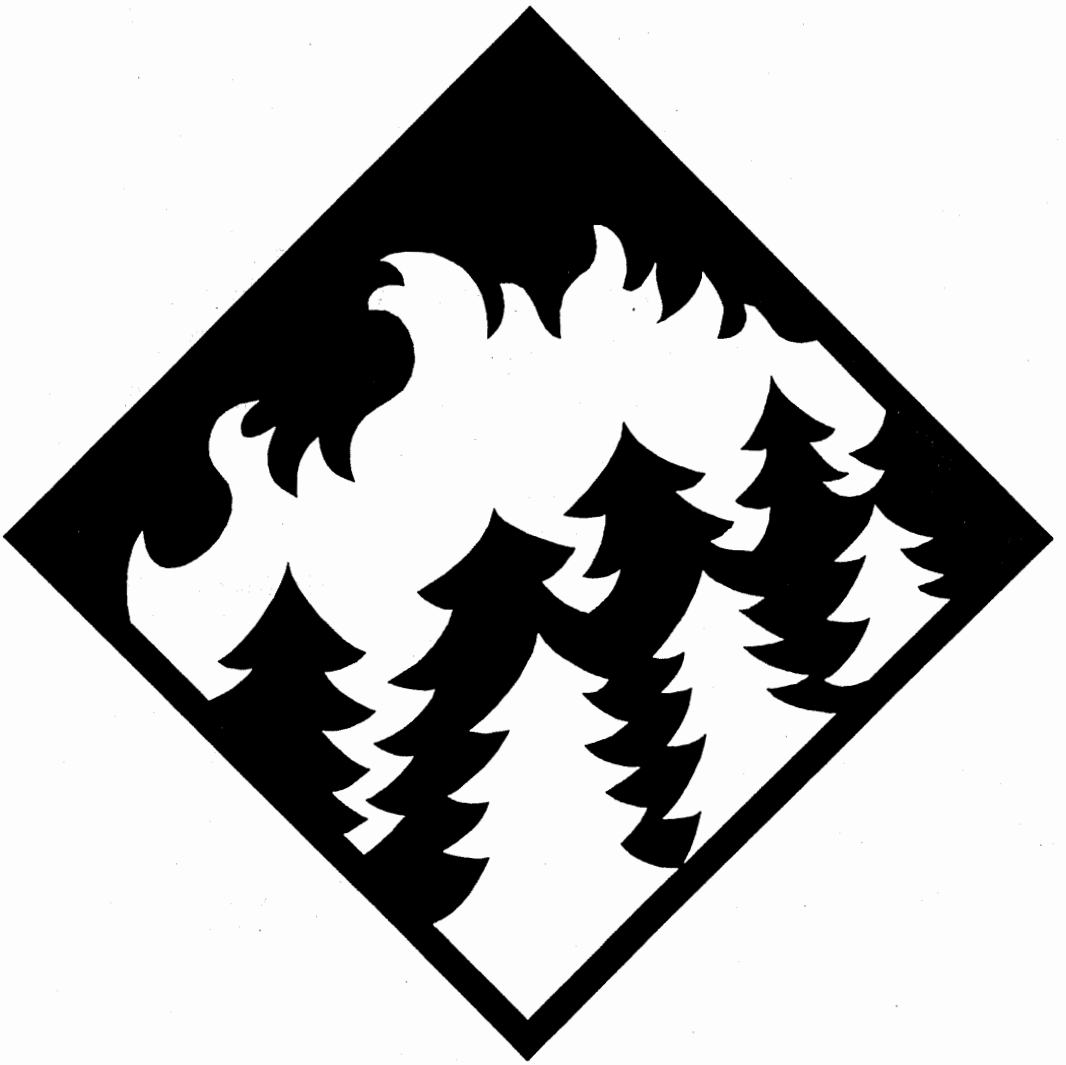


Prescribed Fire Annual Summary
1998

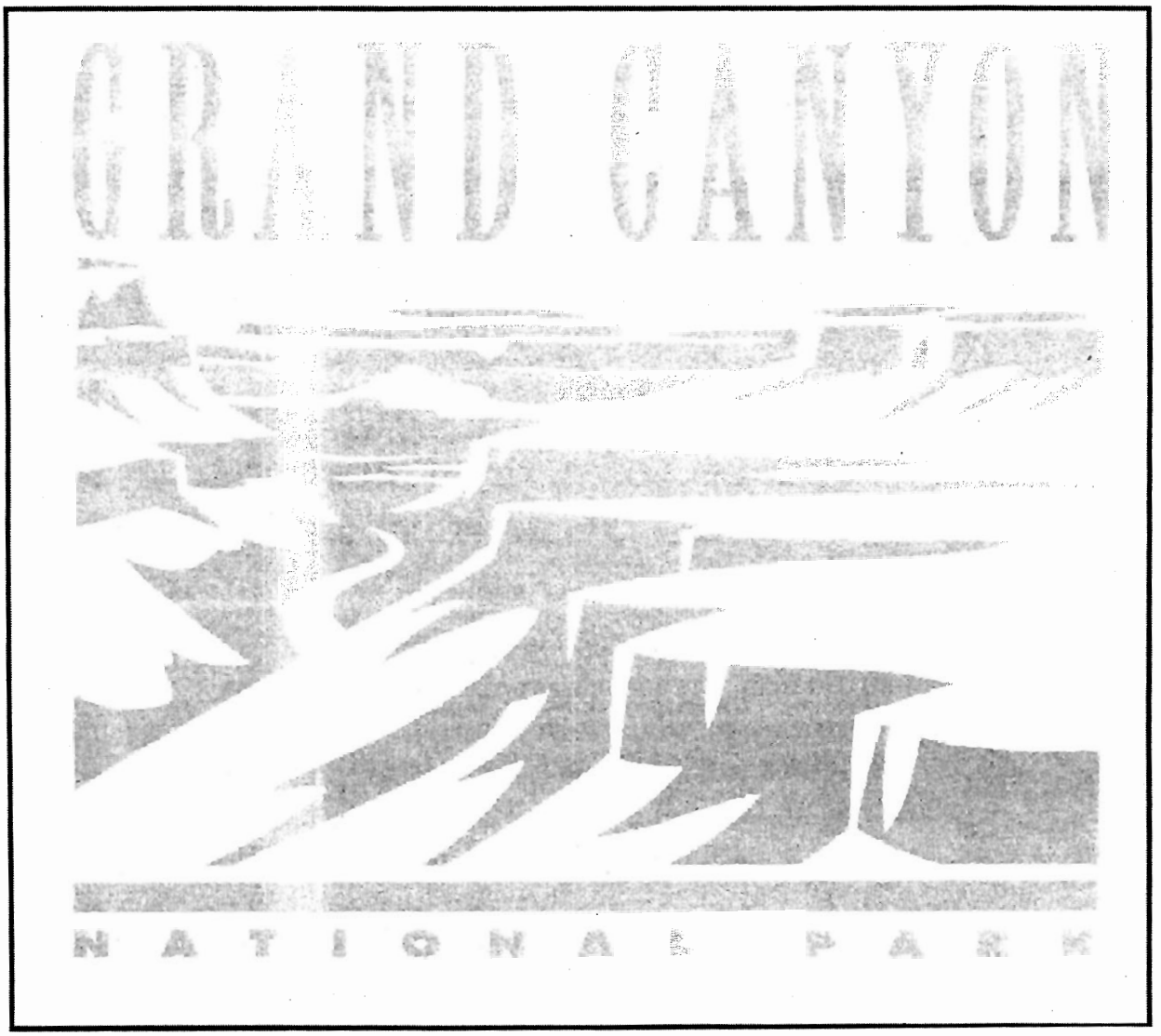
National Park Service
Grand Canyon National Park
Branch of Fire and Aviation
P.O. BOX 129
Grand Canyon, AZ 86023

The Prescribed Fire Annual Summary is broken into two parts. Each part has its own index and appendices.

Acknowledgements

The Prescribed Fire staff would like to recognize the numerous people who helped our program have a successful year. Grand Canyon had a record-breaking year and accomplished all activities in a safe and cost effective manner. Thank you to Arrowhead Interagency Hotshot Crew, BLM Boise Smokejumpers, Kaibab National Forest, Coconino National Forest, Fish and Wildlife Service, Alan Farnsworth, Zion Prescribed Fire Module, Bryce Canyon National Park, Zion National Park, Dave Lentz, Grand Canyon Law Enforcement, Interpretation, Public Affairs Office, and all Fire and Aviation Staff.

