FEID	Poaceae	Idaho fescue	Festuca idahoensis	TRUE
FEOC	Poaceae	western fescue	Festuca occidentalis	TRUE
FERU2	Poaceae	ravine fescue; red fescue	Festuca rubra	TRUE
FESTU	Poaceae	Festuca unknown	Festuca unknown	??
FRVE	Rosaceae	woodland strawberry	Fragaria vesca	TRUE
FUNK1		Forb unknown	Forb unknown	??
GAAP2	Rubiaceae	bedstraw; goose grass; stickywilly	Galium aparine	TRUE
GABO	Rubiaceae	Bolander's bedstraw	Galium bolanderi	TRUE
GADI	Rubiaceae	Lamarck's bedstraw	Galium divaricatum	FALSE

GALIU	Rubiaceae	Galium unknown	Galium unknown	??
GAPU3	Asteraceae	spoonleaf purple everlasting	Gamochaeta purpurea	TRUE
GASH	Ericaceae	salal	Gaultheria shallon	TRUE
GEDI	Geraniaceae	cutleaf geranium	Geranium dissectum	FALSE
GEMO	Geraniaceae	awnless geranium; dovefoot geranium	Geranium molle	FALSE
GNAPH	Asteraceae	Gnaphalium uknown	Gnaphalium unknown	??
GOOB2	Orchidaceae	western rattlesnake plantain	Goodyera oblongifolia	TRUE
GUNK1	Poaceae	Grass unknown	Grass unknown	??
HECOT	Asteraceae	hayfield tarweed	Hemizonia congesta ssp. tracyi	TRUE
HEMA80	Apiaceae	common cowparsnip	Heracleum maximum	TRUE
HIOC	Poaceae	California sweetgrass	Hierochloe occidentalis	TRUE
HODI	Rosaceae	oceanspray	Holodiscus discolor	TRUE
HOLA	Poaceae	common velvetgrass; velvet prom dress!	Holcus lanatus	FALSE
HYGL2	Asteraceae	smooth catsear	Hypochaeris glabra	FALSE
HYPE	Clusiaceae	common St Johnswort	Hypericum perforatum	FALSE
HYRA3	Asteraceae	common cat's-ear; false dandelion	Hypochaeris radicata	FALSE
IRDO	Iridaceae	Douglas iris	Iris douglasiana	TRUE
IRISX	Iridaceae	Iris unknown	Iris unknown	TRUE
JUBO	Juncaceae	Bolander's rush	Juncus bolanderi	TRUE
JUBUB	Juncaceae	toad rush	Juncus bufonius var. bufonius	TRUE
JUCO2	Juncaceae	Colorado rush	Juncus confusus	TRUE
JUEF	Juncaceae	common rush; lamp rush	Juncus effusus	TRUE
JUNCU	Juncaceae	Juncus uknown	Juncus unknown	TRUE
JUPA2	Juncaceae	spreading rush	Juncus patens	TRUE
JUTE	Juncaceae	field rush	Juncus tenuis	TRUE
LAMIA	Lamiaceae	Lamiaceae unknown	Lamiaceae unknown	??
LANEN	Fabaceae	sierra pea	Lathyrus nevadensis var. nevadensis	TRUE
LAVEO	Fabaceae		Lathyrus vestitus var. ochropetalus	TRUE
LETA	Asteraceae	hairy hawkbit; lesser hawkbit	Leontodon taraxacoides	FALSE
LEVU	Asteraceae	oxeye daisy	Leucanthemum vulgare	FALSE
LIAN	Polemoniaceae	false babystars	Linanthus androsaceus	TRUE
LIAP	Apiaceae	celeryleaf licorice-root	Ligusticum apiifolium	TRUE
LIBI5	Linaceae	pale flax	Linum bienne	FALSE
LICA	Apiaceae	California licorice-root	Ligusticum californicum	TRUE
LIDED2	Fagaceae	tanoak	Lithocarpus densiflorus var. densiflorus	TRUE

LILIA	Liliaceae	Liliaceae unknown	Liliaceae unknown	TRUE
LITHO	Saxifragaceae	Lithophragma unknown	Lithophragma unknown	TRUE
LOGA2	Asteraceae	narrowleaf cottonrose	Logfia gallica	FALSE
LOHIV	Caprifoliaceae	pink honeysuckle	Lonicera hispidula var. vacillans	TRUE
LOMI	Fabaceae	desert deervetch	Lotus micranthus	TRUE
LOMU	Poaceae	annual ryegrass; Italian ryegrass	Lolium multiflorum	FALSE
LOPE	Poaceae	italian ryegrass; perennial rye grass	Lolium perenne	FALSE
LOPUP	Fabaceae		Lotus purshianus var. purshianus	TRUE
LUBI	Fabaceae	bicolor lupine; miniature lupine	Lupinus bicolor	TRUE
LUCO6	Juncaceae	Pacific woodrush	Luzula comosa	TRUE
LUNA3	Fabaceae	annual lupine; sky lupine	Lupinus nanus	TRUE
LUPIN	Fabaceae	Lupinus unknown	Lupinus unknown	TRUE
LURI	Fabaceae	riverbank lupine	Lupinus rivularis	TRUE
MADIA	Asteraceae	Madia unknown	Madia unknown	TRUE
MAGR3	Asteraceae	grassy tarweed; slender tarweed	Madia gracilis	TRUE
MAMA	Asteraceae	woodland madia	Madia madioides	TRUE
MAOR3	Cucurbitaceae	coastal manroot; western wildcucumber	Marah oreganus	TRUE
MAST4	Liliaceae	starry false lily of the valley	Maianthemum stellatum	TRUE
MELIC	Poaceae	Melica unknown	Melica unknown	TRUE
MESU	Poaceae	Alaska oniongrass	Melica subulata	TRUE
MICAC2	Asteraceae	q tips	Micropus californicus var. californicus	TRUE
MIDO3	Caryophyllaceae	Douglas' stitchwort	Minuartia douglasii	TRUE
MILA	Asteraceae	cutleaf silverpuffs	Microseris laciniata	TRUE
MITEL	Saxifragaceae	Mitella unknown	Mitella unknown	TRUE
MOMA3	Caryophyllaceae	largeleaf sandwort	Moehringia macrophylla	TRUE
MOVIV	Lamiaceae	coyote mint	Monardella villosa ssp. villosa	TRUE
NEME	Hydrophyllaceae	baby blue eyes; baby blue-eyes	Nemophila menziesii	TRUE
OECE	Rosaceae	Indian plum	Oemleria cerasiformis	TRUE
OSBE	Apiaceae	mountain sweetroot; sweet cicely	Osmorhiza berteroi	TRUE
PAVI3	Scrophulariaceae	yellow glandweed	Parentucellia viscosa	FALSE
PEKE	Apiaceae	Kellogg's yampah	Perideridia kelloggii	TRUE
PHAQ	Poaceae	bulbous canarygrass; Harding grass	Phalaris aquatica	FALSE
PHGR16	Polemoniaceae	slender phlox	Phlox gracilis	TRUE
PHPR3	Poaceae	timothy	Phleum pratense	FALSE
PIEL2	Orchidaceae	elegant piperia	Piperia elegans	TRUE

PLLA	Plantaginaceae	buckhorn plantain; English plantain	Plantago lanceolata	FALSE
PLNO	Boraginaceae	rusty popcornflower	Plagiobothrys nothofulvus	TRUE
POAXX	Poaceae	Poa unknown	Poa unknown	??
POCO	Poaceae	Canada bluegrass; flat-stem blue grass	Poa compressa	FALSE
POGL9	Rosaceae	gland cinquefoil; sticky cinquefoil	Potentilla glandulosa	TRUE
POGR9	Rosaceae	graceful cinquefoil	Potentilla gracilis	TRUE
POLYG	Polygonaceae	Polygonum unknown	Polygonum unknown	??
POMU	Dryopteridaceae	western swordfern	Polystichum munitum	TRUE
POPRP2	Poaceae	Kentucky bluegrass	Poa pratensis ssp. pratensis	FALSE
POTEN	Rosaceae	Potentilla unknown	Potentilla unknown	TRUE
PREM	Rosaceae	bitter cherry; bittercherry	Prunus emarginata	TRUE
PRUNUS	Rosaceae	Unknown Prunus	Prunus unknown	??
PRVU	Lamiaceae	common selfheal	Prunella vulgaris	TRUE
PSMEM	Pinaceae	coast douglas fir; Douglas-fir	Pseudotsuga menziesii var. menziesii	TRUE
PTAQP2	Dennstaedtiaceae	bracken fern	Pteridium aquilinum var. pubescens	TRUE
QUGAG2	Fagaceae	Oregon white oak	Quercus garryana var. garryana	TRUE
QUKE	Fagaceae	california black oak	Quercus kelloggii	TRUE
RAOC	Ranunculaceae	western buttercup	Ranunculus occidentalis	TRUE
RHCAC5	Rhamnaceae	california buckthron	Rhamnus californica	TRUE
RHMA3	Ericaceae	pacific rhododendron	Rhododendron macrophyllum	TRUE
RHOC	Ericaceae	western azalea	Rhododendron occidentale	TRUE
RIBES	Grossulariaceae	Ribes unknown	Ribes unknown	TRUE
RIME	Grossulariaceae	canyon gooseberry	Ribes menziesii	TRUE
RIROC	Grossulariaceae		Ribes roezlii var. cruentum	TRUE
ROGY	Rosaceae	dwarf rose	Rosa gymnocarpa	TRUE
RONUN	Rosaceae	Nootka rose	Rosa nutkana var. nutkana	TRUE
ROSAX	Rosaceae	Rosa unknown	Rosa unknown	TRUE
RUAC3	Polygonaceae	common sheep sorrel	Rumex acetosella	FALSE
RUCR	Polygonaceae	Curley dock	Rumex crispus	FALSE
RUDI2	Rosaceae	Himalaya blackberry	Rubus discolor	FALSE
RULE	Rosaceae	western rasberry	Rubus leucodermis	TRUE
RUPA	Rosaceae	thimbleberry; western thimbleberry	Rubus parviflorus	TRUE
RUSP	Rosaceae	salmonberry	Rubus spectabilis	TRUE
RUUR	Rosaceae	California blackberry	Rubus ursinus	TRUE
SACR2	Apiaceae	Pacific blacksnakeroot	Sanicula crassicaulis	TRUE

SADO	Lamiaceae	yerba buena	Satureja douglasii	TRUE
SCAN4	Lamiaceae	nose skullcap	Scutellaria antirrhinoides	TRUE
SESE3	Cupressaceae	california redwood	Sequoia sempervirens	TRUE
SHAR2	Rubiaceae	blue field-madder	Sherardia arvensis	FALSE
SIBE	Iridaceae	western blue-eyed grass	Sisyrinchium bellum	TRUE
SICA4	Caryophyllaceae	Indian pink	Silene californica	TRUE
SIGA	Caryophyllaceae	common catchfly; windmill catchfly	Silene gallica	FALSE
SIMA	Malvaceae	mapleleaf checkerbloom	Sidalcea malachroides	TRUE
SMRAR	Ruscaceae	**new name Maianthemum racemosa**	Smilacina racemosa	TRUE
SMST4	Ruscaceae	**new name Maianthemum stellata**	Smilacina stellata	TRUE
SOASA	Asteraceae	spiny sowthistle	Sonchus asper ssp. asper	FALSE
SOOL	Asteraceae	annual sowthistle	Sonchus oleraceus	FALSE
SPDO	Rosaceae	rose spirea	Spiraea douglasii	TRUE
SPRO	Orchidaceae	hooded ladies'-tresses;	Spiranthes romanzoffiana	TRUE
STACHYS	Lamiaceae		Stachys unknown	??
STAJR	Lamiaceae		Stachys ajugoides var. rigida	TRUE
STCR2	Caryophyllaceae	crispleaved chickweed; curled starwort	Stellaria crispa	TRUE
STELL	Caryophyllaceae	chickweed	Stellaria unknown	FALSE
SYALL	Caprifoliaceae	common snowberry	Symphoricarpos albus var. laevigatus	TRUE
SYMPH	Caprifoliaceae	Symphoricarpos unknown	Symphoricarpos unknown	TRUE
TACA8	Poaceae	medusahead; medusahead rye	Taeniatherum caput-medusae	FALSE
TAKE	Apiaceae	Kellogg's umbrellawort	Tauschia kelloggii	TRUE
TAOF	Asteraceae	common dandelion	Taraxacum officinale	FALSE
TEGR2	Saxifragaceae	bigflower tellima	Tellima grandiflora	TRUE
TOAR	Apiaceae	Canada hedgeparsley	Torilis arvensis	FALSE
TODI	Anacardiaceae	Pacific poison oak	Toxicodendron diversilobum	TRUE
TOTE	Scrophulariaceae	lesser baby innocence	Tonella tenella	TRUE
TRAL5	Fabaceae	rancheria clover	Trifolium albopurpureum	TRUE
TRBI	Fabaceae	notchleaf clover	Trifolium bifidum	TRUE
TRCH2	Liliaceae	giant wakerobin	Trillium chloropetalum	TRUE
TRBR7	Liliaceae	Bridges' brodiaea	Triteleia bridgesii	TRUE
TRDE	Fabaceae	cowbag clover	Trifolium depauperatum	TRUE
TRDU2	Fabaceae	hop clover; smallhop clover; suckling clover	Trifolium dubium	FALSE
TRER2	Fabaceae	woollyhead clover	Trifolium eriocephalum	TRUE

TRHY3	Liliaceae	white brodiaea; wild hyacinth	Triteleia hyacinthina	TRUE
TRIFO	Fabaceae	Trifolium unknown	Trifolium unknown	FALSE
TRILL	Liliaceae	Trillium unknown	Trillium unknown	TRUE
TRLA	Myrsinaceae	star flower	Trientalis latifolia	TRUE
TRLA16	Liliaceae	Ithuriel's spear	Triteleia laxa	TRUE
TRMI5	Fabaceae	thimble clover	Trifolium microdon	TRUE
TROL	Fabaceae	fewflower clover	Trifolium oliganthum	TRUE
TROV2	Liliaceae	Pacific trillium	Trillium ovatum	TRUE
TRPU16	Scrophulariaceae	dwarf owl's-clover	Triphysaria pusilla	TRUE
TRRE3	Fabaceae	Dutch clover; ladino clover; white clover	Trifolium repens	FALSE
TRSU3	Fabaceae	subterranean clover	Trifolium subterraneum	FALSE
TRWI	Fabaceae		Trifolium willdenovii	TRUE
TRWO	Fabaceae	cow clover; Sierra clover	Trifolium wormskioldii	TRUE
UMCA	Lauraceae	california laurel	Umbellularia californica	TRUE
UNKN1		Unknown	Unknown	??
VAHE	Berberidaceae	white insideout flower	Vancouveria hexandra	TRUE
VAOV2	Ericaceae	California huckleberry; evergreen blueberry	Vaccinium ovatum	TRUE
VIAD	Violaceae	blue violet; hook violet; hookedspur violet	Viola adunca	TRUE
VIAMA3	Fabaceae	American vetch; purple vetch	Vicia americana ssp. americana	TRUE
VICA5	Vitaceae	California grape; California wild grape	Vitis californica	TRUE
VICIA	Fabaceae	Vicia unknown	Vicia unknown	??
VIGL	Violaceae	pioneer violet	Viola glabella	TRUE
VIOLA	Violaceae	Viola unknown	Viola unknown	TRUE
VIPR3	Violaceae	astoria violet; canary violet	Viola praemorsa	TRUE
VISA	Fabaceae	Common Vetch	Vicia sativa	FALSE
VISE3	Violaceae	evergreen violet	Viola sempervirens	TRUE
VUBR	Poaceae	brome six-weeks grass; desert fescue	Vulpia bromoides	FALSE
VUMI	Poaceae	little fescue; small fescue; twoflower fescue	Vulpia microstachys	TRUE
VUMY	Poaceae	foxtail fescue	Vulpia myuros	FALSE
WHMO	Hydrangeaceae	common whipplea	Whipplea modesta	TRUE

C. JOB HAZARD ANALYSIS

<table>
<tr><td colspan="2">JOB HAZARD ANALYSIS (JHA)</td><td>Date: July 29, 2003</td><td>New JHA</td></tr>
<tr><td>Park Unit: Redwood NP</td><td>Division: Resource Management</td><td>Branch: Fire</td><td>Location: South Operations Center</td></tr>
<tr><td colspan="2">JOB TITLE: Fire Effects Monitor</td><td>JHA Number: (1)</td><td>Page __1____of ___2___</td></tr>
<tr><td>Job Performed By:
Fire Effects Monitors & VIPs</td><td>Analysis By: Dana Sandifer &
Julie DuBose</td><td>Supervisor: Rick Young</td><td>Approved By:</td></tr>
</table>

Required Standards and General Notes:	Traveling to Vegetation Monitoring Plots (REDW, ORCA, WHIS)
Required Personal Protective Equipment:	Seat belt, boots, pants, hardhat
Tools and Equipment:	Spare tire, jack, emergency travel kits, automobile & personal first aid kits, radios