Prescribed Fire Operations



"Far and away the best prize that life offers is the chance to work hard at work worth doing."

Theodore Roosevelt

Prescribed Fire Operations Year End Report

Introduction

This report will serve as a summary of Prescribed Fire Operations 1998 calendar year accomplishments. The purpose of this report is to have documentation of accomplishment and other activities to aid Fire Program Managers in decisions and program development at Grand Canyon National Park.

Goals

The goals of the Prescribed Fire Program at Grand Canyon National Park are:

1. Provide a safe working environment for all employees while working on prescribed fire projects.
2. To meet or exceed prescribed fire targets for the fiscal year.
3. Adhere to all guidelines and policies concerning natural and cultural resources for all prescribed fire projects.
4. Provide adequate training opportunities for all prescribed fire staff to further their career development and improve the prescribed fire program at Grand Canyon National Park.

Staffing

The staff for Prescribed Fire Operations in 1998 consisted of a Prescribed Fire Specialist (GS-0462-7/8/9), and two Forestry Technicians (GS-0462-05). The Prescribed Fire Operations Staff participated in prescribed fire activities (this includes planning, burn prep, burn operations, and other daily activities to have the program run – i.e. personnel, staff meetings, etc.), fuel sampling, meetings (usually outside of staff – i.e. with other park personnel and other agencies), fire-use activities and as fire monitors. Please reference the following table for a breakdown of crew activities. Crewmembers kept a daily log of activities. The day activity was categorized by the activity that took most of the day. The days in Table one include both Forestry Technicians. Both of these tables do not include overtime days spent doing the various activities.

Table 1: Two GS-0462-05

Category	Prescribed Fire	Fire Use	Fuel Sampling	Training	Meetings	Suppression Fire	Suppression Aide	Assist Other NPS & Agencies in Rx Fire
Days	**95**	**44**	**26**	**32**	**4**	**41**	**29**	**19**
Percent	**33%**	**15%**	**9%**	**11%**	**1%**	**14%**	**10%**	**7%**

Table 2: One GS-0462-7/8/9

Category	Prescribed Fire	Fire Use	Training include instruct	Meetings	Furlough	A/L, S/L, & FSL	Suppression Fire
Days	**143**	**23**	**29**	**12**	**10**	**30**	**3**
Percent	**57%**	**9%**	**12%**	**5%**	**4%**	**12%**	**1%**

The Prescribed Fire program has funded other positions in fire and resource management to complete compliance and other work to ensure the success and progress of the prescribed fire program at Grand Canyon National Park.

Prescribed fire funded seven suppression personnel for 120 days in 1998. These personnel assisted in prescribed burning prep and execution of prescribed fire projects. Prescribed fire also funded one GS-7 to attend RX-300 (Prescribed Fire Burn Boss).

Prescribed fire has funded one GS-07 GIS technician, one GS-09 archeologist and two GS-05 archeology technicians. Appendix A contains the GIS 1998 accomplishment and 1999 program goals and schedule. Appendix B contains the Archeologist 1998 accomplishment and 1999 program goals and schedule.

Fuel Moisture Monitoring Summary

The fuels moisture-monitoring program is based on the protocols of Grand Canyon National Park's guidelines. These protocols and guidelines are found in Fire Monitoring Handbook for Grand Canyon National Park. Appendix C summarizes where fuel data was collected and what was sampled at each location. Appendix D contains year-end graphs of live and dead fuel moistures. This information was used for prescribed burning, fire-use fires and for monitoring trends at Grand Canyon National Park. All of the material was displayed in key locations for fire personnel to observe.

The current protocols and guidelines are currently under review and will be changed for the 1999 fire season. The reason for these changes include representative sampling sites and a more standardized system for both South Rim and North Rim. This effort will be done jointly between the Fire Effects Specialist and the Prescribed Fire Specialist. Along with changes in protocol, the prescribed fire specialist will attempt to establish a system that tracks trends in data such as 1000-hour fuel moisture departures from long term averages, ERC (energy release component) and 1000-hour minimums and maximums. These will be done in graph form and available for Grand Canyon personnel.

5-Year Burn Plan and Other Burn Rotations

The current 5-year burn plan worked well for resource management and fire management in the 1998 calendar year. Appendix E contains the current 5-year burn plan. The Prescribed Fire Manager and Prescribed Fire Specialist have developed a burn rotation for the South Rim (appendix E). This burn rotation is for the Ponderosa Pine and Pinyon-Juniper Fuel types and is designed to help managers determine burn priorities for the next several years. The next step for development of a burn rotation is a rotation for the North Rim. Once this is done, the several year burn rotations will replace the 5-year burn plan. The development of these rotations will help with FMH Plot Schedule, compliance work and budget development. For the 1999 season, a burn rotation will be started for the Mt. Emma area. This area has not had any previous burn units or FMH plots installed to promote the natural processes of fire. This effort will be done jointly between the Prescribed Fire Manager, Prescribed Fire Specialist and Fire Effects Specialist.

Several long term and landscape burn plans were written in 1998. These plans are designed to last for several years over thousands of acres. Plans written in 1998 include Walhalla (13,000 acres, North Rim), Outlet (10,000 acres, North Rim), Bright Angel Mechanical Treatment and Prescribed Fire Project (460 acres, North Rim), Horsethief (5,500 acres, South Rim) and Topeka (2,532 acres, South Rim). Other burn plans started in 1998/1999 for this objective include Walla Valley (6,000 acres, North Rim), Boundary (8,500 acres, North Rim), Nankoweap, Imperial, Hayden, Vista I and IV, Greenland and Kibbey (3,200 acres, North Rim), and Long Jim I, II, III, Picnic (5,300 acres, South Rim). A map of the all the current burn units for Grand Canyon National Park is located in Appendix F. Smaller unit burn plans were also written in 1998 and include Watson I (300 acres, South Rim) and updates to the Lonetree Project Area (900 acres, South Rim).

Prescribed Fire Summaries

The following pages cover summaries of all completed prescribed fire projects for 1998. Please note when looking at cost, some units contain only FY98 cost and other figures contain FY98 and FY99 costs. A true calendar-year cost of projects was unavailable at the time of this report due to many factors beyond the Prescribed Fire Specialists control. Appendix G contains a spreadsheet showing all prescribed fire projects and total costs. Again, this chart in appendix G is only for FY98 and contains information from calendar year 1997. Appendix H contains all prescribed fire project maps. These project maps will show treatment and/or burned areas for projects that are several thousand acres in size or multi-year projects.

Topeka Prescribed Fire Project

Unit Information:

Size: 2532 acres
Location: South Rim
Fuel Type: Ponderosa Pine
Number of entry: Second Entry
Operational Periods: Two burning periods
Unit Cost: $104,843.71
Cost per Acre: $41.41

OPERATIONS: This unit was a second entry burn that occurred over two days in the spring of 1998. 10 BLM Smokejumpers, Arrowhead Interagency Hotshot Crew, 1 Type 3 BLM engine, 2 Type 3 NPS engines, 1 Type 6 NPS engine, 3 Type 6 FS engines, Rx monitors from GRCA and other misc. personnel from GRCA NP were involved in the burn operations of this unit. Several other people from GRCA NP were involved including public information, interpreters, logistical support, dispatch and other functions to support the personnel.

SAFETY: There were no significant incidents or accidents concerning this burn. CA-1's were filed for strep-throat (1), general illness (2), and insect bite (1). There was no lost time on any of the claims.

Helicopter: The GRCA NP helicopter was used during burn operations for this unit. The helicopter was used for dispensing Ping-Pong balls (firing operations), reconnaissance, and smoke management concerns. The helicopter flew for 10.2 hours and cost $14,479.31. All operations were safe and accident free.

SMOKE MANAGEMENT: GRCA NP worked with ADEQ and Carl Bowman, GRCA Air Quality Specialist, to manage the smoke for this prescribed fire unit. No emission standards were broken during any operational periods. DataRams were used to measure particulate matter in key locations surrounding the prescribed fire activities. GRCA personnel took photos of smoke at different times throughout a 24 hour period to show smoke flows and impacts to the Grand Canyon and Village area. A few smoke complaint letters were written by the public and responded to by the Prescribed Fire Management Staff.

Public Information: There were several public contacts made for this project. Public Service announcements, press releases, and site bulletins were done for this project. A general fire phamplet/handout was given to all visitors via the gate on days when smoke was visible (usually firing operation days). This handout explained the role and benefits of fire. All residents and local hotels were given (delivered by GRCA personnel or posted on door) a general statement and map about the project. Interpreters roamed all overlooks and areas where general publics were, to talk about the prescribed fire project.

See appendix H for map.

Widforss Prescribed Fire Project

Unit Information:

Size: 241 acres (FY98) total 259 acres (Unit is 1030 acres)
Location: North Rim
Fuel Type: Ponderosa Pine and Mixed Conifer
Number of entry: First Entry
Operational Periods: 7 burning periods
Unit Cost: $7,566.91 (FY98 cost only)
Cost per Acre: $34.24 (FY98 cost only)

OPERATIONS: This unit was a first entry burn that occurred over seven burning periods in the fall of 1998. 1 volunteer from the Southeast Region, 5 BLM Smokejumpers, Rx monitors from GRCA and other misc. personnel from GRCA NP were involved in the burn operations of this unit. Several other people from GRCA NP were involved including public information, interpreters, logistical support, dispatch and other functions to support the personnel.

SAFETY: There were no significant incidents or accidents concerning this burn.

Helicopter: The GRCA NP helicopter was used during burn operations for this unit. The helicopter was used for reconnaissance, and smoke management concerns. All operations were safe and accident free.

SMOKE MANAGEMENT: GRCA NP worked with ADEQ and Carl Bowman, GRCA Air Quality Specialist, to manage the smoke for this prescribed fire unit. No emission standards were broken during any operational periods. GRCA personnel took photos of smoke at different times throughout a 24-hour period to show smoke flows and impacts to the canyon.

Public Information: There were several public contacts made for this project. Public Service announcements, press releases, and site bulletins were done for this project. A general fire phamplet and/or handout was given to all visitors via the gate on days when smoke was visible (usually firing operation days). This handout explained the role and benefits of fire. Interpreters roamed South Rim overlooks and areas where general publics were, to talk about the prescribed fire project. The Widforss trail was closed for about three days of this operation. The operations staff made a lot of public contacts during burning. This burn was visible from the road and created a lot of interest in Grand Canyon's Prescribed Burning Program.

See appendix H for map.

Village Fuel Break – Mechanical Treatment and Prescribed Fire Project

Unit Information:

Size: 60 acres thinned (FY97), piled (FY97) and burned (FY98)
(Unit is 2000 acres)
Location: South Rim
Fuel Type: Ponderosa Pine and Pinyon Juniper
Number of entry: First Entry
Operational Periods: Various through out summer for thinning and winter for burning.
Unit Cost: $8,887.62 (FY98 only)
Cost per Acre: $148.13 (FY98 only)

OPERATIONS: This unit was a first entry treatment that occurred over the summer and winter of FY97 and FY98. 1 volunteer from the Southeast Region, 5 BLM Smokejumpers, Rx monitors from GRCA and other misc. personnel from GRCA NP were involved in the burn operations of this unit. Several other people from GRCA NP were involved including public information, interpreters, logistical support, dispatch and other functions to support the personnel.

SAFETY: There were no significant incidents or accidents concerning this project.

Helicopter: The GRCA NP helicopter was not used during any operations for this unit.

SMOKE MANAGEMENT: GRCA NP worked with ADEQ and Carl Bowman, GRCA Air Quality Specialist, to manage the smoke for the piles from this unit. No emission standards were broken during any operational periods.

Public Information: There was not a lot of public interest concerning the burning of the hand piles. Information concerning the burn and smoke was posted in key locations throughout the park and on information boards. A message was posted daily for all park employees concerning the burning of the hand piles. There were no smoke complaints.

See appendix H for map.

Bright Angel Mechanical Treatment and Prescribed Fire Project

Unit Information:

Size: 34 mechanical treatment (Unit is 460 acres)
Location: North Rim
Fuel Type: Ponderosa Pine and Mixed Conifer
Number of entry: First Entry
Operational Periods: 14+ days
Unit Cost: $37,379.40 (FY98 only)
Cost per Acre: $1,098.15 (FY98 only)

OPERATIONS: This unit was a first entry treatment that occurred over the summer and fall of FY98. Arrowhead Interagency Hotshot Crew and personnel from GRCA NP were involved in the mechanical treatment operations of this unit. Several other people from GRCA NP were involved including public information, interpreters, logistical support, dispatch and other functions to support the personnel. The interpreters and public information done for this unit was imperative to the success of this project. This project is highly visible to the public and there was a lot of concern over project necessity and overall goals of the project.

SAFETY: There were no significant incidents or accidents concerning this project.

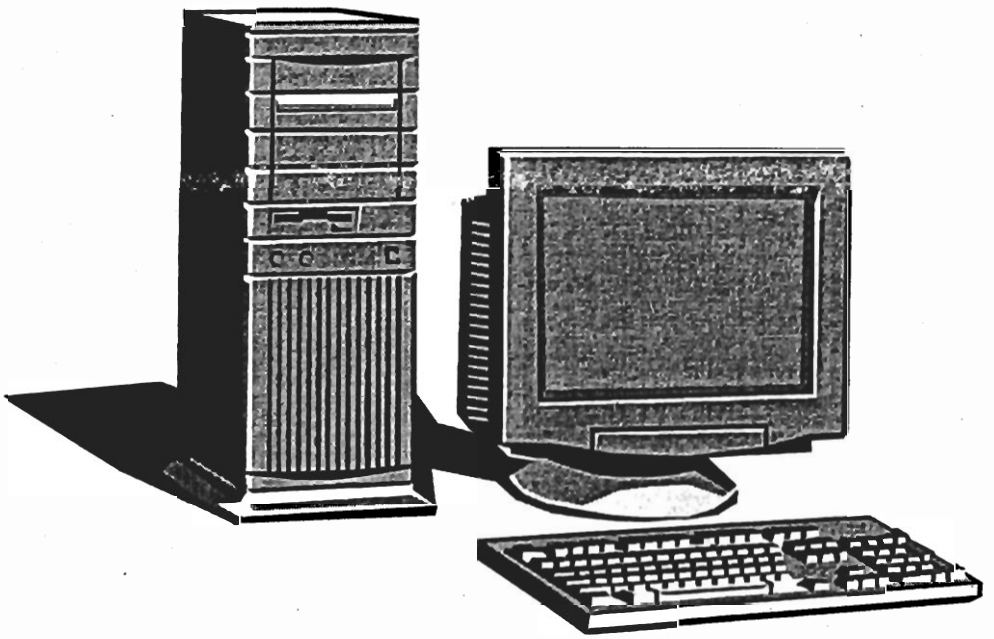
Helicopter: The GRCA NP helicopter was not used during any operations for this unit.

SMOKE MANAGEMENT: There were no smoke management concerns for this project in 1998.

Public Information: There was a lot of public interest concerning the purpose and goals of this project. Information concerning the thinning for defensible space was posted in key locations throughout the North Rim. Once the project was explained to the general public, there was on the site support. Fire Management Staff is still working on internal concerns and is working closely with North Rim Staff to ensure success of this project.

See appendix H for map.

Appendix A: GIS 1998 Accomplishment and 1999 Program Goals



PRESCRIBED FIRE MANAGEMENT
YEAR-END SUMMARY
FIRE GIS/FARSITE MODELING ACTIVITIES
1998

Chronology

July 15 through August 9, 1998

~ The mapping base (DOQQs, or Digital Orthophoto Quarter Quads, merged with DRGs, or Digital Raster Graphics) was photo-interpreted and delineated into fuel models/forest-types, sufficient to permit field verification on the Walhalla pilot project.

~ Cartographic Technician started August 2.

~ FARSITE NT Workstation configured and networked into GRCA/CPFS NT/UNIX system.

~ Purchasing requests submitted for equipment needed in support of Field Season.

~ Field Maps plotted providing coverage for entire Walhalla Plateau.

August 10 through September 17,1998

~ Field work initiated at north end of Walhalla Plateau. Temporary camp facilities set up at north end of Walhalla Plateau.