Sequence of Job Steps	Potential Hazards	Safe Action or Procedure
1) Travelling to Plots – Road	a) Basic hazard of driving (#1 cause of deaths in US) b) Other drivers c) Inclement weather, slippery or unsafe driving surface d) Road construction, road blocks, detours e) Animals in roadway, fallen trees or debris f) Fatigued drivers g) Long hours on the road h) Lost/off-course	a) State-required Defensive Driver course, tailgate safety before departure b) Frequent rotation of drivers c) Check road conditions d) Carry emergency rations, water, traffic sign, flares, vest, first-aid kit, sleeping bag, chains, owner's manual, GSA credit card e) Stay aware, drive at a safe speed, listen to concerns of passengers f) Know route and planned stops g) Have back-up plan for multi-vehicle caravan in case of lost vehicles or stragglers h) Ensure that all drivers know when and how to engage 4-Wheel-Drive
2) Travelling to Plots – Off-road	a) Uneven terrain, tripping hazards b) Potential for getting lost or separated from crew c) Inclement/extreme weather conditions d) Biting insects and animals e) Falling trees or limbs	a) Wear PPE (high-ankled boots, long pants, sunscreen, hat, sunglasses, warm clothes, hardhat) b) Walk in pairs, know route, know how to use map, compass, GPS – plan for meeting if separation occurs c) Carry radios programmed with proper frequencies d) Know frequencies, groups, and channels for other parks. Ensure that all employees know how to operate radios and use proper etiquette. e) Walk slowly, watching for tripping hazards, snags, widow-makers, snakes, bees, poison oak, or other potential biting or dermatitis-causing hazards

REDWOOD NATIONAL PARK	1. WORK PROJECT/ACTIVITY Fire Effects Plot Work	2. LOCATION Klamath Network Parks	3. UNIT RMS-Fire
JOB HAZARD ANALYSIS (JHA)	4. NAME OF ANALYST Julie DuBose	5. JOB TITLE Fire Effects Monitor	6. DATE PREPARED 05-16-06

7. SEQUENCE OF BASIC JOB STEPS	8. POTENTIAL HAZARDS	9. ABATEMENT ACTIONS Engineering Controls * Substitution * Administrative Controls * PPE
1. Transporting rebar in the field	1. a) Can get caught on tree limbs/shrubbery if carried in a backpack b) Possible electrocution if carried during potential or active lightening storms c) Potential for impalement or other injury if tripping occurs	1. a) Watch out for each other. Someone without rebar should walk ahead of or behind the person carrying rebar in order to disentangle them when necessary. b) When lightning is seen or likely to occur, immediately remove rebar from backpack or hands, move away from the area . If threat persists longer than reasonable to wait out the storm, leave the rebar and get another time or day. c) Walk slowly and carefully. Carry rebar in downhill-side-hand if walking in steep terrain. If hiking up- or downhill, keep spacing at least 10 feet apart, in order to avoid rebar falling onto another person in case of a fall or slip.
7. SEQUENCE OF BASIC JOB STEPS	8. POTENTIAL HAZARDS	9. ABATEMENT ACTIONS Engineering Controls * Substitution * Administrative Controls * PPE

2. Installing rebar	2. a) Potential to hit hand/fingers while pounding in rebar b) Material may fly into eye	2. a) Wear gloves while installing rebar. Make sure hammer/mini-sledge is not too heavy to use safely. The hand holding the rebar steady should be at least six inches below the end that is being pounded. b) Wear eye protection when pounding in rebar. Keep head back and as far away as possible while striking the end with a hammer.
3. Locating rebar in the field (locating plot)	3. a) Tripping hazard b) Potential contact with dermatitis-causing plants and insects	3. a) Be aware that rebar may be hidden from view. Walk slowly, scanning the ground and pulling back bushes while searching. Once found, flag rebar that is not easily seen. b) Wear long pants and long-sleeved shirts to avoid contact with poison oak or other dermatitis-causing vegetation. Try to keep equipment out of problem vegetation. If contact occurs, wash area immediately with soap and water, or Technu. Wear fresh uniform each day if contact is occurring.
7. SEQUENCE OF BASIC JOB STEPS	8. POTENTIAL HAZARDS	9. ABATEMENT ACTIONS Engineering Controls * Substitution * Administrative Controls * PPE

4. Collecting field data	4. a) Tripping, spraining, twisting b) Contact with dermatitis-causing plants and insects c) Bee and wasp stings d) Branches or other objects poking in eyes e) Heat stress, dehydration	4. a) Watch footing and identify hazards to coworkers. Flag hazards if necessary. Wear proper footgear and other PPE. Take time going up and down steep slopes or travelling off trail. b) See abatement procedures for 3b. c) Watch for wasp nests in trees, holes in ground indicating the potential for a nest, or yellow-jackets/wasps flying around, indicating a nest may be in close proximity. Put flagging around a tree containing a nest, identifying in writing on the flagging what the hazard is. Flag a large circular area around any ground nests, indicating in writing on the flagging what the hazard is. Do not work in or around the area once the hazard has been identified. d) Wear eye protection. Identify hazards to coworkers. Flag hazards if necessary. e) Carry plenty of water for entire day. Drink frequently. Limit intake of caffeine and other diuretics. Rest if needed.
5. Standing in and hiking through forested areas with a potential for snags or trees to fall	5. Whole trees or parts of trees falling, causing injury or death	5. Wear hard hats. Let others know if a threat exists. Post a lookout if necessary. Avoid walking and working near snags or leaning trees.
10. LINE OFFICER SIGNATURE	11. TITLE	12. DATE

D. CUSTOMIZED DATA SHEET EXAMPLES

Page ___ of ___ Park Code:__________

1a. TREES – INDIVIDUALS (METRIC) – OVERSTORY

Plot ID: ___________________

Date: _____/_____/_____

Project Area: ___________________

Recorders: ____________________________

Burn Status (circle one): PRE YR1 YR2 YR3 YR5 YR10 YR20

Plot Size: __________________________

Snag Plot Size: _______________________

Break Point Diameter: 15 Subplot Fraction: 1

Burn Cycle: ________ (i.e. 01, 02, 03)

QTR.	Tag	Species	Status	Prev. L/D	DBH (cm)	Prev. DBH (cm)	Crown Class	Prev. Crown Class	Damage		
			L D								
			L D								
			L D								
			L D								
			L D								
			L D								
			L D								
			L D								
			L D								
			L D								
			L D								
			L D								
			L D								
			L D								

Crown Class Codes:

D = Dominant
C = Co-Dominant
I = Intermediate
SC = Sub Canopy
O = Open Growth
RS = Recent Snag
LBS = Loose Bark Snag
CS = Clean Snag
BAD = Broken Above DBH
BBD = Broken Below DBH
DD = Dead and Down
CUS = Cut Stump

Damage Codes:

ABGR = Abnormal Growth
BIRD = Bird (Woodpecker Holes)
BLIG = Blight
BROK = Brkn Top
BROM = Witches Broom
BURL = Burl
CONK = Conk, Shelf Fungus
CROK = Crooked Bole
DTOP = Dead Top
EPIC = Sprouting from Bole/Limbs
EPIP = Epiphytes
FIRE = Fire Scar
FORK = Forked Top
FRST = Frost Crk.
GALL = Galls
HOLW = Hollowed Out
INSE = Insects or Signs of
LEAN = Tree is Leaning
LICH = Lichen
LIGT = Lightning Scar
MAMM = Mammal Damage
MISL = Mistletoe Present
MOSS = Moss
OZON = Ozone
ROOT = Root
ROTT = Rot
SPAR = Sparse Foliage
SPRT = Sprout. Frm Base
TWIN = Twin blw DBH
UMAN = Human Damage
WOND = Wound, Cracks

Date Entered: ____________

Initials: _____________

Date Checked: ________________

Initials: ___________

Park Code:____________

2a. TREES – INDIVIDUALS (METRIC) – POLES

Plot ID: __________________
Plot Size: __________________________
Date: _____/_____/_____
Snag Plot Size: _______________________
Project Area: ___________________
Break Point Diameter: 15
Subplot Fraction: _____
Recorders: ____________________________
Burn Cycle: ________ (i.e. 01, 02, 03)
Burn Status (circle one): PRE YR1 YR2 YR3 YR5 YR10 YR20

QTR.	Tag	Species	Status	Prev. L/D	DBH (cm)	Prev. DBH (cm)	Height (m)	Prev. Height (m)
			L D					
			L D					
			L D					
			L D					
			L D					
			L D					
			L D					
			L D					
			L D					
			L D					
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			L D					
			L D					
			L D					
			L D					
			L D					
			L D					
			L D					
			L D					

Height Ranges (in Meters):

0 - 0.15 = **0.15**	2.1 - 3.0 = **3.0**	7.1 - 8.0 = **8.0**
0.16 - 0.3 = **0.3**	3.1 - 4.0 = **4.0**	8.1 - 9.0 = **9.0**
0.31 - 0.6 = **0.6**	4.1 - 5.0 = **5.0**	9.1 + = **10.0**
0.61 - 1.0 = **1.0**	5.1 - 6.0 = **6.0**	
1.1 - 2.0 = **2.0**	6.1 - 7.0 = **7.0**	

Please record height ranges by using the upper end of the range (bold numbers).

Date Entered: ____________
Date Checked: _________
Initials: _____________
Initials: __________

6. SURFACE FUELS (ENGLISH)

Park Code:________

Plot ID: ______________________ Date: _____/_____/_____ Burn Unit: ___________________

Recorders: ___________________________ Burn Cycle: ________ (i.e. 01, 02, 03)

Burn Status (circle one): PRE IM. POST (month____) YR____(1, 2, 5, 10, 20)

	1hr hits 0-.25”	**10hr** hits .25-1”	**100hr** hits 1-3”	**1000hr** hits 3.1"+ Decay Class 3 (Sound)				**1000hr** hits 3.1"+ Decay Class 4 (Rotten)				**Litter and Duff Depths**							
				old		new		old		new			**L**	**D**	**Veg**		**L**	**D**	**Veg**
Transect 1												1				35			
Az: _____												5				40			
												10				45			
Slope%												15							
______												20							
												25							
												30							

	1hr hits 0-.25”	**10hr** hits .25-1”	**100hr** hits 1-3”	**1000hr** hits 3.1"+ Decay Class 3 (Sound)				**1000hr** hits 3.1"+ Decay Class 4 (Rotten)				**Litter and Duff Depths**							
				old		new		old		new			**L**	**D**	**Veg**		**L**	**D**	**Veg**
Transect 2												1				35			
Az: _____												5				40			
												10				45			
Slope%												15							
______												20							
												25							
												30							

	1hr hits 0-.25”	**10hr** hits .25-1”	**100hr** hits 1-3”	**1000hr** hits 3.1"+ Decay Class 3 (Sound)				**1000hr** hits 3.1"+ Decay Class 4 (Rotten)				**Litter and Duff Depths**							
				old		new		old		new			**L**	**D**	**Veg**		**L**	**D**	**Veg**
Transect 3												1				35			
Az: _____												5				40			
												10				45			
Slope%												15							
______												20							
												25							
												30							

	1hr hits 0-.25”	**10hr** hits .25-1”	**100hr** hits 1-3”	**1000hr** hits 3.1"+ Decay Class 3 (Sound)				**1000hr** hits 3.1"+ Decay Class 4 (Rotten)				**Litter and Duff Depths**							
				old		new		old		new			**L**	**D**	**Veg**		**L**	**D**	**Veg**
Transect 4												1				35			
Az: _____												5				40			
												10				45			
Slope%												15							
______												20							
												25							
												30							

Date entered:______________ Date checked:________________

Initials:__________ Initials:___________

FMH-22 REDW GRASS PLOT BURN SEVERITY (Metric)

Plot ID: ______________________________ B / C Date: ____________

Burn Unit: ____________________________ Recorders: ____________________________

Burn Status: (Indicate number of times treated) _______ Post

Record severity every 1.5m. Each observation is from a 4dm square area.

FMH Point	Meter Point	SUBSTRATE	VEGETATION
5	1.5	______	______
10	3.0	______	______
15	4.5	______	______
20	6.0	______	______
25	7.5	______	______
30	9.0	______	______
35	10.5	______	______
40	12.0	______	______
45	13.5	______	______
50	15.0	______	______
55	16.5	______	______
60	18.0	______	______
65	19.5	______	______
70	21.0	______	______
75	22.5	______	______
80	24.0	______	______
85	25.5	______	______
90	27.0	______	______
95	28.5	______	______
100	30.0	______	______

Severity Ratings:

5 = Unburned
4 = Scorched
3 = Lightly Burned
2 = Moderately Burned
1 = Heavily Burned
0 = Not Applicable

FMH Forest Plot Densiometer Data Sheet

Y = canopy, N = no canopy

P1-P2 line	Y or N
2m	
4m	
6m	
8m	
12m	
14m	
16m	
18m	

0P-50P line	Y or N
4m	
6m	
8m	
10m	
12m	
14m	
16m	
18m	
20m	
22m	
24m	
26m	
28m	
30m	
32m	
34m	
36m	
38m	
40m	
42m	
44m	
46m	

Plot:________________________________

Date:________________________________

Plot Read Status:_____________________

Burn Unit:____________________________

UTM Datum:__________

UTM E:______________________

UTM N:______________________

Fir Plot Data Sheet

Plot #:	**Date:**	**Visit:**	PRE	POST	YR02
Burn Unit:		**Treatment:**	EARLY	LATE	
UTM Coordinates (NAD83):	**UTMN:**	**UTME:**		**PDOP:**	
Slope (Hill):	**Plot Azimuth (long axis):**				
Proximity to forest	**Evidence of mechanical**				

Fir Enumeration (Live and ≤ 3' only)	
Tally	

Canopy Cover		
A stake:	HIT	MISS
B stake:	HIT	MISS
C stake:	HIT	MISS
D stake:	HIT	MISS

Photos	
Taken at stake:	
Comments:	

Entered by: ________________ Date: ________

FFI Mumblings

Directions:

1. Turn on desktop computer in Fire Effects office, give it time to boot up to the log in screen before trying to open FFI on any computer other then the desktop. This is our master database computer and must be on for FFI to work; you do not have to be logged into the master computer while using FFI.
2. Double click on the FFI icon on desktop. Note that there will also be FFI Database Administration and Protocol Builder icons, you want just the FFI icon!
3. FFI Database Select window will open; choose INPREDW105504/SQLEXPRESS from the first drop down list. Should this not appear in the drop down list the master computer is not on or fully booted up yet; or you've just crashed the system and we've lost 20 years of data (not really).
4. Enter your user name and password.
5. If it locks up on the first letter of your password, something is wrong, close FFI and talk to Becky or Jen.
6. After you've entered your password, be patient and eventually the Select or enter a database name: pull down list will populate. Choose which fun filled database you'd like to enjoy. Hit OK. Please only work in FFI_REDW, FFI_ORCA and FFI_WHIS unless you're told otherwise.
7. The FFI Administrative Unit window will then open and the database you're trying to open should be listed. Select it, hit CONTINUE.
8. Patience is virtue, Grasshopper.
9. FFI will open to the Project Management page

Common Shrub Belt (Density Belt) Subplot Fractions

Dimensions	# of Transects	Square Meters	Subplot Fraction
50 x 1	1	50	0.05
50 x 1	2	100	0.1
50 x 2	1	100	0.1
50 x 2	2	200	0.2
50 x 5	1	250	0.25
50 x 5	2	500	0.5

Common Seedling Belt (Density Quadrat) Subplot Fractions

Dimensions	# of Transects	Square Meters	Subplot Fraction
5 x 10	1	50	0.05
25 x 10	1	250	0.25
50 x 20	1	1000	1

How to set up a new macro plot in FFI:

1. Start in the Project Management page.
2. Highlight the monitoring type you would like to add a plot to (FQUGA1D09, GMIPR1D03, FQUKE1D09…)
3. Select the New dropdown menu in the top left corner of the screen (directly above the list of monitoring types). From the New menu select Macro Plot.
4. Starting at the top of the screen you will enter a name for the new macro plot; it should be something like this: GMIPR1D0399 with the last two numbers being the plot number.
5. Select Grassland, Forest, or Shrubland from the Type dropdown menu.
6. Leave Purpose blank.
7. Under Site Characteristics please enter all available information. Please note that elevation is in meters!
8. Under Location please enter all information available, most importantly UTMs in NAD83, please only enter NAD83 UTMs for now (do not enter NAD27)!
9. Under Installation please enter an Installation Date (make sure this is the date it was installed and not the day you're entering the data).
10. Enter all crewmembers who were involved in Located By:.
11. Under the Directions area please enter full directions from the FMH-5. Leave Start Point blank.
12. Move on to the Metadata tab and please enter the burn unit where plot was installed, such as: Copper Creek Burn Unit.
13. Continue on to the Comments tab and enter the burn unit again, exactly as you typed it under the Metadata tab.
14. Lastly hit Save at the top. It may take a few moments, but your new Macro Plot should then appear on the left hand side of the screen under the correct Monitoring Type.

How to set up a new plot sampling event:

1. In the Project Management page select the Macro Plot (on the left) you would like to add a sampling event to.
2. Select the New dropdown menu in the top left corner of the screen (directly above the list of monitoring types/macro plots). From the New menu, select Sample Event.
3. Once the Sample Event page appears enter the correct date the plot was read.