~ Field verification of 453 Fuel Model/Forest Type polygons completed for entire Walhalla Plateau.

September 18 through October 24, 1998

~ GIS Correction of Field verified polygons, completed.

~ East Walhalla Burn Plan Map delivered to South Rim.

October 25 through November 19, 1998

~ GIS Fuel Model/Forest Type data attribution for Walhalla Plateau completed (includes canopy cover, vegetation classification and quantification, crown dimensions).

~ Presentation of GRCA Restoration Ecology/FARSITE Modeling/GIS/Computer Mapping at Old-growth Definition Symposium at Harvard Forest (Massachusetts).

~ Submission of abstracts for paper to be presented to 1) Joint Fire Science Conference and Workshop (Boise, ID), and 2) ESRI GIS Conference (San Diego CA).

November 19 through December 4, 1998

~ Dan Spotskey and Don Bertolette attend week-long FARSITE Fire Area Growth Modeling Training at Marana, Arizona and are successfully certified as official FCNs (FARSITE Computer Nerds).

~ Presentation of GRCA's Prescribed Fire Management FARSITE program progress.

~ North Rim 1998 Fire Map (Transept, others) delivered to GRCA

December 5 through December 30, 1998

~ First pass at Fuel Model/Forest Type polygon delineation completed for following quads on North Rim – Havaupai Point, Shiva Temple, Bright Angel Point, Point Imperial, Little Park Lake, and Kanabownits Spring.

~ AML written, run, for automated processing of Resource Photomaps (hybrid of DOQQs and DRGs). Production of draft 'Photomaps' initiated.

~ Draft versions of Resource Photomaps successfully produced.

~ Prescribed Fire Unit Boundary Maps (8.5" x 11", 11" x 17", 22" x 34", 36" x 44") completed, with new labeling schema.

Conclusion

With the completion of this field season's mapping of the Walhalla Plateau, our ability to utilize pattern recognition/photo-interpretive skills has provided us with good model for Fuel Model/Forest Type prediction, and a solid base for collection of field data for the rest of the North Rim. With the

winter assembly of wind, weather, and other ancillary data, preliminary FARSITE modeling, and model calibration could begin by early spring.

PRESCRIBED FIRE MANAGEMENT
FARSITE FOR 1999

The FARSITE Fire Area Growth Modeling program is on schedule, as field data collection and field verification of Fuel Model/Forest Type (FM/FT) polygons for the Walhalla Plateau are complete.

Current activities include preparations for 'modeling' North Rim FM/FT polygons after those occuring on Walhalla Plateau, anticipating similar elevational and latitudinal ranges.

Future Activities follow in a chronological fashion:
By May
Both FCN's to be 'Red-carded'
Preliminary FARSITE Model calibration (based on Walhalla data) should begin by April.
With successful ancillary data collection (wind, weather, slope, aspect, elevation), preliminary FARSITE Model runs for the North Rim could begin prior to field season.
Develop Fire Perimeter Acquisition Protocols
Be ready to run FARSITE on active Fires
Resource Maps (Photo/Topo) complete
By October
Complete North Rim Polygon Field Verification
Acquire Fire Perimeters per above protocol
Use FARSITE During Active Prescribed/Wild Fire
By December
Start South Rim polygon delineation of Fuel Models/Forest Types
Start Fire History acquisition and integration

With such progress likely, it is important to anticipate facilities, equipment, training, and certification needs, well in advance.

Lodging Needs– With known shortages for lodging on the North Rim, and the anticipated duration of the field season, lodging is a critical consideration.
With the offer (by GIS Tech) of a PORV (Privately Owned Recreational Vehicle) to serve as 1) North Rim seasonal residence, and as a Science

Center GIS Remote Lab/Office; provision of a North Rim RV space (power, water, sewer, phone) would be function- and cost-effective. PORV would initially function as a residence and office during the week while work is close by, and over the weekends for field equipment storage, and as needed for weekend lodging. As field season progresses and field work gets progressively further from the North Rim, the PORV during the week would function as a field office, and during the weekends, as needed for lodging, and/or storage site.

Transportation Needs – To access remote sites located throughout the more remote locations of the North Rim, a reasonably heavy-duty vehicle should be provided. Not solely for crew transport over primitive road conditions, it may on occasion be used to transport pack horses (needed to access wilderness camp locations where primitive roads are non-existent). The vehicle would be needed for transportation between Flagstaff and the North Rim.

Equipment Needs – The following equipment needs are general and will be specified in DI-1 requisition forms, at a later date:
1) a high capacity laptop computer capable of performing FARSITE Modeling tasks under field conditions associated with Fire Use and Prescribed Fire Management Scenarios, with associated hardware to make it functional in field conditions (large format – 11"x17" Epson inkjet printer, AC/DC power inverter) [$7000-$9000]
2) a scanner, for converting paper manuscripts, photos, and slides to digital format [$600-$1000]
3) the appropriate cabling and GPS receivers for various fire management activities (not limited to perimeter data collection) [$100 - $3000]
4) 9" x 9" and 18" x 18" (latter size to be given to Prescribed Fire Mgmt., after Field Verification Work done) color aerial photography (NHAP) for North and South Rims (Cost Not Known, as this should be a combined purchase, for economy of purchase) [estimate our portion to be $2500]
5) dedicated slide carousels for presentations [$100]
6) a laser measuring device capable of simultaneously measuring horizontal, slope, and vertical distances (for collection of tree heights, crown size) [$2500-$3000]

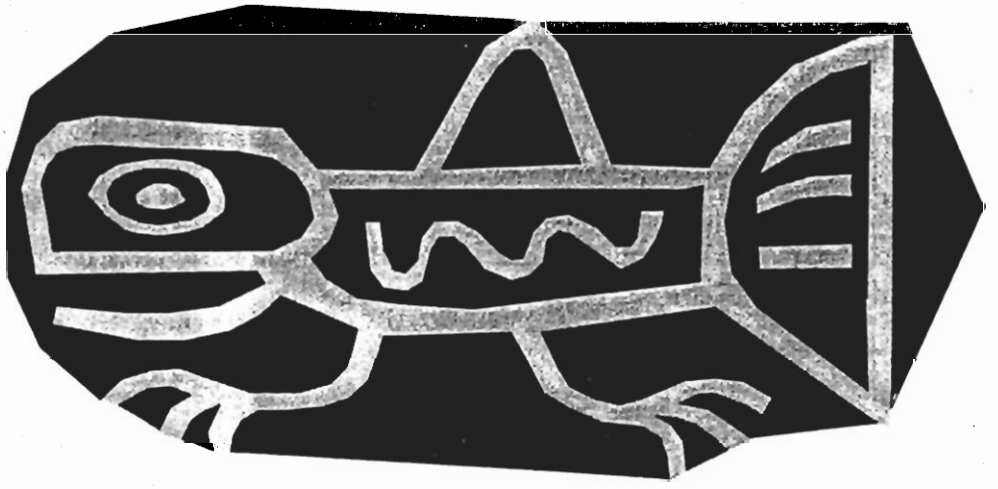
Training/Certification Needs– For both data collection and fire

management activities

1) Initial firefighter training classes sufficient to acquire 'red card' rating, as well as additional and advanced wildland fire activities (sufficient to permit ground- and air-based activities)
2) Packhorse Management 101 (Care and Feeding of Wilderness Stock).
3) Appropriate First Aid, CPR, training as required for crew supervisors
4) Tuition Reimbursement for Restoration Ecology classes at NAU

Presentation of Papers – With two presentations of paper currently planned (Boise ID in June, San Diego in July), and involvement as FARSITE Instructors anticipated in future FARSITE Model training sessions, preparation and travel time should be anticipated.

Appendix B: Archeology 1998 Accomplishment and 1999 Program Goals



[redacted] 1998

GRCA RX Fire Archaeology
Accomplishments

Completed Clearances and Assessments

Walhalla

- 14,242 project acres
- 394 recorded cultural resources within project
- compilation of archaeological survey information dating back to 1918

Topeka

- 1,939 project acres
- compilation of information from four previous prescribed burns and a total of ten earlier clearances
- 60 acres along perimeter and interior roads surveyed for current project
- 42 archaeological sites recorded within project
- 9 archaeological sites would be adversely effected by fire and were protected.
  → These included historic Native American wickiups and a sweatlodge as well as Historic Anglo sites.

James T. Owens' Drift Fence Assessment

- Assessment of 1.15 miles of drift fence constructed in 1919 by James T. Owens
- Ultimately deemed ineligible for the National Register

North Rim Boundary Drift Fence Assessment

- Assessment of 7 miles CCC fence built between 1938-1941
- Deemed ineligible for the National Register

Fieldwork in Progress

Horsethief Burn Unit

- As of Dec 31, 1998:
  → 516 acres surveyed
  → 60 sites recorded (total site acreage: 108)

North Rim Mechanical Burn Unit

- No fieldwork needed, pulling together previous surveys and known sites.
- Anticipated completion: January, 1999
- 5 sites within project area.

Personnel

At various times over year, 11 archaeologists worked on RX Fire projects as well as other ongoing projects

In October, 1998 3 term positions (funded by RX fire) were filled

- GS-9 Archeologist
- 2 GS-5 Archeological Technicians
- Also 1 term GS-5 Arch Tech who floats between projects but works primarily for fire

Management Documents

Annual Work Plan

- Based on 5 Year Burn Plan
- Outlines work priorities and projected activities for crew for 1999
- Signed off by FMO, Chief of Cultural Resources, RX Fire Manager, RX Fire Archaeologist

Draft Document Outlining Compliance Methods

- Includes legal framework, sampling strategies, survey methods, site documentation guidelines

Developing Survey Plans for Each Burn Unit

- Unit-specific sampling strategies
- Includes previous surveys, known sites, and other background info

Paper by Amy and Tonja accepted for presentation at George Wright Society annual conference.

- *North Rim Complex Fires: Integrating Fire Use and Resource Protection at Grand Canyon*
- March, 1999, Asheville, NC

Fiscal 1999 Work Plan

Grand Canyon National Park
RX Fire Archaeology
(3 person crew)

Tentative Schedule

- ***November 1998***
  - Fieldwork –
    - Horsethief Sub-Unit 3 Survey and Site Recording Con't
  - Office –
    - Fiscal 1998 Summary
    - October 1998 Summary
    - Data entry and artifact processing from Horsethief Sub-Unit 3
    - Survey Plan for Shoshone Point Burn Unit
    - Background research for Historic features in Horsethief (tank, fences, roads)

- ***December 1998***
  - Fieldwork –
    - Priority 1: Shoshone Point Burn Unit, Survey and Site Recording
    - Priority 2: Horsethief Burn Sub-Unit 3 Survey and Site Recording Con't
  - Office –
    - November 1998 Summary
    - Data entry and artifact processing from Horsethief Sub-Unit 3 and Shoshone
    - Background research for Historic features in Horsethief (tank, fences, roads)
    - Bright Angel Point compliance document
    - Survey strategies document

DECEMBER 15, 1998 - Meeting between Amy, Jan, Ken, and Kim to assess progress and priorities.

JANUARY 1, 1999 – Bright Angel Point compliance document complete.

- ***January 1999***
  - Fieldwork –
    - Priority 1: Shoshone Point Burn Unit, Survey and Site Recording
    - Priority 2: Horsethief Burn Sub-Unit 3 Survey and Site Recording Con't
  - Office –
    - December 1998 Summary
    - Data entry and artifact processing from Horsethief and Shoshone
    - Survey plans for Horsethief Sub-Units 1, 2, 4, 5
    - PA with SHPO re: this program (survey strategies, site recording, fence treatment, etc)
    - Survey Strategies document

JANUARY 31, 1999 – Final Survey Strategies Document and Draft PA re:this program.

- ***February 1999***
  - Fieldwork –
    - Priority 1: Shoshone Point Burn Unit, Survey and Site Recording
    - Priority 2: Horsethief Burn Sub-Unit 3 Survey and Site Recording Con't
  - Office –
    - January 1999 Summary
    - Data entry and artifact processing from Horsethief 3 and Shoshone
    - Survey plans for Vista IV/Kibbey/Hayden/Vista I/Greenland/Imperial/Nankoweap
    - PA with SHPO regarding treatment of historic fences
    - South Rim Pine Survey Plans

MARCH 1, 1999 –Shoshone Point compliance document complete.
Final PA with SHPO.
Meeting between Amy, Jan, Ken, and Kim to assess progress and priorities.

- ***March 1999***
  - Fieldwork –
    - Priority 1: Horsethief Sub-Unit 3
    - Priority 2: South Rim Pine (to be determined)
  - Office –
    - February 1999 Summary
    - Shoshone Point artifact processing and and data entry

APRIL 1, 1999 – Horsethief Sub-Unit 3 compliance document complete.

- ***April 1999***
  - Fieldwork
    - South Rim Pine (to be determined)
  - Office
    - March 1999 Summary
    - South Rim Pine (to be determined) data entry and artifact processing

- ***May 1999***
  - Fieldwork –
    - Start on Outlet as soon as weather allows
    - Otherwise, South Rim Pine (to be determined)
  - Office –
    - April 1999 Summary
    - Outlet data entry and artifact processing

JUNE 1, 1999 - Meeting between Amy, Jan, Ken, and Kim to assess progress and priorities.

- ***June 1999***
  - Fieldwork –
    - Finish Outlet
  - Office –
    - May 1999 Summary
    - Outlet data entry and artifact processing

JULY 1, 1999 – Outlet compliance document complete.

- ***July 1999***
  - Fieldwork -
    - Priority 1: NWIV
    - Priority 2: Vista IV/Kibbey/Hayden/Vista I/Greenland/Imperial/Nankoweap
  - Office –
    - June 1999 Summary
    - Outlet data entry and artifact processing
    - NWIV fence assessment, data entry
    - South Rim Pine Survey Plan

AUGUST 1, 1999 – NWIV compliance document complete (including fence assessment).

- ***August 1999***
  - Fieldwork -
    - Vista IV/Kibbey/Hayden/Vista I/Greenland/Imperial/Nankoweap

- Office –
  - July 1999 Summary
  - Vista IV/Kibbey/Hayden/Vista I/Greenland/Imperial/Nankoweap data entry and artifact processing

SEPTEMBER 1, 1999 – Vista IV/Kibbey/Hayden compliance document complete.

- ***September 1999***
  - Fieldwork -
    - Vista IV/Kibbey/Hayden/Vista I/Greenland/Imperial/Nankoweap
    - South Rim Pine (tbd) Burn Unit
  - Office –
    - August 1999 Summary
    - South Rim Pine (tbd) data entry and artifact processing
    - Fiscal 99 Summary
    - 2000 Annual Work Plan

OCTOBER 1, 1999 – Vista I/Greenland/Imperial/Nankoweap compliance documents complete.
South Rim Pine (to be determined) compliance document due.
Fiscal 2000 Annual Work Plan complete.

Prepared by:

Amy Horn-Wilson Date: Dec 17, 1998
Amy Horn-Wilson Archaeologist

Reviewed by:

Ken Kerr Date: 12/18/98
Ken Kerr Prescribed Fire Manager

Approved by:

Janet R. Balsom Date: 12/17/98
Janet R. Balsom Chief, Branch of Cultural Resources

Dan Oltrogge Date: 12/28/98
Dan Oltrogge Chief, Branch of Fire and Aviation

Survey Priorities (arranged by preferred burning schedule).
(After 10/21/98 meeting between Amy, Ken and Kim)

Survey Block	Compliance Due	Burning Dates
N Rim Mechanical	Jan 1, 1999	ongoing
Horsethief Sub-Unit 3	April 1, 1999	Spring 1999
Shoshone	March 1, 1999	Spring 1999
Outlet	July 1, 1999	Late Su-Fall 1999
NWIV	August 1, 1999	Late Su-Fall 1999
Vista IV/Kibbey/Hayden	Sept 1, 1999	Fall 1999
Vista I/Greenland/Imperial/Nanko	Oct 1, 1999	Fall 1999
**Horsethief Sub-Units 1,2,4,5	April 1, 2000	Spr 2000
South Rim Pine (tbd)	Oct 1, 1999	Spr 2000
**Pasture	April 1, 2000	Sum 2000
**Sublime/Walla Valley	Aug 1, 2000	Fa 2000
**Uncle Jim	Aug 1, 2000	Fa 2000
**Boundary	Aug 1, 2000	Fa 2000

** = timelines for compliance are based on burning preference. All of these surveys will not be completed on schedule with current personnel.