4. Ensure the correct Macro Plot is listed.
5. Under the Protocols tab select the Add/Remove Protocols button (it is not intuitive and does not look like a button!).
6. When the Protocol Selector window opens highlight the protocol under the Available Protocols that you will need to enter information into, and hit the >> button in the middle to move it to the Assigned Protocols.
7. **Here is a guide of what data goes into what protocol:**
    a. **30 and 50m veg. transect = *Cover – Points (metric)***
    b. **Species observed on above veg. transect = *Cover – Species Composition***
    c. **Shrub belts = *Density – Belts (metric)***
    d. **Seedlings = *Density – Quadrats (metric)***
    e. **Browns or Grassland post burn severity points = *Postburn Severity (metric)***
    f. **Browns transects = *Surface Fuels (be careful not to select the metric option!)***
    g. **Overstory and pole size trees = *Trees – Individual (metric)***
    h. **Immediate postburn tree data = *Trees – Individual (metric)***
8. Once you have selected all of the protocols you will need to enter data into, hit OK and the Protocol Selector window will close and the chosen protocols should then be listed.
9. Under the Team tab please add all crewmembers' names that were involved in data collection.
10. Once completed hit Save at the top of the screen and wait until the new sampling event has appeared under the correct Macro Plot on the left side of the screen.

How to enter a plot into FFI from start to finish:

<u>Browns Transects</u>

1. Browns transect data are entered under the Surface Fuels (double check it is NOT the metric protocol!) tab.
2. Start at the top with Fine Woody Debris (in small blue lettering).
3. Number of transects should be 4, assuming it's a typical FMH forest plot.
4. 1 hr Transect Length: 6'
5. 10 hr Transect Length: 6'
6. 100 hr Transect Length: 12'
7. Transect column is what transect it is, typically 1-4.
8. Azimuth is the azimuth of each transect.
9. Slope is the slope of each transect.
10. 1, 10 and 100 hr count columns are simply the tally of each for each transect.
11. Next go to the lower left hand corner to Coarse Woody Debris, a.k.a. 1000 hours.
12. Number of transects should be 4.
13. Transect length should be 50.
14. Transect column is what transect the 1000 hour is found on.
15. The slope relates to the slope of the specific transect entered into column 1.
16. Do not worry about log number.
17. Enter diameter of 1000 hour log, it must be at least 3.1 or greater, do not enter 3.0 logs!
18. Decay class discerns if it is a solid or rotten log. Please use decay class 3 for solid logs and decay class 4 for rotten logs until further notice.
19. Enter the foot mark where the log is found on the transect in the comment column like so: @21'
20. Move on to the Duff and Litter section in the lower right hand corner.
21. Transect is again 1-4.

22. Sample location will be 1, 5, 10, 15, 20…
23. The Off Set column should be placed at Yes if reading is taken at a spot other than at the actual tape measure point (if there's a rock, rotten log, stump in way…).
24. Enter litter depth and duff depth into appropriate column.
25. Hit save and hope for no red exclamation points!

Veg. Transect

1. Veg. transects get entered under the Cover - Points (metric) tab.
2. Number of Transects: 1 or 2, depending on how many are read for a plot…
3. Transect length: 50m transect = 49.8 (it is important to enter specifically 49.8 otherwise the numbers get funky towards the bottom), 30m transect = 30
4. Num. Points/Tran: 50m transect = 166, 30m transect = 100
5. Q4-Q1 transect is always transect 1!! This would then make Q3-Q2 transect #2.
6. Actually entering data:
    a. Starting in the far left column, Transect, will always be 1 or 2, I suggest starting with 1 if there are multiple.
    b. Point is the point # (1-166 or 1-100). It will not let you enter anything in the tape column; it will automatically increase itself 0.3 m for each new point after you hit return.
    c. Order number is the order plants are on the datasheet if there are multiple plants at each point (i.e. at point 3, tape 0.9, height of 0.05 with ROGY and then WOOD, ROGY would be Order 1, and WOOD would be 2).
    d. Height is the height of the first species found at that point, if there are multiple species per point, the second species gets a height of 0. Please ensure this 0 gets entered for data uniformity, do not leave this column blank. If the species does not have a height, such as LITT or ROCK, please enter a 0.
    e. Species is where you actually type in the four letter code for the species. Watch out, it likes to fill things in for you and it can be utterly frustrating getting it to enter the species you actually want! Don't fret if there is a number behind the code. FFI will not allow you to enter any funky four letter codes; if it's not in our plant database you cannot enter it! If you cannot find the four letter code that is listed on the field data sheet, start by checking this website which is the Jepson Online Interchange: http://ucjeps.berkeley.edu/interchange/ I would recommend trying to enter the Genus if you can figure it out, and then search for the species that corresponds. If you're entering old data the name has most likely changed and it will tell you this under the taxonomic details on the website of each species. DO NOT enter new plants into our database without talking to Becky or Jen first!
    f. Status is L or D for Live or Dead. Ensure that all non living things such as LITT, WOOD, ROCK are entered as D! BOLE is L and there will occasionally be plants listed as D. Remember that dead annuals are always entered as "L."
    g. When you hit enter it will start the next row, transect, point, tape and status columns will automatically populate.
    h. If there is an unknown that cannot be identified to at least species it will be entered into FFI as GUNK1 or FUNK1. NEVER add a new FUNK or GUNK to the species list!
7. Hit save and hope for no red exclamation points!
8. If there are any species observed (exotics only, within 5 meters of the line) go to the "Cover-Species Composition (metric)" tab.
9. Please use 0.1 for the Minimum Cover Level at the top of the form.
10. Enter the species code for the plant; leave the rest of the columns blank.

Seedlings

1. Seedlings are entered under the Density – Quadrats (metric) tab.
2. Number of Transects: 1
3. Number of Quad./Tran.: 1
4. Length is 5, width is 10, unless all of Q1 was used, at which point it would be length: 25, width 10
5. Multiply length and width to get Quad. Area.
6. Transect and Quad columns will each be 1, unless again there were multiple areas where data were taken.
7. Item code is seedling spp.
8. Status is live or dead (L or D)
9. Please leave Size Class and Age Class empty.
10. Count is the number/tally of seedlings for each class.
11. Height is in actual meters, DO NOT USE the height code here! Please use the top end of each height code, i.e. height code 5 = 2m, height code 1 = 0.15 (this is a moot point with new 2009 data sheets…)
12. Subplot fraction is VERY IMPORTANT! Simply take your Quad Area from above and divide by 1000. So, if our seedling quad is 5 x 10, or 50 square meters, the subplot fraction is 0.05. Please see chart on page two for quick subplot fraction reference!
13. Hit save and hope for no red exclamation points!

Shrubs

1. Shrubs are entered into the Density – Belts (metric) tab.
2. Number of transects will be one or two.
3. Number of Subbelts will be how many times the belt was broken up, usually into 5m sections (for a 30m belt this would be 6, for a 50m belt this is usually 10).
4. Transect length should be 30 or 50.
5. Transect width should be listed on the data sheet, if it's not please ensure you find this data out and then write it on the data sheet!
6. Transect Area is the length times the width (30 x 10m belt would be 300, 50 x 2 would be 100…)
7. If there are two shrub belts, the Q4-Q1 belt will always be Transect 1; it is also this way for the veg. transects!
8. Item Code is the shrub species, again please do not add species to our database without talking to Jen or Becky first!
9. Status is L for Live and D for Dead.
10. Leave size class blank.
11. Age Class will be I for Immature, M for Mature and R for Resprout.
12. Count is the tally for that species and size class, live or dead for each subbelt.
13. Please leave Height blank.
14. Subplot fraction is again very important. Please refer to the table on the first page of this long winded document to ensure you are using the correct subplot fraction for the correct size shrub belt!
15. When you are complete make sure you hit Save at the top of the page. It will not allow you to change tabs/protocols until the information is saved or the entire page is blank. Hope for no angry red exclamation points!

Trees, Overstory and Pole

1. Overstory and pole size trees are entered into the Trees – Individual (metric) tab.
2. Plot size is 0.1 (1000m = 1/10 of a hectare)
3. Snag plot size is 0.1
4. Break Pnt. Diameter is 15 (meaning that all trees 15 cm dbh and less are pole, 15.1 is overstory).
5. Quarter column on far left is whatever quarter the tree is in (1-4).
6. Subplot fraction: overstory trees will be 1, (assuming overstory are recorded within entire plot), pole size trees will be 0.25, 0.5 or 1 (if pole size tree data are collected only in Q1, use 0.25 – or ¼ of the plot, if poles are recorded in Q1 and Q2 – which is rare, use 0.5, and if pole data were collected in the entire plot (all quarters) use 1).
7. Tag number is hopefully obvious. If there is no tag number, please enter 0 as I don't think FFI will allow you to leave it blank.
8. Species is the species of tree.
9. Status is L or D or live or dead, we don't use the other options they give you.
10. DBH should be obvious. You MUST enter a DBH, it is the only way to filter overstory versus pole size trees for analysis purposes! If there is no DBH listed please look at the data sheets from the most previous read and use those DBHs. This is applicable even is the tree is dead!
11. Height is only used for pole size trees. Please enter a height in meters, not the height code. Please use the upper end of the height code, i.e. height code 8 = 5m. This again a moot point with the new 2009 datasheets.
12. We do not currently use crown ratio on traditional FMH plots.
13. Crown class will be D = dominant, C = codominant, LBS = loose bark snag; it will not allow you to use numbers in this column.
14. If entering burn severity such as scorch height, percent or char height scroll to the right until you find the columns labeled as such (they are right before the damage code columns).
15. If there are damage codes on the data sheet please make sure to enter them, scroll to the right until you find these. There is room for 5 damage codes; we do not currently use the damage severity column related to each damage code.
16. If you are entering a REDW QUGA plot and there are notes about how many live and dead stems are included in the tagged tree clump (hopefully you'll find this information on data sheets starting in 2009) please enter this information into the columns titled 'Num. Live Stems' and 'Num. Dead Stems'.
17. Hit save and hope for no red exclamation points!

Immediate Post Burn Data:

1. Most of the time you will need these protocols for a forest plot immediate post burn read:
    a. Postburn Severity (metric)
    b. Surface Fuels
    c. Trees – Individuals (metric)
2. If it is a grass plot you will only need Postburn Severity (metric).
3. Once the new read is set up with protocols, navigate to the data entry and edit section.
4. Surface Fuels are entered the same way.
5. Postburn Severity:
    a. Number of Transects: 4 for forest, 1 for grass
    b. Transect Length: 50 for forest, 30 for grass
    c. Number of Points/Transect: 10 for forest, 20 for grass

   d. Plot Type: Forest or Grass
   e. Point Area: 400 (this is a 2dm x 2dm area)
   f. Transect Number will be 1-4 for forest, 1 for grass
   g. Point will be 1-10 for forest, 1-20 for grass
   h. Tape column indicates what mark on the tape the reading is being taken
   i. Vegetation and Substrate are numbers 0-5 relating to the burn severity
6. Trees – Individual
   a. All trees will be entered as they are for other reads. All trees need to have a tag number, and most importantly, a DBH! To enter the scorch height, percent and char height scroll numerous columns to the right. They will be found immediately before the damage codes.

How to quality check a plot in FFI from start to finish:

1. In lower left hand corner, select Data Entry and Edit.
2. Navigate to the Monitoring Type and then to the plot. Example: You want to quality check BSAGE1D06-55; maximize BSAGE1D06, and then maximize B:BSAGE1D06:55.
3. Click on the specific sample event, listed by date in this format: year/month/date, which you would like to quality check.
4. Quality check data for errors. Should you happen to find an error, make the necessary changes and then hit Save, which is located in the upper left corner of the big window, directly below the protocol tabs.
5. It may give you a warning that it is unable to save due to errors on the form. We hope that wherever the error is, a small red circle with an exclamation point will appear. This does not always happen. If you're not able to figure out where the error is and it won't let you save, hit Cancel. This means you now have to try to redo your changes.
6. Things to look for:
   a. Take time to specifically look at subplot fractions, and Browns transect 1000 hours. Commonly if you are quality checking old data that was imported from FEAT these two things will need to be changed. See tables above to find correct subplot fraction. For plots that were imported from FEAT (anything 2007 and earlier) and if there are multiple 1000 hours but not all transects are represented, FFI usually messed up the transect number where the log was found. Please ensure that the far left column 'Transect' matches what transect it says in the farthest right column 'UV3' (it will say something like Fuel1 or Fuel3 meaning transect 1 and transect 3).
   b. Also check out the Cover – Points (metric) form to ensure that all LITT, ROCK and other non-plants have a D for dead in the Status column.
   c. Please check to make sure that the burn unit where the plot is located got entered into the Metadata and Comments within the Project Management section.
   d. Check to make sure if it's a 50m veg. transect, the top of the form it actually says 49.8 for Transect Length – otherwise you'll notice funny tape numbers such as 48.09 towards the end.

How to produce a pretty plot spp. list:

1. Enter FFI.
2. Click on Query at the bottom of the left hand menu.
3. Once in Query start at the left and work your way to the right, with Method and the protocol drop down list.

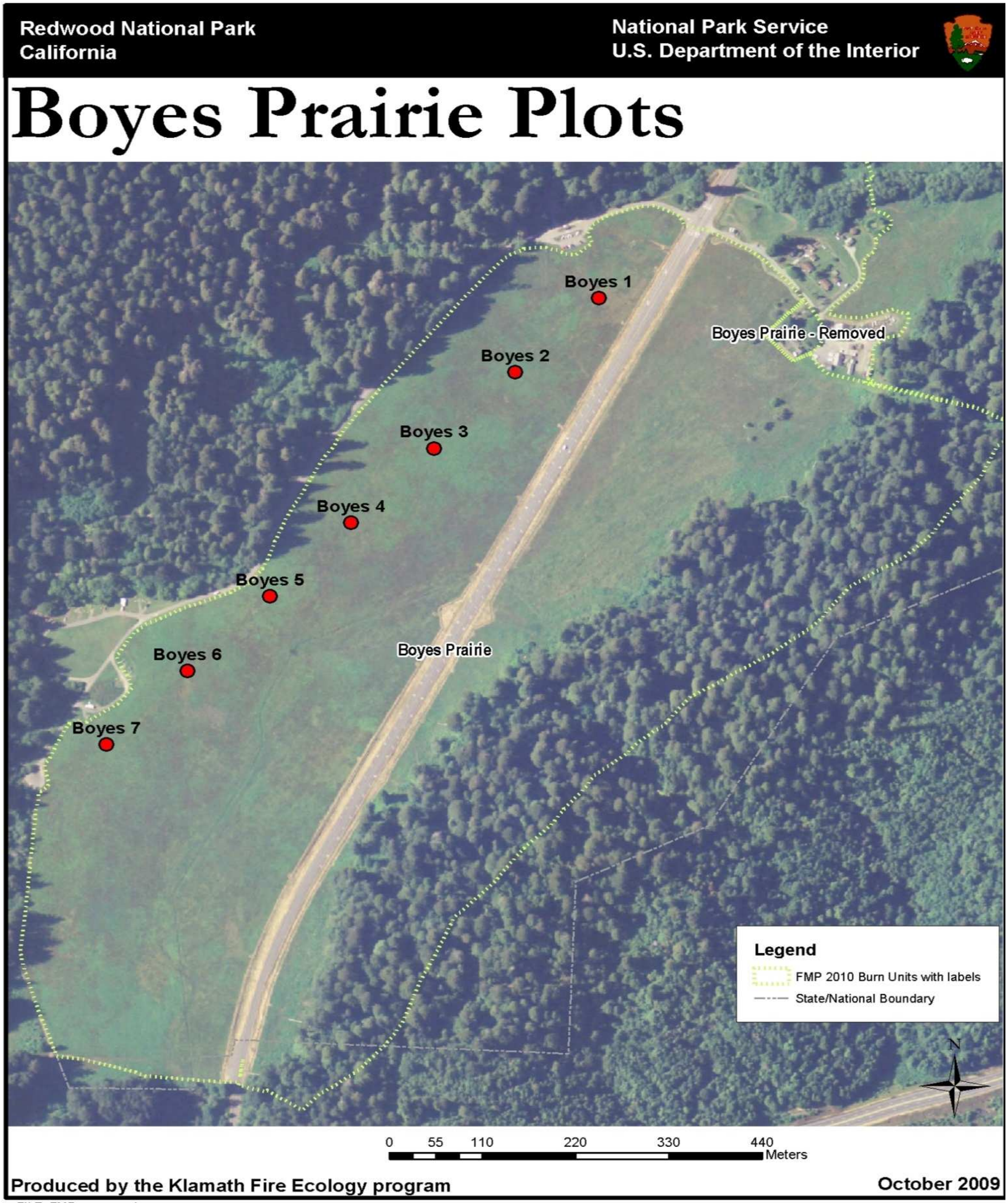
4. Choose Cover – Points (metric) from drop down list, and then highlight (by clicking) Cover – Points (metric) from list below when it appears.
5. Under Macroplot highlight the macroplot that you'd like to produce a list for; it is possible to highlight more than one, so be careful that you only highlight what you want!
6. Under Sample Event and Monitoring Status highlight all; this will ensure that all reads are represented on the report.
7. Now go to the Additional/Calculated Fields tab.
8. Under Species Field click boxes: Scientific Name, Common Name and Nativity.
9. Go to the Grouping and Summary Calculations Tab
10. Under Macroplot Group By click the Macroplot box.
11. In Species Attributes click Species.
12. Click on the top of the Species Symbol column to alphabetize query.
13. Go to the top of the page and hit export. Save it somewhere where you can find it and please put at least the plot number at the end so we can differentiate between the different plots.
14. Navigate to where you saved it, do a Save As. Change document name into something meaningful such as FBUGR1D55-09 (plot name) Spp. List 1999, also change document type to Microsoft Office Excel Workbook.
15. Please then put a nice header at the top of the plot name, delete the macroplot column after you've identified the plot in the top header and delete the Row Count column. Make all columns wide enough to read and fit on one page, landscape orientation. Please save this document in the appropriate Park folder, Spp. List folder within the Fire Effects Folder on the S:// drive.