Anticipated Project Schedule
RX Fire Archaeology (crew of 3)
Fiscal 1999

	Oct 98	Nov 98	Dec 98	Jan 99	Feb 99	Mar 99	April 99	May 99	June 99	July 99	Aug 99	Sept 99
Nrim Mechanical												
Horsethief 3 Field												
Horsethief 3 Office												
Shoshone Field												
Shoshone Office												
South Rim Pine Field												
South Rim Pine Office												
Outlet Field												
Outlet Office												
NWIV Field												
NWIV Office												
VistaIV/Ki/H Field												
VistaIV/Ki/H Offic												

Grand Canyon National Park

Projected Timeframe for RX Fire Project Archaeological Clearance

Burn Unit	Proposed Burn Date	Total Acreage	Sample %	Total Survey Acreage	Previous Survey Acreage	Acreage to Survey	Survey Rate (acres per person/day)	Survey Time (person days)	Field Time for crew of 3	Office Time for crew of 3
[illegible]right Angel Pt Mechanical	[illegible]ongoing	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]day	1week
[illegible]orsethief Sub-Unit 3	[illegible] Spring 1999	2200 (373 pondo)	100 in pondo; 20 in p/j	740		740	5-10	[illegible]	5-10 weeks	0 weeks
Shoshone	Spring 1999	1058	50	529	0	529	[illegible]	[illegible]05	[illegible]7 weeks	[illegible]weeks
Outlet (Outlet, Widforss, Trail [illegible] nd II, Dragon Land II)	Late Su-Fall 1999	9959	20	1991	808	1183	[illegible]	[illegible]	[illegible]4 weeks	[illegible]weeks
[illegible]/IV	Late Su-Fall 1999	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Vista IV/Kibbey/Hayden	Fall 1999	902	20	180	81	99	[illegible]	[illegible]	1week	2 weeks
Greenland/Vista I/Sam [illegible]	Fall 1999	776	20	156	0	156	[illegible]	[illegible]	1week	1week
Imperial/Na[illegible]kowEap	Fall 1999	1465	20	293	0	293	[illegible]	[illegible]	2 weeks	2 weeks
Rim Mech[illegible]anical	[illegible]ongoing	100/year	100	100	tbd	100	[illegible]	[illegible]	1week	1week
Long Jim I	[illegible]	1526	50	763	tbd 100?	663?	[illegible]	[illegible]	3 weeks	3 weeks
Horsethief Sub-Unit 1	Spr 2000	998 (270 pondo	100 in pondo; 20 in p/j	415		415	5-10	42-83	3-6 weeks	6 weeks
Horsethief Sub-Unit 2	Spr 2000	845 (370 pondo)	100 in pondo; 20 in p/j	465		465	5-10	47-93	3-6 weeks	6 weeks
Horsethief Sub-Unit 4	Spr 2000	419 (91 pondo)	100 in pondo; 20 in p/j	157		157	5-10	16-32	2-3 weeks	3 weeks
Horsethief Sub-Unit 5	Spr 2000	917 (199 pondo	100 in pondo; 20 in p/j	342		342	5-10	35-69	3-5 weeks	5 weeks
[illegible]asture	Sum 2000	4200		2100?	tbd - 100?	2000?	10	200	14 weeks	10 weeks
[illegible]ublime II/Walla Valley	Fa 2000	1316								
Sublime I	Fa 2000	8555								
Uncle Jim/Fuller/Roaring	Fa 2000	3222			tbd					
[illegible]oundary	Fa 2000	approx 8300	20	1660	tbd	1660	20-25	67-83	4-6 weeks	6 weeks
Long Jim III	Spr 2001	1264								
Long Jim II	Spr 2002	4752								

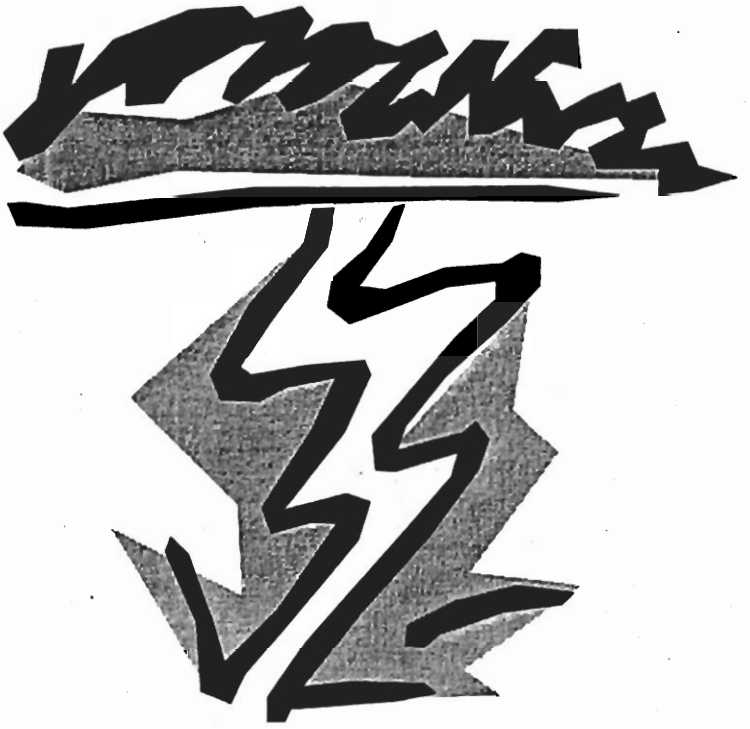
[illegible] = To be completed by Oct 1, 1999
[illegible] = To be completed by Spring 2000

Maximum thru 9/99	29 weeks	28 weeks
10/99-3/00	20 weeks	20 weeks

The survey acreages of these units will be revised based on a stratified sampling strategy. Units [illegible]ill be stratified based on vegetation, slope, drainages, and historic records.
[illegible]hoshone and Long Jim I Burn Units currently show the maximum acreage to be surveyed.
[illegible]d = to be determined

Document Update: December 17, 1998

Appendix C: Grand Canyon National park Fuel Moisture and Fire Weather Monitoring Program