How to produce a pretty overstory, pole or immediate postburn tree data sheet:

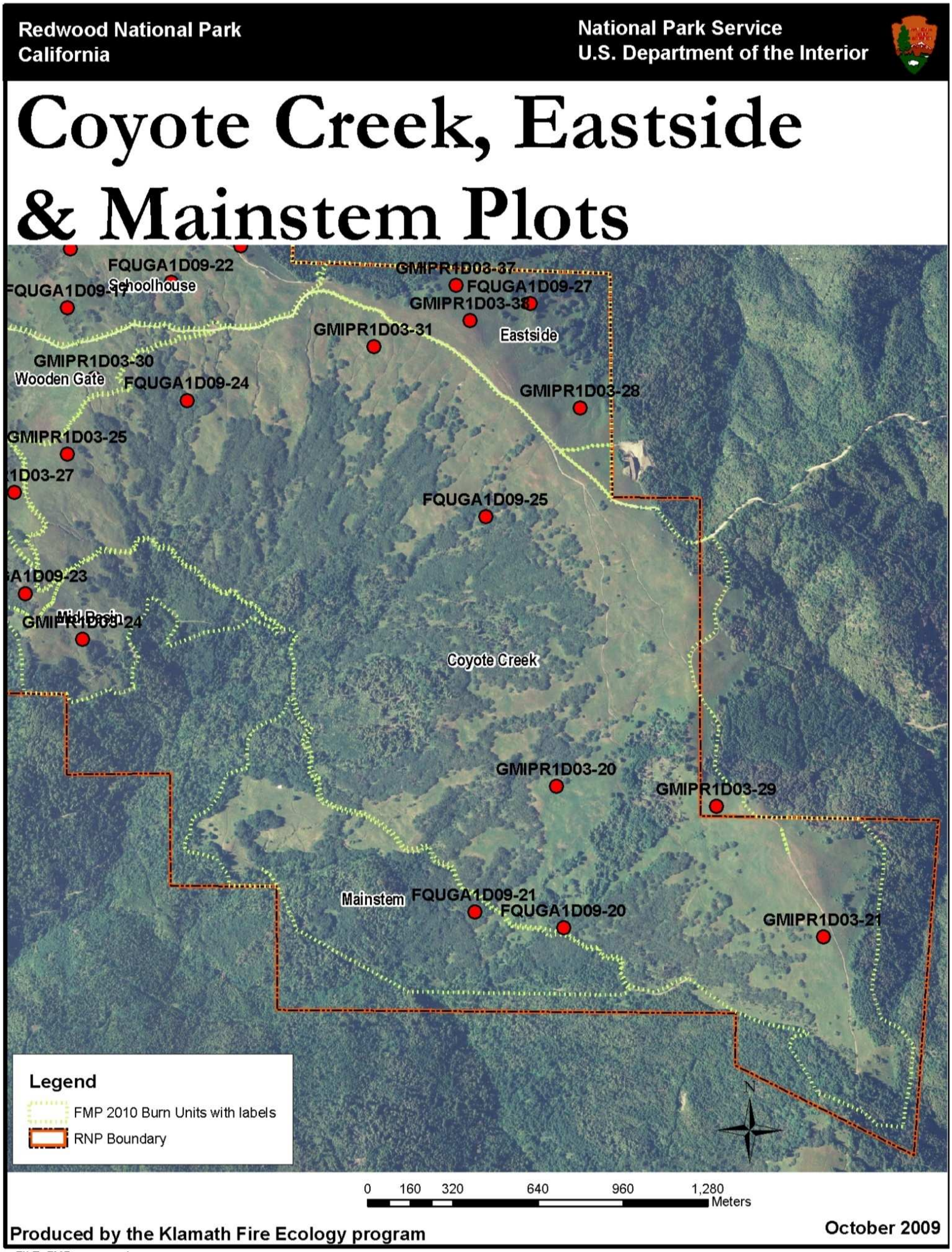
1. Enter FFI.
2. Click on Query at the bottom of the left hand menu.
3. Once in Query start at the left and work your way to the right, starting under Method and the protocol drop down list.
4. Choose Trees – Individual (metric) from drop down list, and then highlight (by clicking) Trees – Individual (metric) from list below when it appears.
5. Under Macroplot highlight the macroplot that you'd like to produce a list for; it is possible to highlight more than one, so be careful that you only highlight what you want!
6. Under Sample Event and Monitoring Status please find the most recent read with tree data. HINT: this will NOT be a POST read!
7. Under Species please check the boxes 'Exclude non-vascular:' and 'Exclude trees dead/down:'.
8. Click on the top of the Quarter (QTR) column so that all trees in Q1 are at the top of the query.
9. Go to the top of the page and hit export. Save it somewhere where you can find it and please put at least the plot number at the end so we can differentiate between the different plots.
10. Navigate to where you saved it, open it and delete ALL columns, except for these from the spreadsheet: Species Symbol, QTR, SubFrac, TagNo, Status, DBH, Height, CrwnCl, and DamCd1, DamCd2, Dam Cd3.
11. Once all unnecessary columns are deleted, center all data in the columns/rows so it looks a little prettier.
12. Now determine what field data sheet you'll be pasting this information into; will it be overstory, poles or immediate post burn?
13. If you are creating an overstory sheet, either look at the Height or SubFrac column to determine which are poles and which are overstory trees. Please cut and paste all poles to a new excel spreadsheet to get out of your way. Poles will most likely always have a height, where as overstory trees should never have a height. Poles will not have damage codes.

14. Once it has been determined which trees are poles, and they have been removed, the Height and SubFrac columns can be deleted. Please double check for trees that have the crown class DD, these are dead and down trees and we do not want them on the data sheet.
15. Select the entire excel page (this is very important, all columns of data must be selected or you will have to start over from step one!) and under the Data menu choose sort. Sort by Quarter column (ascending order), then by Tag Number (ascending). If you have a header column, which you should, please choose this option and the header should un-highlight. Once OK is clicked the page should be sorted by quarter and then tag number.
16. Now the data needs to end up in the same column order as the field data sheet, so cut and paste the Species Symbol column between the TagNo and Status columns. Insert an extra column between Species and Status, Status and DBH, and DBH and Crown Class. In a nutshell this is the order that columns should be in on the excel sheet: Quarter, Tag, Species, blank, Status, blank, DBH, blank, Crown Class, Damage Codes.
17. Now go to S://drive, fire effects folder, FFI folder, Datasheets folder, Excel folder. Open the Overstory Tree field data sheet. Please immediately do a 'Save As' and rename it with the plot name.
18. Now simply cut and paste data from excel sheet into data sheet. Please ensure that all data transfers and ends up in the correct column on the data sheet. Please cut and paste the L and D back into the Status column. Please fill out the top part of the data sheet as much as possible, with at least the Plot ID filled out.
19. Once all data is on the data sheet, save and print out to take into the field.
20. Producing a pole data sheet is very similar, except that you will need the height column. You will not need the crown class and damage code columns.
21. Insert an extra column between Species and Status, Status and DBH, and DBH and Height. To review, your excel sheet should have the columns in this order: Quarter, Tag, Species, blank, Status, blank, DBH, blank, Height.
22. Again, sort the data by quarter and then by tag number. Copy and paste into pole data sheet and print out.
23. For an Immediate Postburn Tree data sheet, follow the above guidelines except delete height, crown class and damage columns.
24. Organize excel spreadsheet in this way: Quarter, Tag, Species, blank, Status, blank, DBH
25. Again please cut and paste, fill out top of data sheet, save and print.

F. MAPS



FILE: FMP maps.mxd



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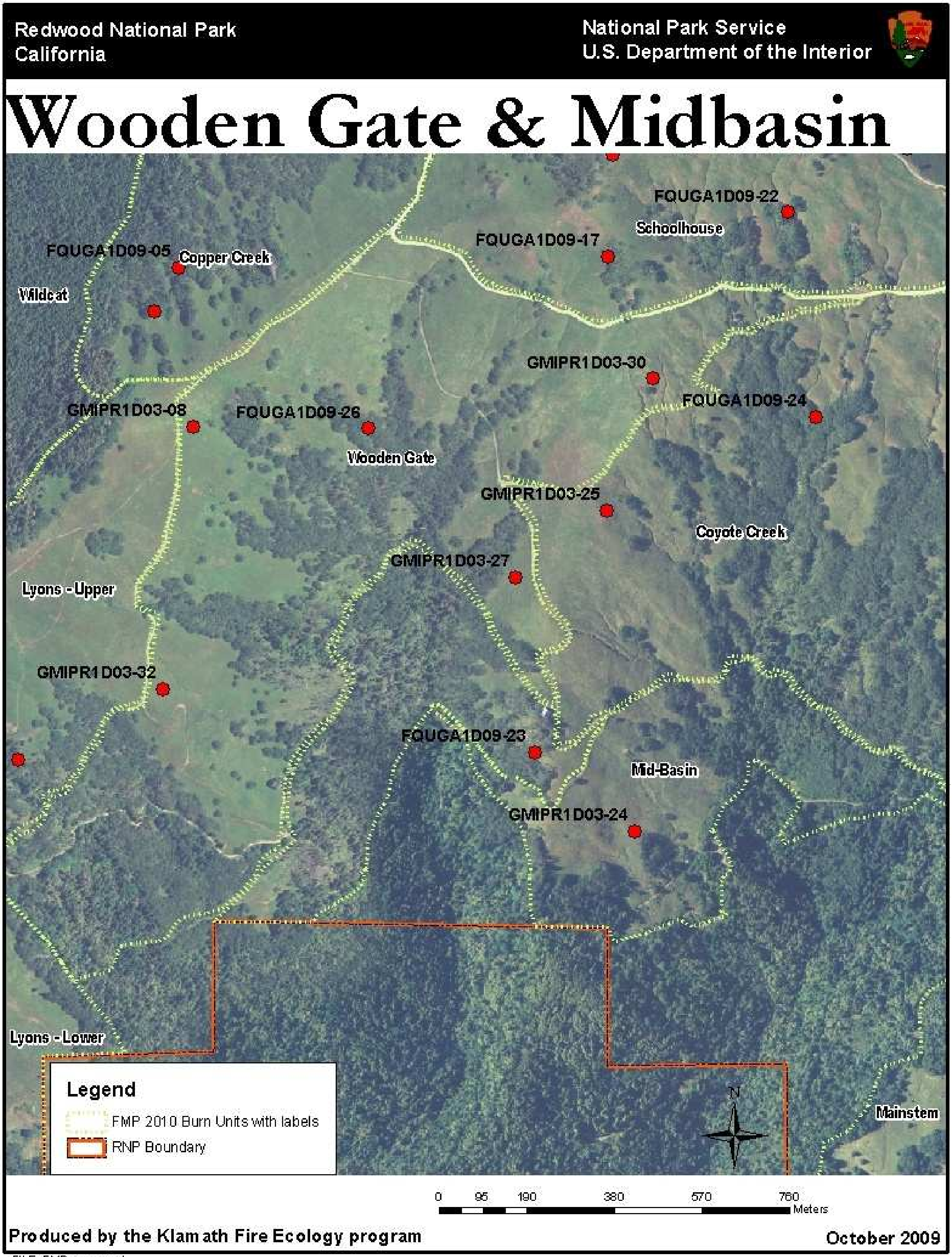

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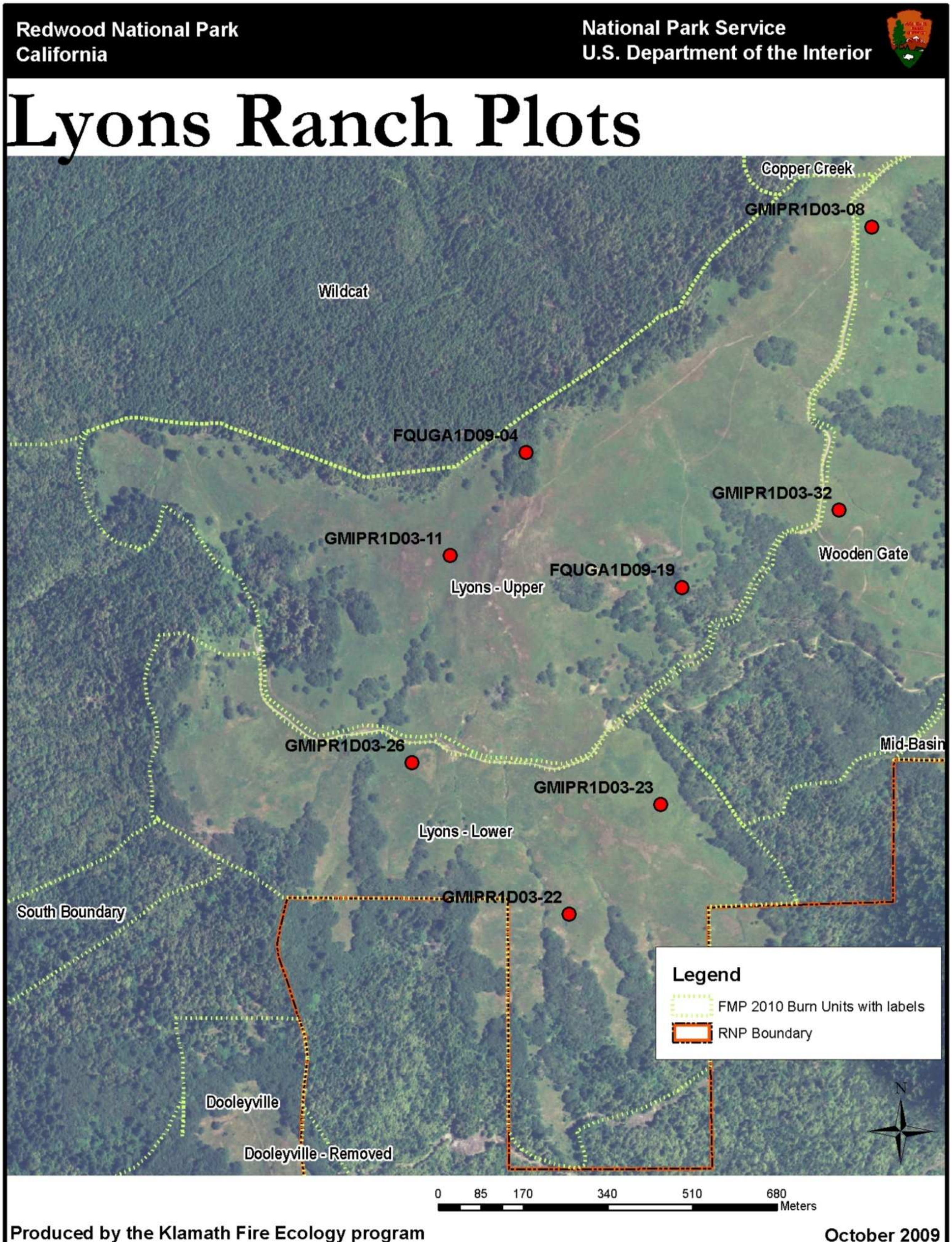