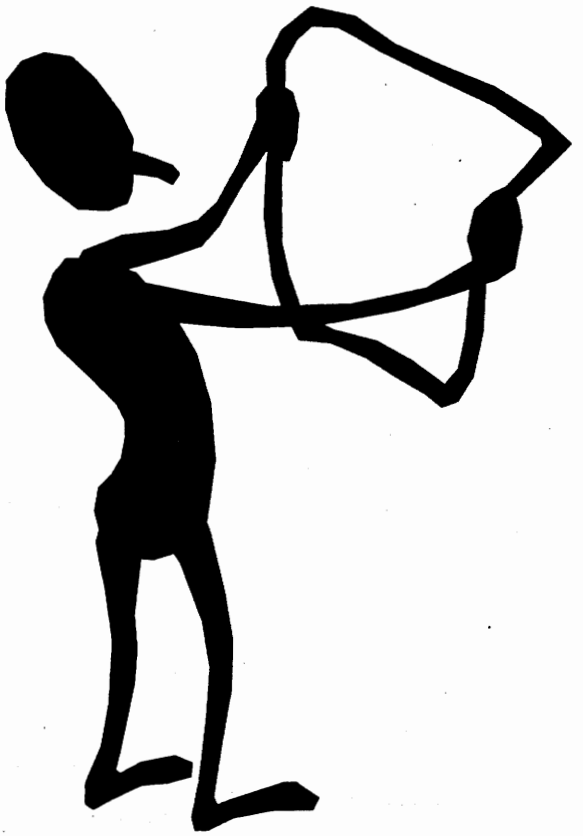


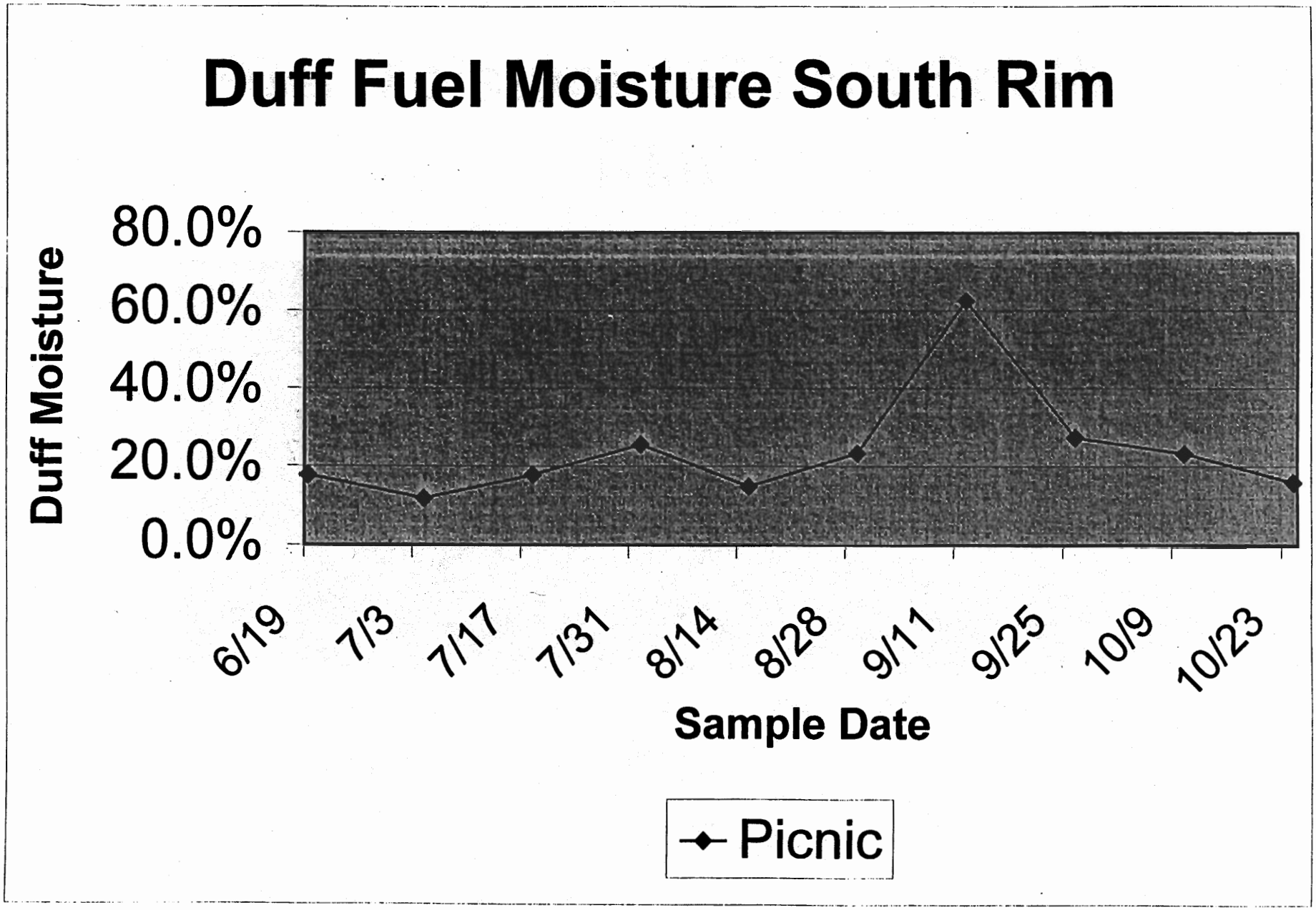
Grand Canyon National Park
Branch of Fire and Aviation Management
Fuel Moisture and Fire Weather Monitoring Plan

Station Name/ID	Location Elevation	R I M	Litter/ Duff	10 hour TLFM	1000 hour TLFM	Live FM	Wx Station	Rain Gauge	Hygro
Bright Angel 020211	NRim Helibase 8300'	North	NO	Yes RAWS	Yes RAWS	No	RAWS	N	N
Lindberg 020220	Lindberg Hill 8800'	North	NO	Yes RAWS	Yes RAWS	No	RAWS	N	N
Tower	NRim Entrance Tower 9165'	North	Duff Only	No	5 min.	No	Manual	Y	N
Walhalla 020222	Walhalla Plateau 8332'	North	Duff Only	Yes RAWS	5 min.	QUGA 5 min.	RAWS Hygro if RAWS moved	Y	N
Swamp Ridge	Swamp Ridge Road 7960'	North	Duff Only	NO	5 min.	QUGA 5 min.	Manual	Y	N
South Gate	South Gate Road 7000'	South	Duff Only	NO	5 min.	No	Manual	Y	Y
Tusayan 020207	Tusayan USFS	South	No	Yes RAWS	Yes RAWS	No	RAWS	N	N