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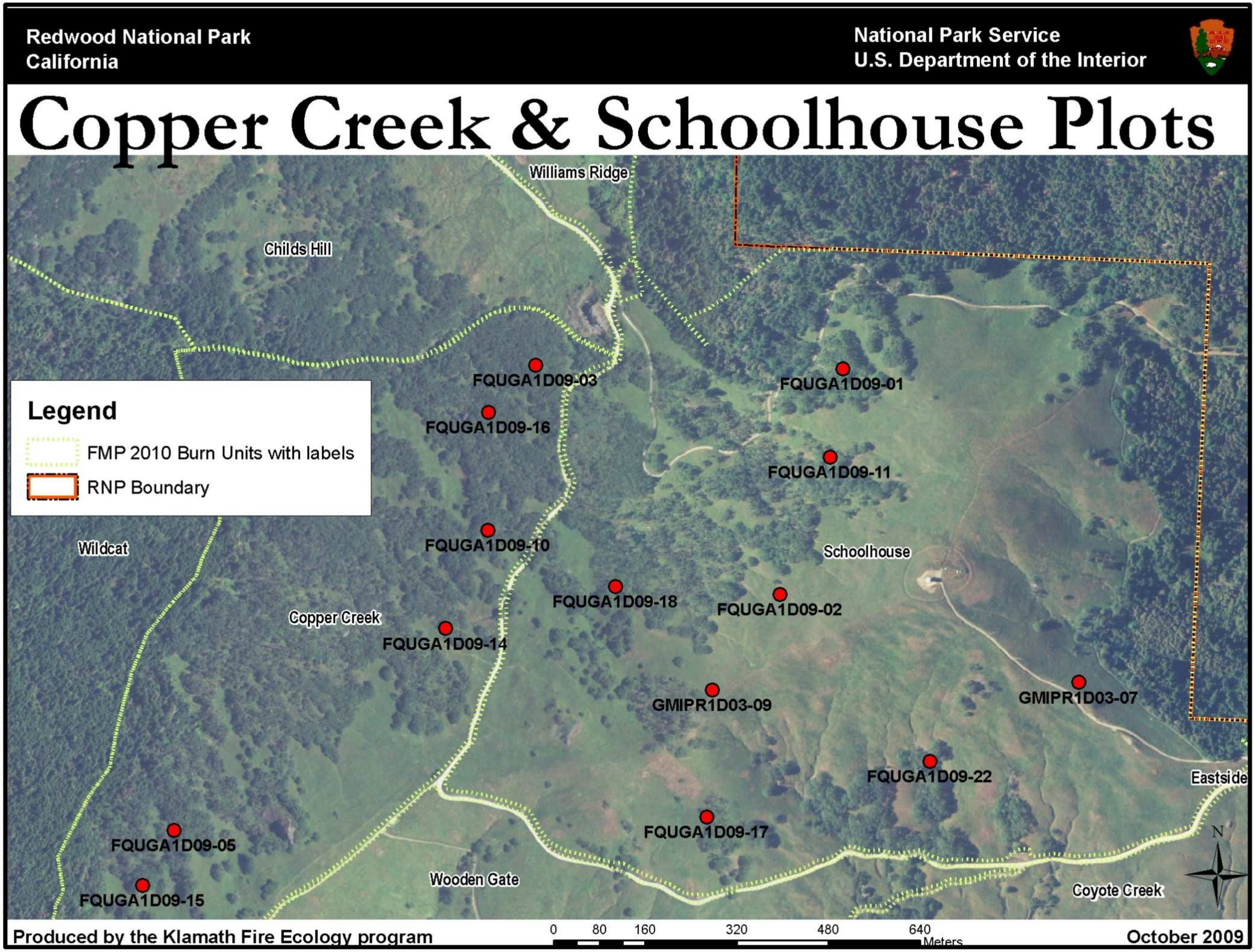

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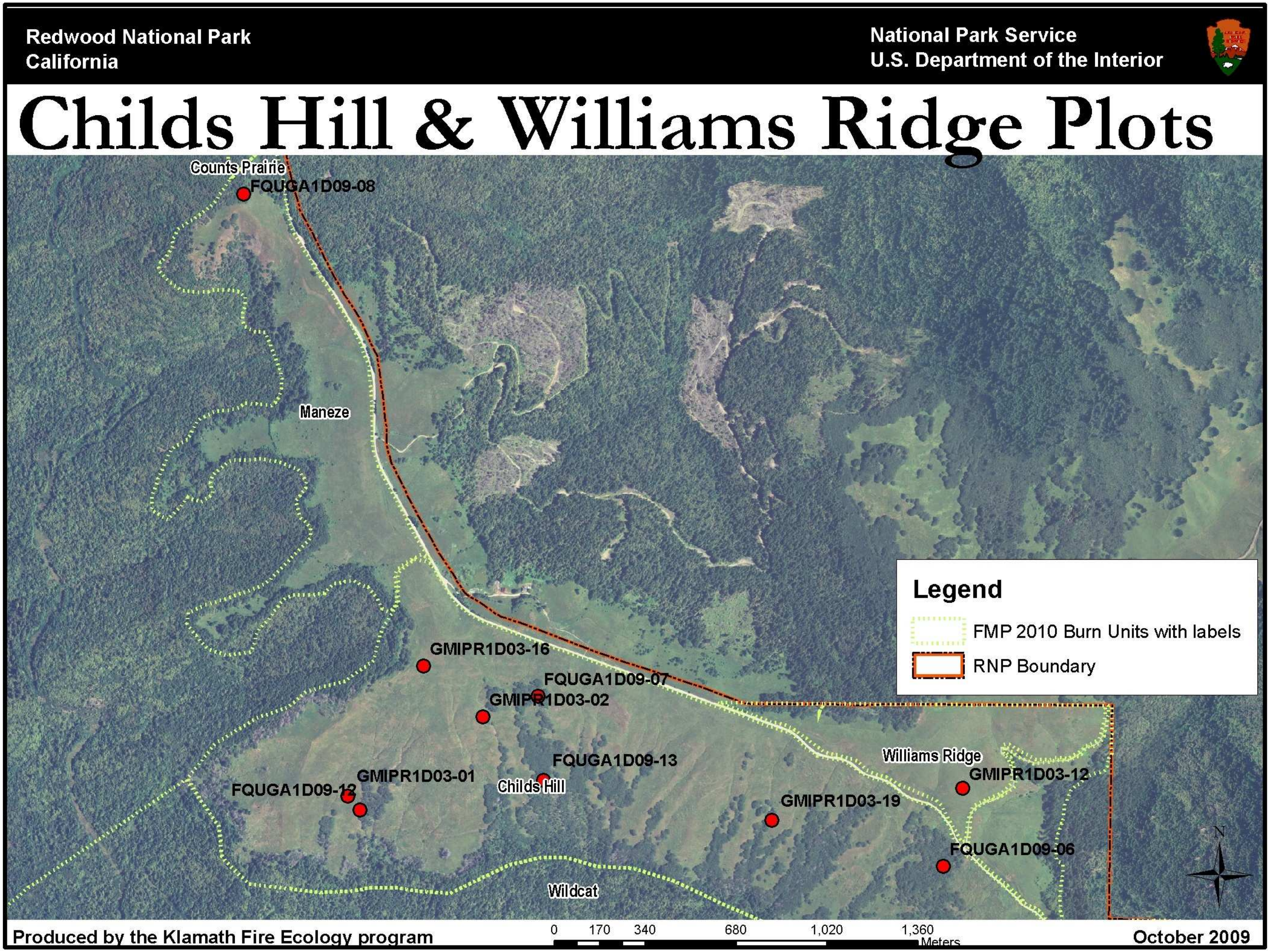
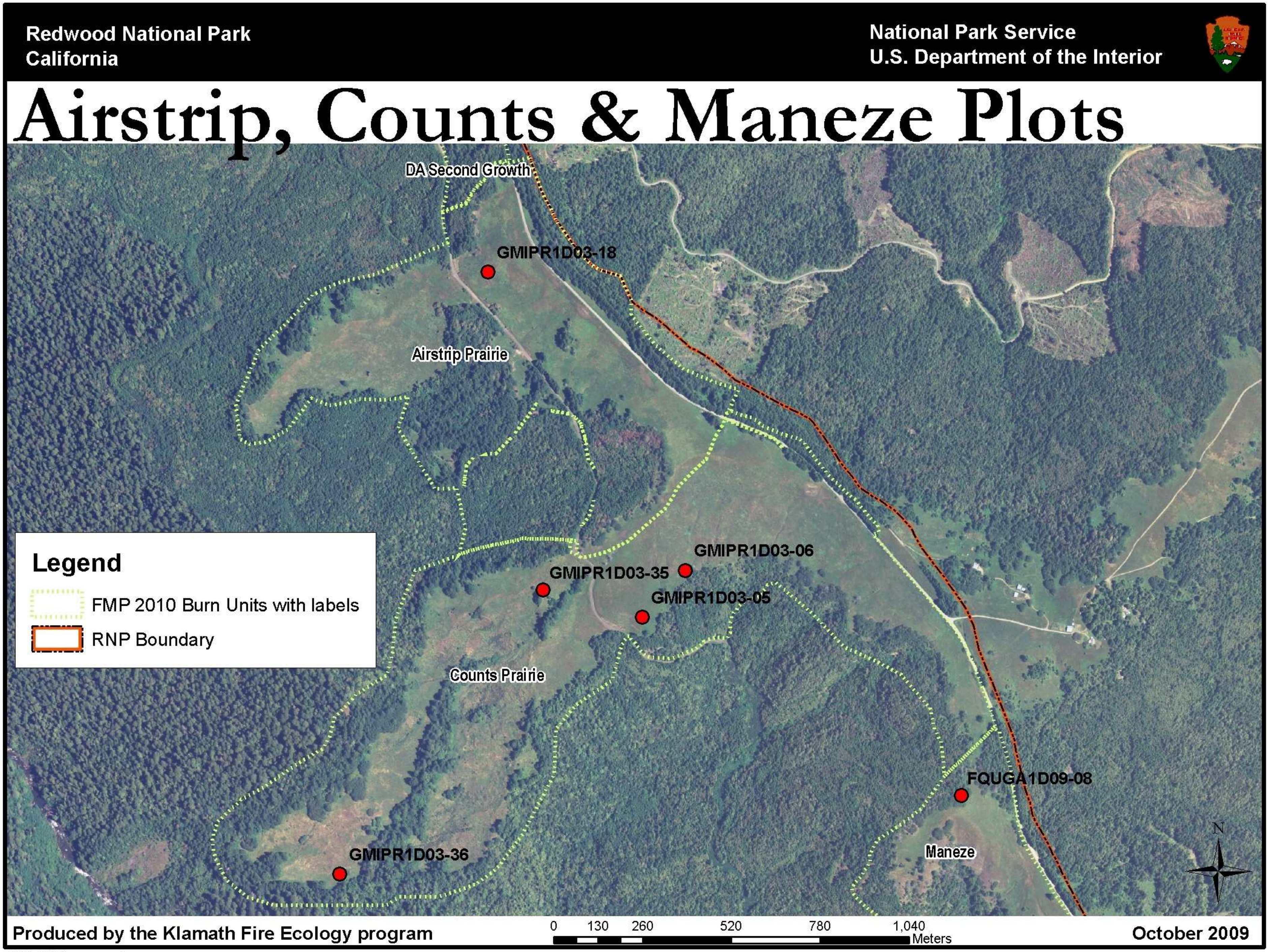


FILE: FMP maps.mxd

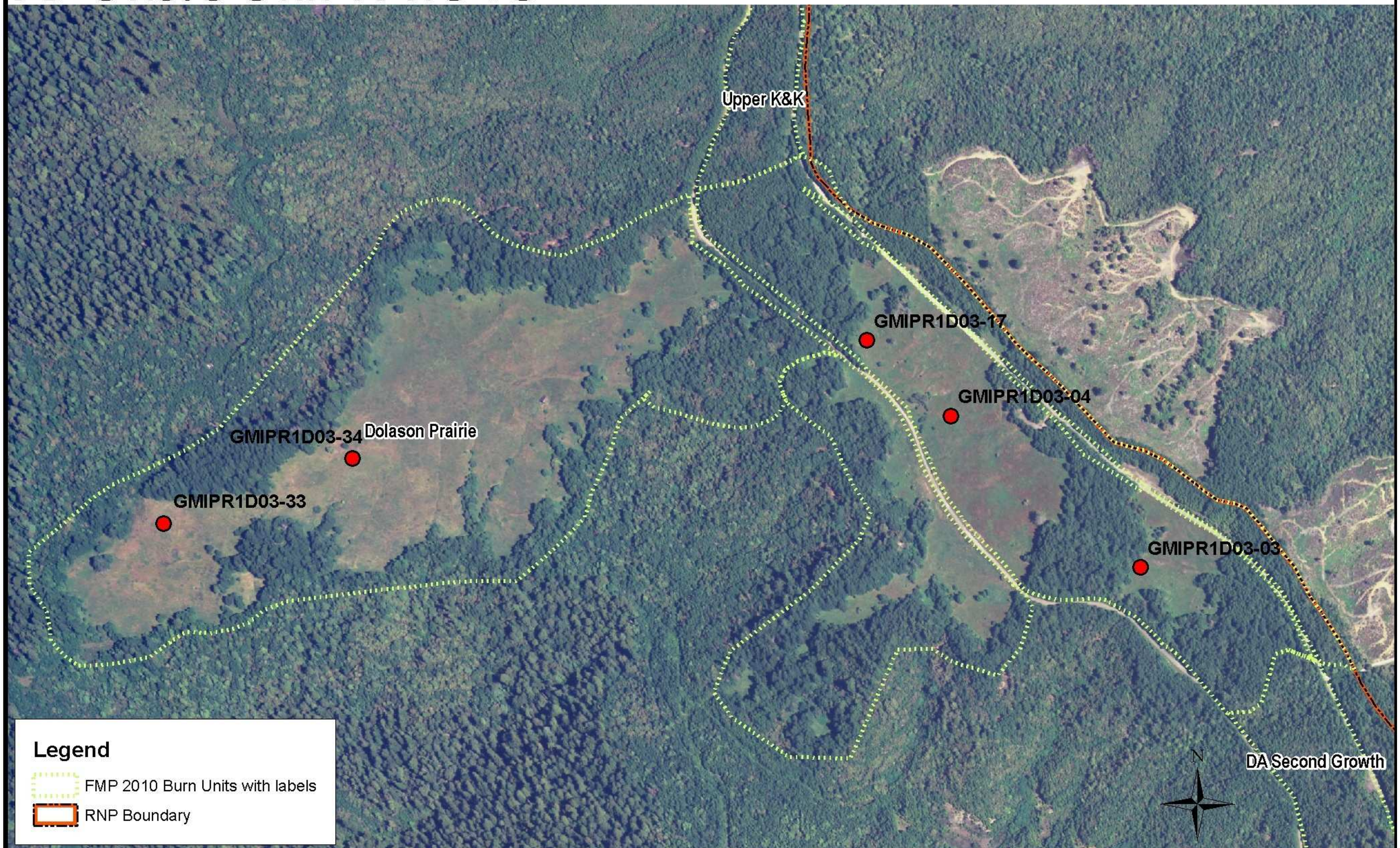


FILE: FMP maps.mxd

Redwood National Park
California

National Park Service
U.S. Department of the Interior

Dolason Plots



Produced by the Klamath Fire Ecology program

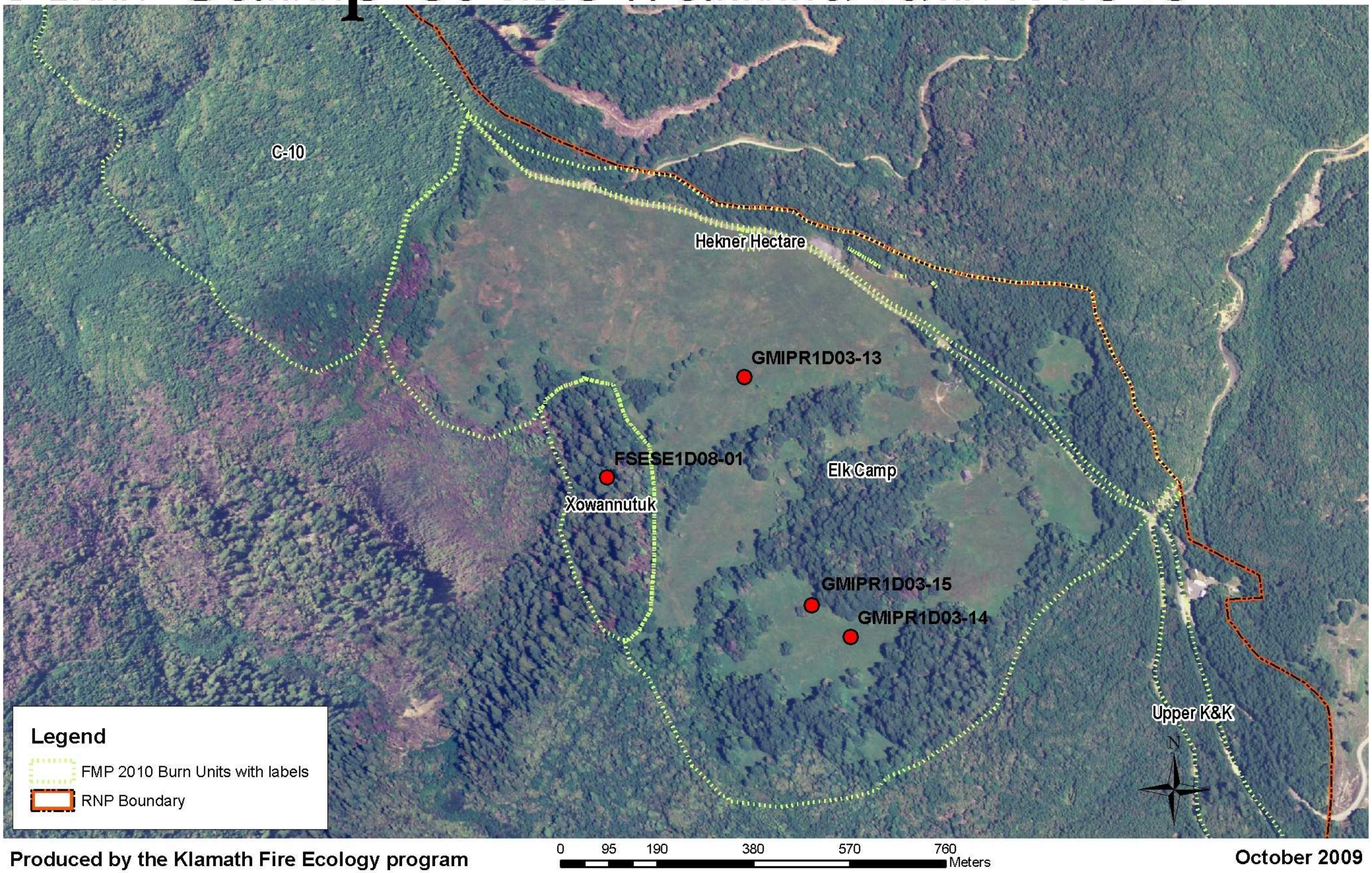
October 2009

FILE: FMP maps.mxd

Redwood National Park
California

National Park Service
U.S. Department of the Interior

Elk Camp & Xowannutuk Plots



Produced by the Klamath Fire Ecology program

FILE: FMP maps.mxd

October 2009

F. MONITORING SCHEDULE

Plot monitoring schedules are recorded within a plot matrix. A matrix exists for active and inactive plots within Redwood; the active plot matrix is shown below.

		NAD 27		NAD 83											
Burn unit	Monitoring Plot	UTMe	UTMn	UTMe	UTMn	PRO2	PRO1	PRE	00YR10	01Burn	01Post	01YR01	01YR02	01YR05	01YR09
Boyes Creek	FSESE1D08-03			x	x			Aug-97							
Boyes Prairie	Boyes 1			414496	4579551			Aug-00		2000		Jul-01			
Boyes Prairie	Boyes 2			414397	4579454			Aug-00		2000		Jul-01			
Boyes Prairie	Boyes 3			414301	4579355			Aug-00		2000		Jul-01			
Boyes Prairie	Boyes 4			414203	4579258			Aug-00		2000		Jul-01			
Boyes Prairie	Boyes 5			414107	4579162			Aug-00		2000		Jul-01			
Boyes Prairie	Boyes 6			414010	4579065			Aug-00		2000		Jul-01			
Boyes Prairie	Boyes 7			413914	4578969			Aug-00		2000		Jul-01			
Bridge Ridge	FSESE1D08-04	418431	4557519	418325	4557722			Aug-99	Jul-09						
Child's Hill	FQUGA1D09-06	425071	4556522	424948	4556721		Aug-90	Jul-94		Oct-96	*	Jun-97	Aug-98	Aug-01	Jul-05
Child's Hill	FQUGA1D09-07	423528	4557160	423430	4557358		Aug-90	Jul-94		Oct-96	*	Jul-97	Sep-98	Aug-01	Jul-05
Child's Hill	FQUGA1D09-12	422862	4556736					Aug-94		Oct-96	Nov-96	Jul-97	Aug-98	*	*
Child's Hill	FQUGA1D09-13	423549	4556847				Jul-91	Sep-94		1996 (didn't actually burn)		Jul-97	Sep-98	*	*
Child's Hill	GMIPR1D03-01	422816	4556788				Jun-90	Jun-94		Oct-96	Nov-96	Jul-97	Jul-98	Jun-01	Jul-05
Child's Hill	GMIPR1D03-02	423312	4557082	423224	4557280		Jun-90	Jun-94		Oct-96	Nov-96	Jun-97	Jul-98	Jun-01	Jul-05
Child's Hill	GMIPR1D03-10	can't	find					Jun-90		Oct-96	*	Jun-97	Jul-98	*	*
Child's Hill	GMIPR1D03-16	423097	4557278	423002	4557472		Jul-91	Jul-94		Oct-96	Nov-96	Jun-97	Jul-98	Jun-01	Jul-05
Child's Hill	GMIPR1D03-19	424402	4556696				Jul-91	Jul-94		Oct-96	*	Jun-97	Jul-98	*	*
Copper Creek	FQUGA1D09-03	425334	4556126	425218	4556314		Jul-90	Aug-95		Oct-96	*	Jul-97	Aug-98	Aug-01	
Copper Creek	FQUGA1D09-05	424691	4555302	424587	4555502		Aug-90	Aug-95		Oct-96	*	Aug-97	Aug-98	Aug-01	
Copper Creek	FQUGA1D09-10	425229	4555832	425135	4556026		Sep-90	Aug-95		Oct-96	*	Jul-97	Aug-98	Sep-02	
Copper Creek	FQUGA1D09-14	425155	4555660	425061	4555854		Jul-91	Aug-95		Oct-96	*	Jul-97	Aug-98	Sep-02	
Copper Creek	FQUGA1D09-15	424622	4555220	424532	4555406		Aug-91	Aug-95		Oct-96	*	Jul-97	Sep-98	Sep-02	
Copper Creek	FQUGA1D09-16	425236	4556029	425136	4556232		Aug-91	Aug-95		Oct-96	*	Jul-97	Aug-98	Sep-02	
Counts, Upper	GMIPR1D03-05	421493	4559565			Jun-90	Jun-94	Jun-97		Oct-97	Nov-97				
Counts, Upper	GMIPR1D03-06	421619	4559703			Jun-90	Jun-94	Jun-97		Oct-97	Nov-97				
Counts, Upper	GMIPR1D03-18	421041	4560577			Jul-91	Jun-94	Jun-97		Oct-97	Nov-97				
Counts, Lower	GMIPR1D03-36	420608	4558812				Jun-93	Jun-97		Oct-97	Nov-97				
Counts, Lower	GMIPR1D03-35	421200	4559646	421106	4559842		Jun-93	Jun-97		Oct-97	Nov-97		Jun-99		

Burn unit	Monitoring Plot	02Burn	02POST	02YR01	02YR02	02YR05	03Burn	03POST	03YR01	03YR02	03YR05
Boyes Creek	FSESE1D08-03										
Boyes Prairie	Boyes 1	2004		Aug-05	*		Oct-08	Oct-08	*	2010	
Boyes Prairie	Boyes 2	2004		Aug-05	*		Oct-08	Oct-08	*	2010	
Boyes Prairie	Boyes 3	2004		Aug-05	*		Oct-08	Oct-08	*	2010	
Boyes Prairie	Boyes 4	2004		Aug-05	*		Oct-08	Oct-08	*	2010	
Boyes Prairie	Boyes 5	2004		Aug-05	*		Oct-08	Oct-08	*	2010	
Boyes Prairie	Boyes 6	2004		Aug-05	*		Oct-08	Oct-08	*	2010	
Boyes Prairie	Boyes 7	2004		Aug-05	*		Oct-08	Oct-08	*	2010	
Bridge Ridge	FSESE1D08-04										
Child's Hill	FQUGA1D09-06	Oct-05	*	*	*	2010					
Child's Hill	FQUGA1D09-07	Oct-05	*	*	*	2010					
Child's Hill	FQUGA1D09-12	Oct-05	*	*	*	2010					
Child's Hill	FQUGA1D09-13	Oct-05	*	*	*	2010					
Child's Hill	GMIPR1D03-01	Oct-05	*	*	*	2010					
Child's Hill	GMIPR1D03-02	Oct-05	*	*	*	2010					
Child's Hill	GMIPR1D03-10	Oct-05	*	*	*	2010					
Child's Hill	GMIPR1D03-16	Oct-05	*	*	Jul-07	2010					
Child's Hill	GMIPR1D03-19	Oct-05	*	*	*	2010					
Copper Creek	FQUGA1D09-03	Oct-02	*	*	Aug-04	*	Oct-08	Nov-08	*	2010	
Copper Creek	FQUGA1D09-05	Oct-02	Nov-02	*	Jun-04	*	Oct-08	Nov-08	*	2010	
Copper Creek	FQUGA1D09-10	Oct-02	*	*	Aug-04	*	Oct-08	Nov-08	*	2010	
Copper Creek	FQUGA1D09-14	Oct-02	Nov-02	*	Aug-04	*	Oct-08	Nov-08	*	2010	
Copper Creek	FQUGA1D09-15	Oct-02	Nov-02	*	Aug-04	*	Oct-08	Nov-08	*	2010	
Copper Creek	FQUGA1D09-16	Oct-02	Nov-02	*	Sep-04	*	Oct-08	Nov-08	*	2010	
Counts, Upper	GMIPR1D03-05	Oct-01					2005	*	*	*	2010
Counts, Upper	GMIPR1D03-06	Oct-01					2005	*	*	*	2010
Counts, Upper	GMIPR1D03-18	Oct-01					2005	*	*	*	2010
Counts, Lower	GMIPR1D03-36	Oct-01									
Counts, Lower	GMIPR1D03-35	Oct-01	Dec-02	*	Jul-03	*					

Burn unit	Monitoring Plot	NAD 27 UTMe	NAD 27 UTMn	NAD 83 UTMe	NAD 83 UTMn	PRO2	PRO1	PRE	01Burn	01Post	01YR01	01YR02	01YR06	01YR10	02Burn	02POST	02YR01
Coyote Creek, Upper	GMIPR1D03-21	428452	4552960	428358	4553156			Jun-92	Oct-94	Dec-94	Jun-95	May-96			Oct-96	Oct-96	Jun-97
Coyote Creek, Upper	GMIPR1D03-29	428051	4553456	427956	4553648			Jun-92	Oct-94	Dec-94	Jun-95	Jun-96			Oct-96	Oct-96	Jun-97
Coyote Creek, Lower	GMIPR1D03-20	427448	4553531	427354	4553725			Jun-92	Oct-94	Dec-94	Jun-95	Jun-96			Oct-96	Nov-96	Jun-97
Coyote Creek, Lower	GMIPR1D03-25	425581	4554798	425515	4554975			Aug-92	Oct-94	Nov-94	Jun-95	Jun-96			Oct-96	Nov-96	Jun-97
Coyote Creek, Lower	GMIPR1D03-31	426771	4555184	426668	4555380			Jun-92	Oct-94	Nov-94	Jun-95	Jun-96			Oct-96	Oct-96	Jun-97
Coyote Creek, Lower	FQUGA1D09-20	427496	4552997	427381	4553192			Jul-92	Oct-94	Nov-94	Aug-95	Aug-96			Oct-96	Oct-96	May-97
Coyote Creek, Lower	FQUGA1D09-24	426057	4554980	425967	4555177			Jul-92		Nov-94	Aug-95	Aug-96					Aug-97
Coyote Creek, Lower	FQUGA1D09-25	427183	4554553	427088	4554739			Aug-92	Oct-94	Nov-94	Aug-95	Aug-96			Oct-96	*	May-97
Dolason, Upper	GMIPR1D03-03	420582	4561517	420486	4561712		Jun-90	Jun-95	Oct-95	*	Jul-96	Jun-97			1997	Dec-97	
Dolason, Upper	GMIPR1D03-04	420189	4561833	420118	4562005		Jun-90	Jun-95	Oct-95	*	Jul-96	Jun-97			1997	Nov-97	
Dolason, Upper	GMIPR1D03-17	420059	4561929	419956	4562151		Jun-91	Jun-95	Oct-95	*	Jul-96	Jun-97			1997	Nov-97	*
Dolason, Lower	GMIPR1D03-33	418691	4561600					Jun-93	Oct-95	*	Jul-96	Jul-97			1997	Nov-97	
Dolason, Lower	GMIPR1D03-34	419056	4561726					Jun-93	Oct-95	*	Jul-96	Jul-97			1997	Nov-97	*
Eastside	GMIPR1D03-28	427532	4554952	427444	4555149	Jun-92	Aug-98	Jul-08									
Eastside	GMIPR1D03-37	x	x	426978	4555610			Jul-09									
Eastside	GMIPR1D03-38	x	x	427030	4555477			Jul-09									
Eastside	FQUGA1D09-27	x	x	427255	4555542			Jul-09									
Elk Camp, Lower	GMIPR1D03-13	418822	4564091	418722	4564282			Jun-91	Oct-93	Nov-93	Jun-94	Jun-95			Oct-95	Nov-95	*
Elk Camp, Lower	GMIPR1D03-14	419025	4563575	418932	4563769		May-94	Jul-97	1997	Nov-97					2001		
Elk Camp, Lower	GMIPR1D03-15	418952	4563634			Jun-91	Jun-94	Jul-97	1997	Oct-97					2001		
Little Bald Hills	FPIJE1D02-02	can not find!						Jul-92									
Little Bald Hills	FPIAT1D04-01	414629	4623439					Jul-92									
Lyon's Ranch, Upper	FQUGA1D09-04	424012	4554483	423923	4554703		Jul-90	Aug-93	Oct-93	*	Sep-94	Aug-95			Sep-96	Oct-96	Jul-97
Lyon's Ranch, Upper	FQUGA1D09-19	424330	4554238	424237	4554432			Jul-92	Oct-93	Nov-93	Sep-94	Aug-95			Sep-96	Nov-96	Jul-97
Lyon's Ranch, Upper	GMIPR1D03-11	423863	4554303	423771	4554496		Jul-90	Jun-93	Oct-93	Nov-93	Jul-94	Jun-95			Sep-96	*	Jun-97
Lyon's Ranch, Lower	GMIPR1D03-22	424013	4553768	424010	4553775			Jun-92	Oct-93	Nov-93	Jul-94	Jun-95	Jul-99	Jul-03	Oct-04	Nov-04	*
Lyon's Ranch, Lower	GMIPR1D03-23	424291	4553803	424194	4553995			Jun-92	Oct-93	Nov-93	Jul-94	Jun-95	Jul-99	Jul-03	Oct-04	Nov-04	*
Lyon's Ranch, Lower	GMIPR1D03-26	423813	4553883	423694	4554079			Jun-92	Oct-93	Nov-93	Jul-94	Jun-95	Jul-99		Oct-04		

Burn unit	Monitoring Plot	02YR02	02YR05	03Burn	03POST	03YR01	03YR02	03YR05	04 Burn	04POST	04YR01	04YR02	04YR05	05 Burn	05 Post	05YR01	05YR02	05YR05
Coyote Creek, Upper	GMIPR1D03-21	Jun-98		Aug-98	Sep-98	*	Jun-00	Jul-03	Oct-03	Oct-03	Jul-04			Oct-05	Oct-05	*	*	2010
Coyote Creek, Upper	GMIPR1D03-29	Jun-98		Aug-98	Nov-98	*	Jun-00	Jul-03	Oct-03	Oct-03	Jul-04			Oct-05	Oct-05	*	*	2010
Coyote Creek, Lower	GMIPR1D03-20	Jun-98		Aug-98	Sep-98	*	Jun-00	Jul-03	Sep-05	Nov-05	*	*	2010					
Coyote Creek, Lower	GMIPR1D03-25	Jun-98		Aug-98	Oct-98	*	Jun-00	Jul-03	Sep-05	Nov-05	*	*	2010					
Coyote Creek, Lower	GMIPR1D03-31	Jul-98		Aug-98	Sep-98	*	Jun-00	Jul-03	Sep-05	Nov-05	*	Jul-07	2010					
Coyote Creek, Lower	FQUGA1D09-20	Jul-98		Aug-98	Oct-98	*	*	Sep-03	Sep-05	*	*	*	2010					
Coyote Creek, Lower	FQUGA1D09-24	Jul-98			Oct-98				Sep-05				2010					
Coyote Creek, Lower	FQUGA1D09-25	Jul-98		Aug-98	Nov-98	*	*	Sep-03	Sep-05	*	*	*	2010					
Dolason, Upper	GMIPR1D03-03			Sep-98	Nov-98				2001					2006	*	*	Jul-08	2011
Dolason, Upper	GMIPR1D03-04			Sep-98	Nov-98				2001					2006	*	*	Jul-08	2011
Dolason, Upper	GMIPR1D03-17			Sep-98	Nov-98	*	Aug-00		Oct-01	Dec-01	*	Jul-03	*	2006	*	*	*	2011
Dolason, Lower	GMIPR1D03-33			Oct-05				2010										
Dolason, Lower	GMIPR1D03-34	Jun-99	Jun-02	Oct-05	*	*	*	2010										
Eastside	GMIPR1D03-28																	
Eastside	GMIPR1D03-37																	
Eastside	GMIPR1D03-38																	
Eastside	FQUGA1D09-27																	
Elk Camp, Lower	GMIPR1D03-13	Jul-97		Sep-97	Nov-97	*	Jul-99	Jun-02	Oct-03	Oct-03	Jul-04	*	Jul-08					
Elk Camp, Lower	GMIPR1D03-14			2003				Jul-08										
Elk Camp, Lower	GMIPR1D03-15			2003				*										
Little Bald Hills	FPIJE1D02-02																	
Little Bald Hills	FPIAT1D04-01																	
Lyon's Ranch, Upper	FQUGA1D09-04	Jul-98		Aug-98	Oct-98	*	Aug-00		Oct-02	Nov-02	*	Jul-04		Oct-07	Oct-07	*	Jul-09	
Lyon's Ranch, Upper	FQUGA1D09-19	Aug-98		Aug-98	Oct-98	*	Aug-00		Oct-02	Nov-02	*	Aug-04		Oct-07	Oct-07	*	Jul-09	
Lyon's Ranch, Upper	GMIPR1D03-11	Jul-98		Aug-98	Oct-98				Oct-02	*				Oct-07			Jul-09	
Lyon's Ranch, Lower	GMIPR1D03-22	*	Jul-09															
Lyon's Ranch, Lower	GMIPR1D03-23	*	Jul-09															
Lyon's Ranch, Lower	GMIPR1D03-26		Jul-09															