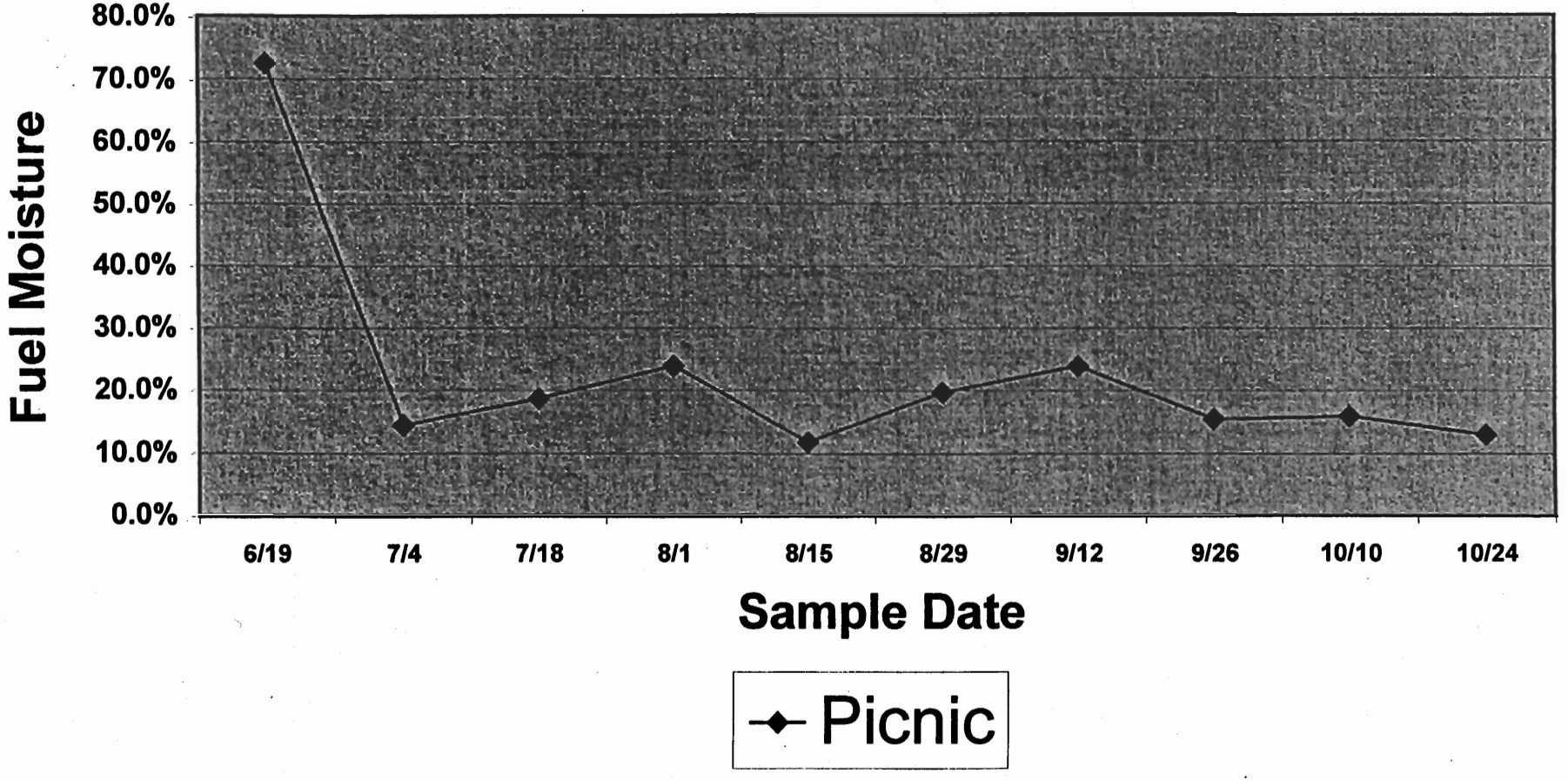
6/12/98
Fire:planning

Appendix D: Year End Summary: Fuel Moistures Live and Dead

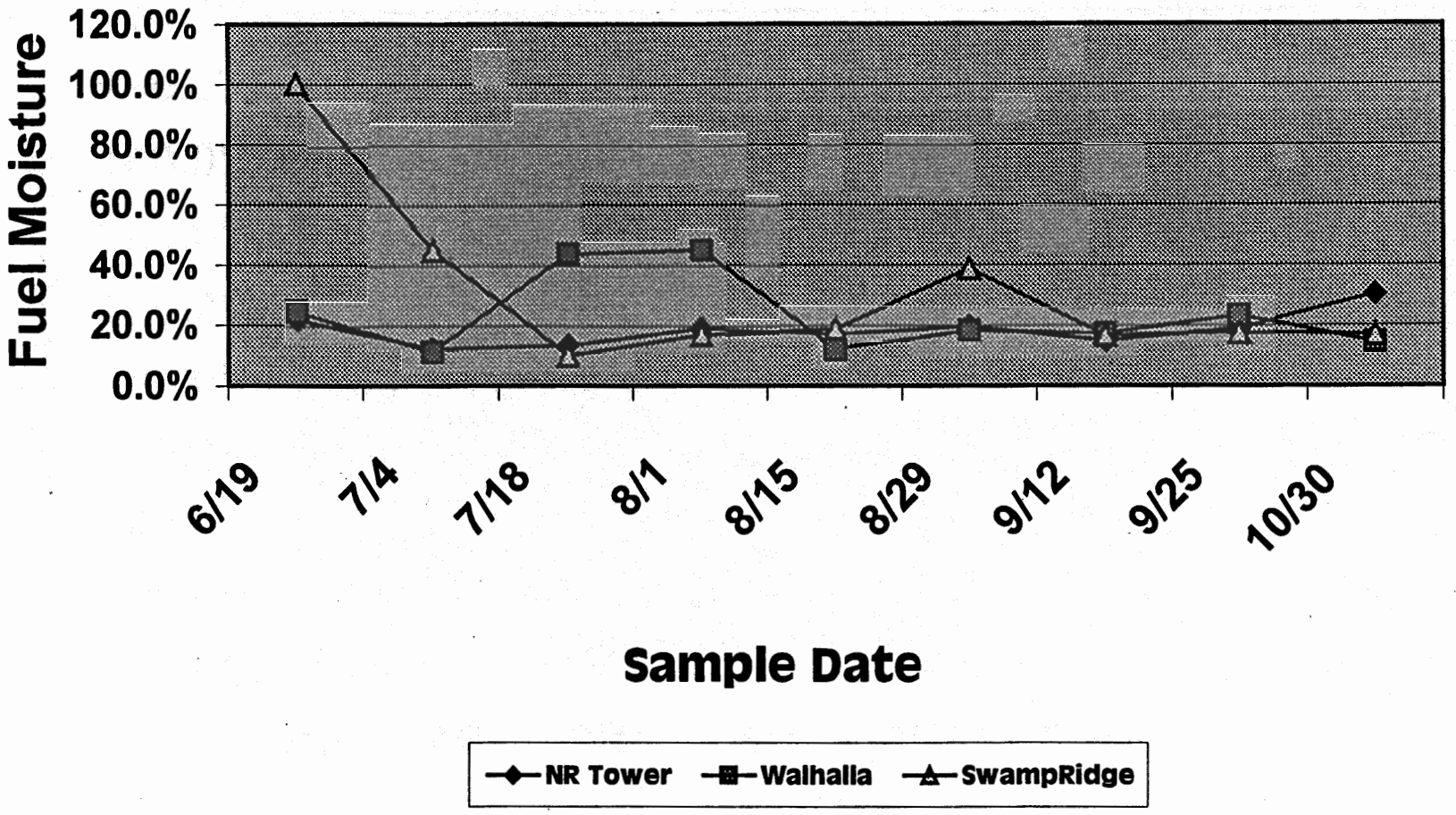


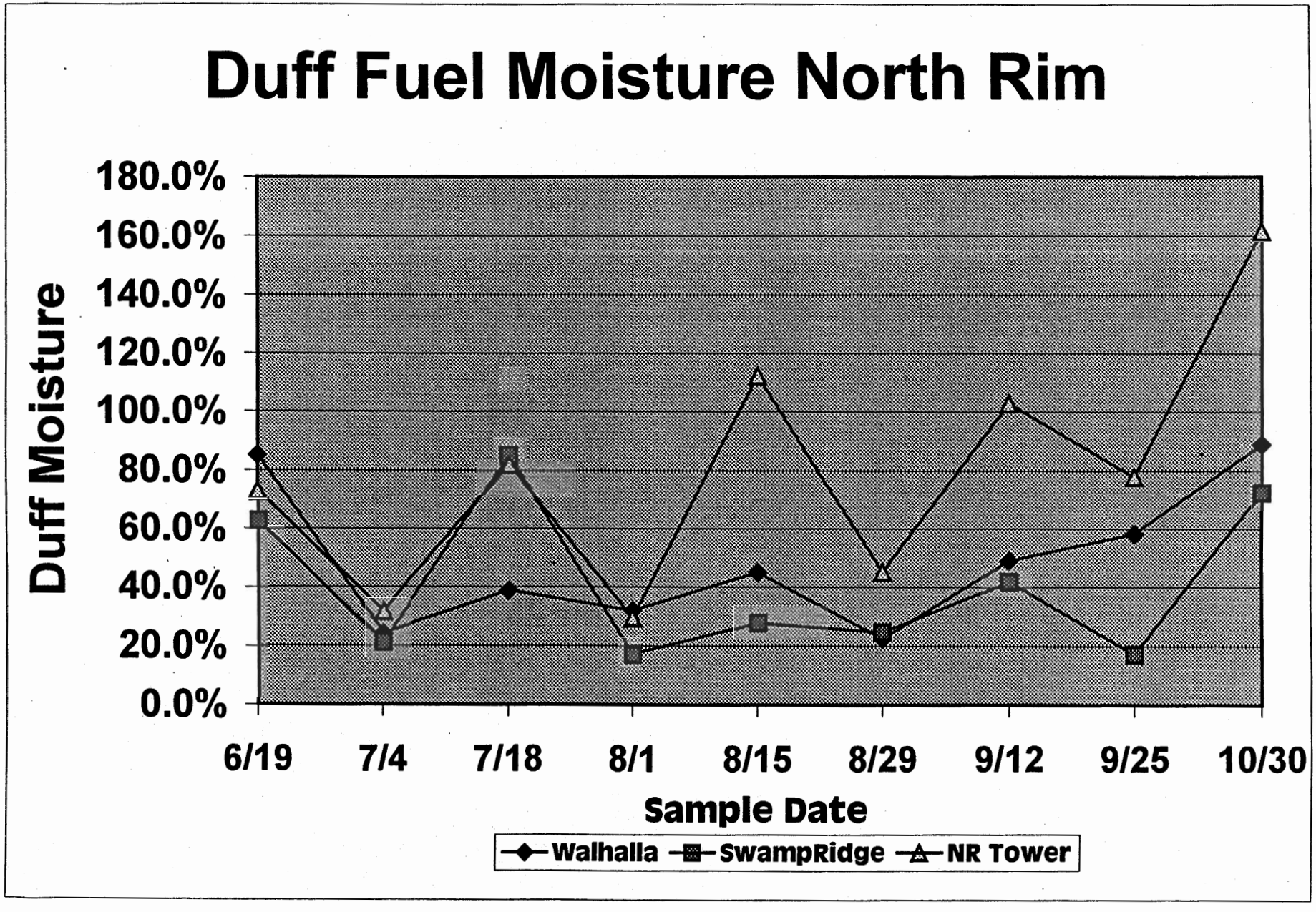

Duff Fuel Moisture South Rim
Duff Moisture
80.0%
60.0%
40.0%
20.0%
0.0%
6/19
7/3
7/17
7/31
8/14
8/28
9/11
9/25
10/9
10/23
Sample Date
Picnic