Burn unit	Monitoring Plot	NAD 27 UTMe	NAD 27 UTMn	NAD 83 UTMe	NAD 83 UTMn	PRO1	PRE	01Burn	01Post	01YR01	01YR02	01YR05	01YR10	02Burn	02POST	02YR01	02YR02	02YR05
Mainstem	FQUGA1D09-21	427145	4553062	427048	4553251	Jul-92	Aug-98	Sep-98	Nov-98	*	*	Aug-03		Oct-05	*	*	*	2010
Maneze	FQUGA1D09-08	422435	4559034	422330	4559239	Aug-90	Jul-94	Aug-97	Nov-97	Sep-98	Jul-99			Oct-01	Dec-01	*	Aug-03	
Midbasin	FQUGA1D09-23	425474	4554269	425358	4554450	Jul-92	Aug-98	Aug-98	Oct-98	*	*	Aug-03	Jul-08					
Midbasin	GMIPR1D03-24	425685	4554083	425574	4554278	Jun-92	Sep-98	Sep-98	Nov-98	*	Jun-00	Aug-03	Jul-08					
Miller Creek	FSESE1D08-02						Oct-96											
Schoolhouse	FQUGA1D09-01	425850	4556119	425755	4556308		Jul-93	Oct-93	Dec-93	Aug-94	Jul-95			Sep-95	Oct-95	Aug-96	*	
Schoolhouse	FQUGA1D09-02	425642	4555935	425645	4555914	Jul-90	Jul-93	Oct-93	Dec-93	Aug-94	Jul-95			Sep-95	Nov-95	Jul-96	*	
Schoolhouse	FQUGA1D09-11	425798	4555974	425733	4556153		Jul-91	Oct-93	Nov-93	Aug-94	Jul-95			Sep-95	Jan-96	Aug-96	*	
Schoolhouse	FQUGA1D09-17	425619	4555329	425517	4555525		Aug-91	Oct-93	Dec-93	Sep-94	Jul-95			Sep-95	Oct-95	Aug-96	*	
Schoolhouse	FQUGA1D09-18	425454	4555734	425358	4555927		Aug-91	Oct-93	Dec-93	Sep-94	Jul-95			Sep-95	Nov-95	Aug-96	*	
Schoolhouse	FQUGA1D09-22	425993	4555425	425907	4555622		Jul-92	Oct-93	Dec-93	Sep-94	Jul-95			Sep-95	*	*	*	
Schoolhouse	GMIPR1D03-07	426266	4555566	426167	4555760	Jun-90	Jul-93	Oct-93	Nov-93	Jul-94	Jun-95			Sep-95	Nov-95	Jun-96	Jun-97	
Schoolhouse	GMIPR1D03-09	425619	4555548	425527	4555747	Jun-90	Jul-93	Oct-93	Nov-93	Jul-94	Jun-95			Sep-95	Nov-95	Jun-96	Jun-97	
William's Ridge, West	GMIPR1D03-12	425116	4556820	425020	4557013		Jul-90	1991	Dec-91					1992	Nov-92	Jul-93	Jul-94	
Wooden Gate	FQUGA1D09-26	425093	4554961	424997	4555152		Aug-92	Oct-94	Nov-94	Aug-95	Aug-96			Oct-96	Oct-96	Jul-97	Aug-98	
Wooden Gate	GMIPR1D03-08	424712	4554966	424618	4555157	Jun-90	Jul-94	Oct-94	Nov-94	Jun-95	Jul-96			Oct-96	Oct-96	Jun-97	Jun-98	
Wooden Gate	GMIPR1D03-27	425412	4554636	425318	4554830		Jun-92	Oct-94	Nov-94	Jun-95	Jun-96			Oct-96	Nov-96	Jun-97	Jul-98	
Wooden Gate	GMIPR1D03-30	425706	4555065	425616	4555261		Jun-92	Oct-94	Nov-93	Jul-94				1994	Nov-94	Jun-95		
Wooden Gate	GMIPR1D03-32	424644	4554396	424552	4554587		Jun-92	1993	Nov-94	Jun-95	Jul-96			Oct-96	Oct-96	Jun-97	Jul-98	
Xowannatuk	FSESE1D08-01	418540	4563889	418451	4564083		Sep-95	Oct-95	Jan-96	Aug-96	Aug-97	Aug-00		Oct-03	Oct-03	*	*	Jul-08

Burn unit	Monitoring Plot	03Burn	03POST	03YR01	03YR02	03YR05	04 Burn	04POST	04YR02	04YR05	05 Burn	05 Post	05YR01	05YR02	05YR05	06 Burn	06 Post	06YR02
Mainstem	FQUGA1D09-21																	
Maneze	FQUGA1D09-08	Oct-05	Nov-06	*	Jul-08	2011												
Midbasin	FQUGA1D09-23																	
Midbasin	GMIPR1D03-24																	
Miller Creek	FSESE1D08-02																	
Schoolhouse	FQUGA1D09-01	Aug-98	Oct-98	*	*		Oct-01	*	*		Sep-04	*	*	*		Sep-08	*	2010
Schoolhouse	FQUGA1D09-02	Aug-98	Oct-98	*	Aug-00		Oct-01	Dec-01	Aug-03		Sep-04	Sep-04	*	*		Sep-08	Oct-08	2010
Schoolhouse	FQUGA1D09-11	Aug-98	Oct-98	*	Aug-00		Oct-01	Dec-01	Sep-03		Sep-04	Sep-04	*	*		Sep-08	Oct-08	2010
Schoolhouse	FQUGA1D09-17	Aug-98	Oct-98	*	*		Oct-01	*	*		Sep-04	*	*	*		Sep-08	*	2010
Schoolhouse	FQUGA1D09-18	Aug-98	Oct-98	*	*		Oct-01	*	*		Sep-04	*	*	*		Sep-08	*	2010
Schoolhouse	FQUGA1D09-22	Aug-98	Oct-98	*	Aug-00		Oct-01	Dec-01	Aug-03		Sep-04	Oct-04	*	*		Sep-08	Oct-08	2010
Schoolhouse	GMIPR1D03-07	Aug-98	Sep-98	*	Jul-00		Oct-01	Dec-01	Jul-03		Sep-04	Oct-04	*	*		Sep-08	Oct-08	2010
Schoolhouse	GMIPR1D03-09	Aug-98	Sep-98	*	Aug-00		Oct-01	Dec-01	Jul-03		Sep-04	Oct-04	*	*		Sep-08	Oct-08	2010
William's Ridge, West	GMIPR1D03-12	1995	Oct-95	Jul-96	Jun-97		1997	Nov-97	Jun-99	Jun-02	Oct-05	*	*	*	2010			
Wooden Gate	FQUGA1D09-26	Aug-98	Sep-98		Aug-00	Aug-03	Sep-04	Oct-04			Sep-08	Oct-08	*	2010				
Wooden Gate	GMIPR1D03-08	Aug-98	Sep-98		Jun-00	Jul-03	Sep-04	Oct-04			Sep-08	Oct-08	*	2010				
Wooden Gate	GMIPR1D03-27	Aug-98	Sep-98		Aug-00	Jul-03	Sep-04	Oct-04			Sep-08	Oct-08	*	2010				
Wooden Gate	GMIPR1D03-30	1996	Nov-96	Jun-97	Jul-98		1998	Sep-98			2004		*			Sep-08	Oct-08	2010
Wooden Gate	GMIPR1D03-32	Aug-98	Sep-98				2004				Sep-08	Oct-08	*	2010				
Xowannatuk	FSESE1D08-01																	

G. BALD HILLS "FIR PLOTS" METHODOLOGY

Purpose

To assess whether we are meeting our fire management objectives with respect to killing small (≤ 3' tall) Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) and grand fir (*Abies grandis*), hereafter referred to as "small fir," in prairies and oak woodlands of the Bald Hills. Plot design will enable rapid assessment of fire effects on targeted small fir populations.

Early-Season Units Fire Management Objectives

In oak woodlands with conifer encroachment, reduce density of live small fir by ≥ 70% within two years of the burn.

In open grassland, reduce density of live small fir by ≥ 80% within two years of the burn.

Late-Season Units Fire Management Objectives

In oak woodlands with conifer encroachment, reduce density of live small fir by ≥ 50% within two years of the burn.

In open grassland, reduce density of live small fir by ≥ 80% within two years of the burn.

Fire Effects Monitoring Objective

Measure density of live small fir individuals with a sufficient sample size to be 80% confident of detecting a change (50%, 70%, or 80%, depending on the fire management objective). Accept a 20% chance of saying a change occurred when it in fact did not, and accept a 20% chance of detecting no change when a true population change did occur.

Monitoring Design

Fir plots are classified by vegetation community and burn prescription in order to assess fire management objectives. The different types of fir plots are as follows:

1. Open Grassland (FIRG)
2. Oak Woodland Early (FIROE)

3. Oak Woodland Late (FIROL)

The "Open Grassland" vegetation community includes the interface between oak woodlands and grasslands, as long as canopy cover over the plot is < 40%. Oak woodland fir plots should be located under canopy cover of ≥ 40%.

At least one plot will be installed in each burn unit to measure each relevant fire management objective. Fire effects monitoring objectives will be assessed at the program level; for each fire management objective, plots across all burn units will be lumped to assess whether minimum plot numbers have been reached.

Plots are short-term in nature; they will be removed after the two year post-burn sampling event. If minimum sample size has not been reached before a unit re-burns, new plots will be established within the unit that target live small fir populations.

Fir Plot Design

1. Plot Distribution and Placement

Plot locations will be randomly selected within areas of known live small fir populations. The number of plots installed in each burn unit depends on the number of potential plot sites, the size of the burn unit, and the workload of the Fire Effects Team. In large units (> 250 acres), the installation of three plots per fire management objective is ideal. Installation of one plot per fire management objective in small units (< 100 acres) is acceptable.

Each burn unit will be surveyed for potential plot sites and these sites will be marked with a GPS unit. Plot sites will be randomly selected from the potential site pool.

2. Plot Protocols

Each fir plot will be marked with a GPS unit (PDOP < 5). Maps will be created of fir plot locations within each burn unit; no detailed directions to each plot need to be written. Since finding rebar can be problematic in the Bald Hills, designate one nearby reference feature and write good directions (e.g., measure distance with a measuring tape) from the plot to this reference feature. Mark the reference feature with a GPS unit and take a photo of the reference feature if it will help locate the plot in the future.

Each fir plot is a 100 m^2 rectangle, 5 m x 20 m in dimension. At each randomly selected fir plot location, orient the plot to capture the maximum number of small fir. Mark all four plot corners with rebar, and wrap a measuring tape around the rebar to demark the plot. When installing rebar stakes, keep in mind that the project is short-term in nature; ensure that rebar stakes are secure, but able to be removed at a later time. Starting at 0° (north) and working clockwise, designate the plot stakes A, B, C, and D. Mark each plot with a brass racetrack tag with the plot name (e.g., FIRG01) and Rx Fire, and attach this tag to the "A" stake. Take one digital photo from the stake with the view that best represents the plot and record this on the datasheet. Record the azimuth along the long axis of the plot.

Record site conditions for each plot:

- UTM coordinates at "A" stake (NAD83)
- Slope (hill)
- Aspect
- Proximity to forest edge (meters)
- Evidence of mechanical thinning

Within the plot, enumerate live small firs. Use a sampling rod with height marks to determine if the firs are ≤ 3' tall. Use of a counter may facilitate sampling efforts.

Collect data on pre-burn canopy cover using a moosehorn densitometer at A, B, C, and D stakes.

If it is safe to do so, collect plot-specific during-burn data on fire weather and behavior and record appropriate parameters (e.g., flame length, rate of spread, flame zone depth, wind speed).

Sample each fir plot pre-burn (within a year of ignition), immediately post-burn (within 2 weeks to 2 months after the burn), and two years post-burn. At the post-burn visits, enumerate live small firs. Take digital photographs at the post-burn visits (mimic the pre-burn photos), but do not sample post-burn canopy cover. Remove all burned plots after the two year post-burn sampling event; retain plots only if they did not experience any fire. If plots do not burn, record this and re-sample the plot within one year of the next prescribed fire.

Plot Rejection Criteria:

- Plot located within 50 meters of another fir plot
- Plot located within 25 meters of a perennial stream and/or riparian vegetation present
- Plot located in area of anomalous fuels (e.g., Himalayan blackberry patch, slash)
- Plot located within 25 meters of areas with known cultural resources
- Plot located within 25 meters of a road, trail, fireline, or structure

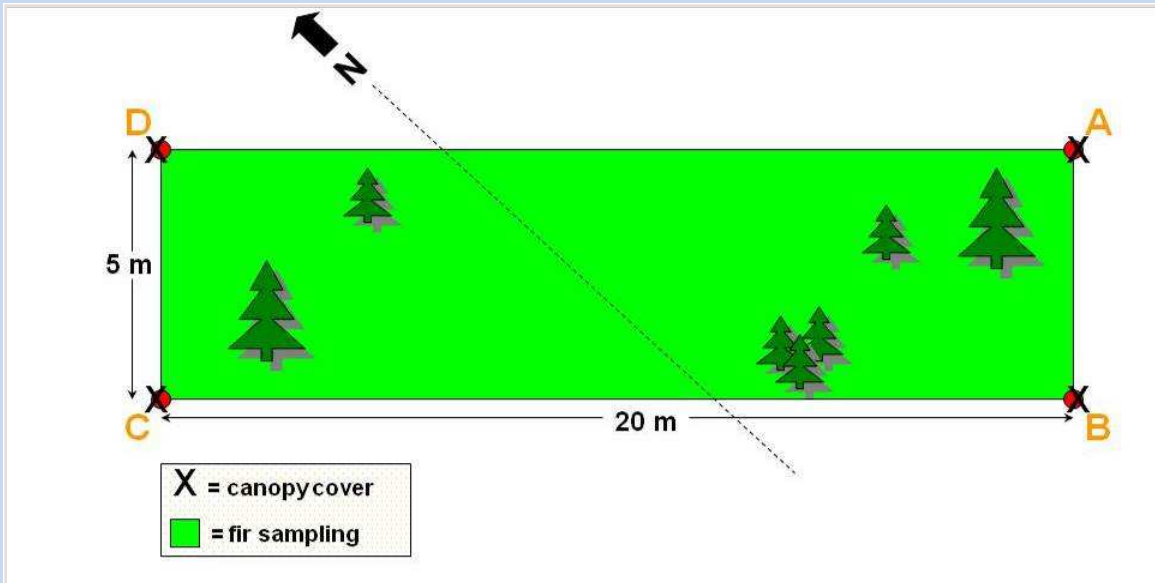


Figure 8. Fir Plot diagram.

Data Management

Data will be collected and managed by the Fire Effects Monitoring Team. Data will be entered into a customized Excel spreadsheet (S:\team\shdata\Fire\Fire Effects Team\Parks\REDW\Fir plot stuff\Fir Plots Data Entry.xls) and analyzed by the Fire Ecologist. Results of data analysis will be made available to Redwood Fire and Resource Management staff and will be reported in unit burn plans and Fire Ecology program annual results.

FMH Densiometer Protocol

The purpose of adding this extra protocol to standard FMH forest plot protocols is to help directly measure the specific fire management objective to not reduce overall oak woodland canopy cover by ≥ 10% 2 years post-burn, as measured from original pre-burn levels. To facilitate measuring this objective densitometer readings will be taken at all FMH forest plots within the Redwood National and State Parks Oak Woodland (FQUGA1D09) Monitoring Type.

Using a GRS densitometer (also known as a 'Moosehorn' densitometer), readings will be taken at 30 points within a forest FMH plot along the P1-P2 line and the 0P-50P line. Readings will be taken at the 2, 4, 6, 8, 12, 14, 16 and 18m points along the P1-P2 line. Readings will also be taken at the 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46m points along the 0P-50P line. This protocol will be read preburn and two year post burn.

If any canopy is seen through the densitometer it is a hit (yes), if no canopy is seen it is a miss (no).

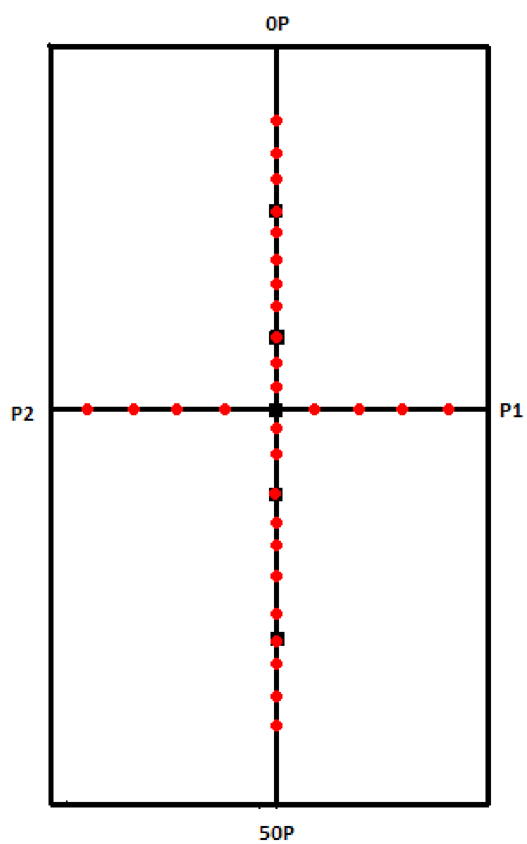


Figure 1. Diagram of points where densiometer readings are taken in standard FMH forest plot, not to scale.

J. BALD HILLS OAK WOODLAND (FQUGA1D09) FMH-4

FMH-4 **MONITORING TYPE DESCRIPTION SHEET** Park: **REDW**

Monitoring Type Code: FQUGA1D09 **Date Described:** 9/16/09

Monitoring Type Name: Oregon Oak Woodland

Preparer: J. Beck, T. Bradley, D. Brown, T. LaBanca, S. Samuels

Burn Prescription: Units will be burned from late summer (August) to late fall (December). 1-hr TLFM 6 - 12%; 10-hr TLFM 5-20%; 100-hr TLFM 7-35%. Temperature 35-85°F; relative humidity 30-75%; mid-flame wind speed 0 - 9 mph with gusts to 12 mph. Average flame length 2'; rate of spread < 5 chains per hour; probability of ignition < 50%.

Fire Management Objectives: Do not reduce the relative cover of native plants by ≥ 10% two years postburn as measured from original pre-burn conditions.

Fire Monitoring Objectives: Measure relative cover of native plant species with a sufficient sample size to be 80% confident of detecting a 10% change (5.5%) from original preburn conditions. Accept a 20% chance of saying a change occurred when it in fact did not; and accept a 20% chance of detecting no change when a true change occurred.

Fire Monitoring Variable(s): relative native plant cover

Physical Description: Mid to upper elevation (165-1000 meters) oak woodlands in coastal foothills with generally southwest aspect (although woodlands span all aspects) with 0-50% slopes. Climate is characterized by winter rainfall (165-203 cm annually) and summer fog. Soils are typically well drained Haplumbrepts of coarse sandstone and imperfectly drained Haplodalfs of fine textured mudstone, both having a well developed A horizon and poorly developed subsoils.

Biological Description: Oregon white oak (*Quercus garryana* var. *garryana*) is the dominant tree species, with at least 35% canopy cover. Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) may be present in the understory, but live overstory representation is not common. Other tree species may include black oak (*Quercus kelloggii*), big leaf maple (*Acer macropyllum*), and Pacific madrone (*Arbutus menziesii*). Shrub cover can be as high as 50%, but in most stands is below 5%. Brush species include ocean spray (*Holodiscus discolor*), honeysuckle (*Lonicera hispidula* var. *vacillans*), hazlenut (*Corylus cornuta*), coyote brush (*Baccharis pilularis*), berries (*Rubus* spp)., and rose (*Rosa* spp). Herbaceous cover is greater than 50%, and is represented by a high diversity of species (231 species have been recognized in the Bald Hills), approximately 55% of which are native. Common species include bracken fern (*Pteridium aquilinum* var. *pubescens*), tall oatgrass (*Arrhenatherum elatius*), California oatgrass (*Danthonia californica*), blue wildrye (*Elymus glaucus*), bedstraw (*Galium* spp.), and clover (*Trifolium* spp.).

Rejection Criteria: Exclude riparian corridors, anomalous vegetation patches, large rock outcroppings or barren areas (> 20% of the plot), or areas within 30 meters of roads, burn unit boundaries, culturally sensitive areas, trails, or structures.

Notes:

<u>Overstory Trees</u>: Collect DBH data on all boles of twinned oaks. Collect data on sprouting dead oaks (use the damage code "SPRT"). Maintain the tree tag protocol adopted by the preburn data collectors.

<u>Pole Sized Trees</u>: Collect data on all trees in Q1. Map and tag all trees in this quarter. Collect DBH data on all boles of twinned pole-sized oaks. Maintain the tree tag protocol adopted by the preburn data collectors.

<u>Seedling Trees</u>: Do not consider sprouting oaks as seedlings; collect data only on oaks originating from seed. Do not map seedlings.

Herbaceous Transect: Originally vegetation was sampled along two 50-m long transects (Q4-Q1 and Q3-Q2). This was deemed excessive in 1998 and vegetation sampling was limited to one 30 m transect along Q4-Q1. Additionally, the presence of plant species within 5 meters on either side of the vegetation transect used to be recorded. In 2008, this was discontinued and only exotic plants of concern were recorded in this 10 meter belt.

Shrub Density Belt: Recorded in one 10 meter wide belt on the inside of the plot along the 30 meter long Q4-Q1 transect. Do not collect data for clonal shrub species or poison oak (*Toxicodendron diversilobum*). ***Note: As of 2008, shrub belt data collection has been suspended.***

Fuel Transects: Continue to read 4 standard Brown's transects. Note whether vegetation is present or not at each point.

Burn Severity: Collect along fuels transects.

Photos: Take copies of PRE, 01YR01, and 01YR02 photos in the field and replicate the same shots for all other reads. Ensure new photos repeat the photo sequence and are of good quality.

Unknown Plant Species: Document any unknown species by collecting voucher specimens when possible. Do not collect plants within 5 meters of the plot. If it is impossible to collect a voucher specimen, photograph or sketch the plant. Try to gather as much information as possible about the plant: family, annual/perennial, native/exotic, lifeform, etc.). For data entry into the FFI database, utilize generic unknown codes (e.g., "LILIA" for unknown Liliaceae) in the species list before making up new unknown codes.

Sampling Schedule: Read plots on this schedule: preburn, immediately postburn, two years postburn, five years postburn, and every subsequent five years postburn. Do not sample the plots one year postburn (YR01).

Canopy Cover: Collect a total of 30 canopy cover readings with a Moosehorn densiometer at the following points along the P1 – P2 line: 2, 4, 6, 8, 12, 14, 16, 18 m; and at the following points along the 0P – 50P line: 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46m. **Collect these data immediately before the burn and two years postburn.**

Fuel Model: This monitoring type was determined to be a fuel model 09 during early monitoring efforts in the 1990s. To maintain consistency with plot names on plot folders, tags, slides, photos, in the FFI database, etc., this fuel model will remain unchanged, even though for purposes of fire behavior modeling, fuel model 08 is currently used in prescribed fire planning and fire behavior modeling in the oak woodlands.

GENERAL PROTOCOLS		YES (X)	NO (X)		YES (X)	NO (X)
Preburn	Control Plots		X	Herb Height	X	
	Herbaceous Density		X	Abbreviated Tags	X	
	OP/Origin Buried		X	Crown Intercept		X
	Voucher Specimens	X		Herb. Fuel Load		X
	Stereo Photography		X	Brush Individuals		X
	Shrub Density Belt: **Currently suspended! Do not collect.**			Stakes Installed: **17**		
	10 m wide, 30 m long, along Q4-Q1—no clonal species, no TODI					
	Herbaceous Data Collected at: **30 m along Q4-Q1**					
Burn	Duff Moisture		X	Flame Zone Depth	X	
Postburn	Herbaceous Data		X	Herb. Fuel Load		X
	100 Pt. Burn Severity		X	**Collect severity data along fuels transects**		

FOREST PLOT PROTOCOLS		YES (X)	NO (X)		YES (X)	NO (X)
Overstory	Area sampled: **50 x 20 m**			Quarters Sampled: **Q1-Q4**		
	Tree Damage	X		Crown Position	X	
	Dead Tree Damage	**SPRT only**	X	Dead Crown Position	X	
Pole-size	Area Sampled: **25 x 10 m**			Quarters Sampled: **Q1**		
	Height	X		Poles Tagged	X	
Seedling	Area Sampled: **5 x 10 m**			Quarters Sampled: **Subset of Q1**		
	Height	X		Seedlings Mapped		X
Fuel Load	Sampling Plane Length: **50'**			Fuel Continuity/Opt		X
	Aerial Fuel Load/Opt		X	**1/10/100 hour fuels sampled at 6/6/12/50/50'**		
Canopy Cover	30 points	X				
Postburn	Char Height	X		Mortality	X	

K. BALD HILLS MIXED PRAIRIE (GMIPR1D03) FMH-4

FMH-4 **MONITORING TYPE DESCRIPTION SHEET** Park: **REDW**

Monitoring Type Code: GMIPR1D03 **Date Described:** 9/16/09

Monitoring Type Name: Bald Hills Mixed Prairie

Preparer: J. Beck, D. Brown, T. La Banca

Burn Prescription: Units will be burned from late summer (August) to late fall (December). 1-hr TLFM 5 - 12%; 10-hr TLFM 5-20%; 100-hr TLFM 7-35%. Temperature 35-85°F; relative humidity 22-75%; mid-flame wind speed 0 - 9 mph with gusts to 12 mph. Average flame length 2 – 27'; rate of spread 3 - 60 chains per hour; probability of ignition < 50%.

Fire Management Objective: Do not reduce the relative cover of native plants by ≥ 10% two years postburn as measured from original preburn conditions.

Fire Monitoring Objectives: Measure relative cover of native plant species with a sufficient sample size to be 80% confident of detecting a 10% change (5.5%) from original preburn conditions. Accept a 20% chance of saying a change occurred when it in fact did not; and accept a 20% chance of detecting no change when a true change occurred.

Fire Monitoring Variable(s): relative native plant cover

Physical Description: Mid to upper elevation (165-950 meters) prairie balds of coastal foothills. Generally southwest aspect of moderate to steep slopes. Precipitation ranges from 165-203 cm annually, characterized by winter rainfall and substantial summer fog. Soils typically well drained Xerumbrepts of coarse sandstone and imperfectly drained Haploxeralfs of fine textured mudstone, both having well developed A-horizons and poorly developed subsoils.

Biological Description: Area dominated by annual and winter dormant perennial grasses and forbs, 60-75% cover, including tall oatgrass (*Arrhenatherus elatius)*, sweet vernal grass (*Anthoxanthum odoratum)*, blue wildrye (*Elymus glaucus)*, California oat grass (*Danthonia californica)*, and other grass species dominating; forbs include sheep sorrel (*Rumex acetocella*), English plantain (*Plantago lanceolata*), clover (*Trifolium* spp.), flax (*Linum bienne*), and lilies (*Brodiaea* spp., *Dichelostemma* spp., *Triteleia* spp.); occasional bare soil up to 15%.

Rejection Criteria: Exclude riparian corridors, anomalous vegetation patches, large rock outcroppings or barren areas (> 20% of the plot), or areas within 30 meters of roads, burn unit boundaries, culturally sensitive areas, trails, or structures.

Notes:

Herbaceous Transect: The presence of plant species within 5 meters on either side of the vegetation transect used to be recorded. In 2008, this was discontinued and only exotic plants of concern were recorded in this 10 meter belt.

Unknown Plant Species: Document any unknown species by collecting voucher specimens when possible. Do not collect plants within 5 meters of the plot. If it is impossible to collect a voucher specimen, photograph or sketch the plant. Try to gather as much information as possible about the plant: family, annual/perennial, native/exotic, lifeform, etc.). For data entry into the FFI database, utilize generic unknown codes (e.g., "LILIA" for unknown Liliaceae) in the species list before making up new unknown codes.

Sampling Schedule: Read plots on this schedule: preburn, immediately postburn, two years postburn, five years postburn, and every subsequent five years postburn. Do not sample the plots one year postburn (YR01).

Photos: Take copies of PRE, 01YR01, and 01YR02 photos in the field and replicate the same shots for all other reads. Ensure new photos repeat the photo sequence and are of good quality.

FMH-4 **PLOT PROTOCOLS**

GENERAL PROTOCOLS		**YES (X)**	**NO (X)**		**YES (X)**	**NO (X)**
Preburn	Control Plots		**X**	Herb Height	**X**	
	Herbaceous Density		**X**	Abbreviated Tags	**X**	
	OP/Origin Buried		**X**	Crown Intercept		**X**
	Voucher Specimens	**X**		Herb. Fuel Load		**X**
	Stereo Photography		**X**	Brush Individuals		**X**
	Belt Transect Width: **n/a**			Stakes Installed: **2 (0P, 30P)**		
	Herbaceous Data Collected at: **0P-30P (30 meters)**					
Burn	Duff Moisture		**X**	Flame Zone Depth	**X**	
Postburn	Herbaceous Data		**X**	Herb. Fuel Load		**X**
	100 Pt. Burn Severity		**X**	Severity collected along: **0P-30P (every 5 meters)**		

L. FEMO REPORT TEMPLATE

RX FIRE NAME

Redwood National Park

Date

Name, Position [FEMO or FEMO(t)], REDW Fire Effects

PROJECT OVERVIEW

This section should include project acreage, boundaries, elevations, description of the fuel models located within the unit, and any other information that may be helpful. The burn plan and/or IAP will be very helpful while writing this section.

PROJECT OBJECTIVES

These can be found either in the IAP or in the burn plan.

PROJECT RESOURCES

Include all resources assigned to the incident, their role, and location if possible.

SUMMARY OF BURN OPERATIONS

TEST BURN

Important information should include location, time, weather conditions, fire behavior, and general observations.

IGNITION PATTERN

Please include an ignition chronology with as much detail as possible. The number and type of igniters, a timeline, and any holding issues should be addressed here. If there are multiple days of ignitions, please split this section out for each day.

WEATHER SUMMARY

Include burn prescription, spot weather forecast info and accuracy, prior precipitation information, fuel moisture information, ERC and BI for previous and actual burn days, seasonal information (e.g., dry year? wet year? normal year?), and any other useful weather information here. Please also include the highs and lows for temperature, RH, pertinent wind information, and general sky observations. If there are multiple days of ignitions, please separate this section out by date. The actual weather observation data sheets should be cut and pasted into this document as an appendix.

FIRE BEHAVIOR SUMMARY

This section should describe the fire behavior observed on the fire throughout the day. Please avoid taking fire behavior observations directly on the fire lines where igniters are lighting. If there are multiple days of ignitions, please separate this section out by date. Include a few pictures of the fire behavior observed. The actual fire behavior observation data sheets should be cut and pasted into this document as an appendix.

SMOKE SUMMARY

Include a chronology of smoke movement and dispersal throughout the burn. If there are multiple days of ignitions, please separate this section out by date. Include a picture of the smoke column and/or dispersal. Reference the Smoke Management Plan for the burn and address whether the smoke management strategy was effective or not. The actual smoke observation data sheet should be cut and pasted into this document as an appendix.

FIRE EFFECTS SUMMARY

If there are any permanent FMH plots, photopoints, or non-permanent plots (Fir Plots) within the project boundaries, please discuss them here. If safety allows, try to collect fire behavior data from actual plot locations during burning. Also, if possible, conduct immediate postburn sampling after combustion has finished. If possible, discuss whether immediate post burn objectives were achieved (some objectives may be more long term and will cannot be assessed within the time frame of this report). Discuss each objective separately and in detail. Include a few preburn and postburn plot photos here, percent of the unit burned, fire severity, and future monitoring that will be conducted in this unit (if there are plots – what is the sampling schedule).

COMMENTS

Present overall thoughts on how burn went from a FEMO perspective and incorporate comments from AAR into this section. Please try to end on a positive note (even if the burn escaped there must be some positive comment).

FIRE WEATHER OBSERVATION FORM

FIRE NAME: **DATE:** **OBSERVERS:**

TIME	LOCATION	ELEVATION	ASPECT	DRY BULB	WET BULB	RELATIVE HUMIDITY	WIND SPEED (GUSTS)	WIND DIRECTION	% CLOUD COVER	% SHADING	FINE DEAD FUELMOISTURE	PROB. OF IGNITION	COMMENTS (PRECIP, FIRE BEHAVIOR, SMOKE, ETC)

MAX TEMP: ____________________ MIN RH: ____________________ MIN TEMP: __________________ MAX RH:____________________

TIME OF MAX TEMP: ___________ TIME OF MIN RH:_____________ TIME OF MIN TEMP: __________ TIME OF MAX RH: ____________

FIRE BEHAVIOR OBSERVATION FORM

FIRE NAME:	DATE:	OBSERVERS:

TIME	LOCATION	ELEVATION	FUEL TYPE	SLOPE	ASPECT	FIRE TYPE (circle one)	RATE OF SPREAD: ☐ CH/HR ☐ FT/MIN ☐ FT/HR	FLAME LENGTH	FLAME HEIGHT	FLAME ZONE DEPTH	COMMENTS
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					
						B H F					

SMOKE OBSERVATION FORM

FIRE NAME:	**OBSERVERS:**

DATE	TIME	OBSERVER LOCATION AND ELEVATION	ELEVATION OF COLUMN ABOVE GROUND	COLUMN DIRECTION	APPROX. ELEVATION OF INVERSION LAYER ABOVE GROUND	OTHER OBSERVATIONS*

*visibility, type, volume, character, color, plume type: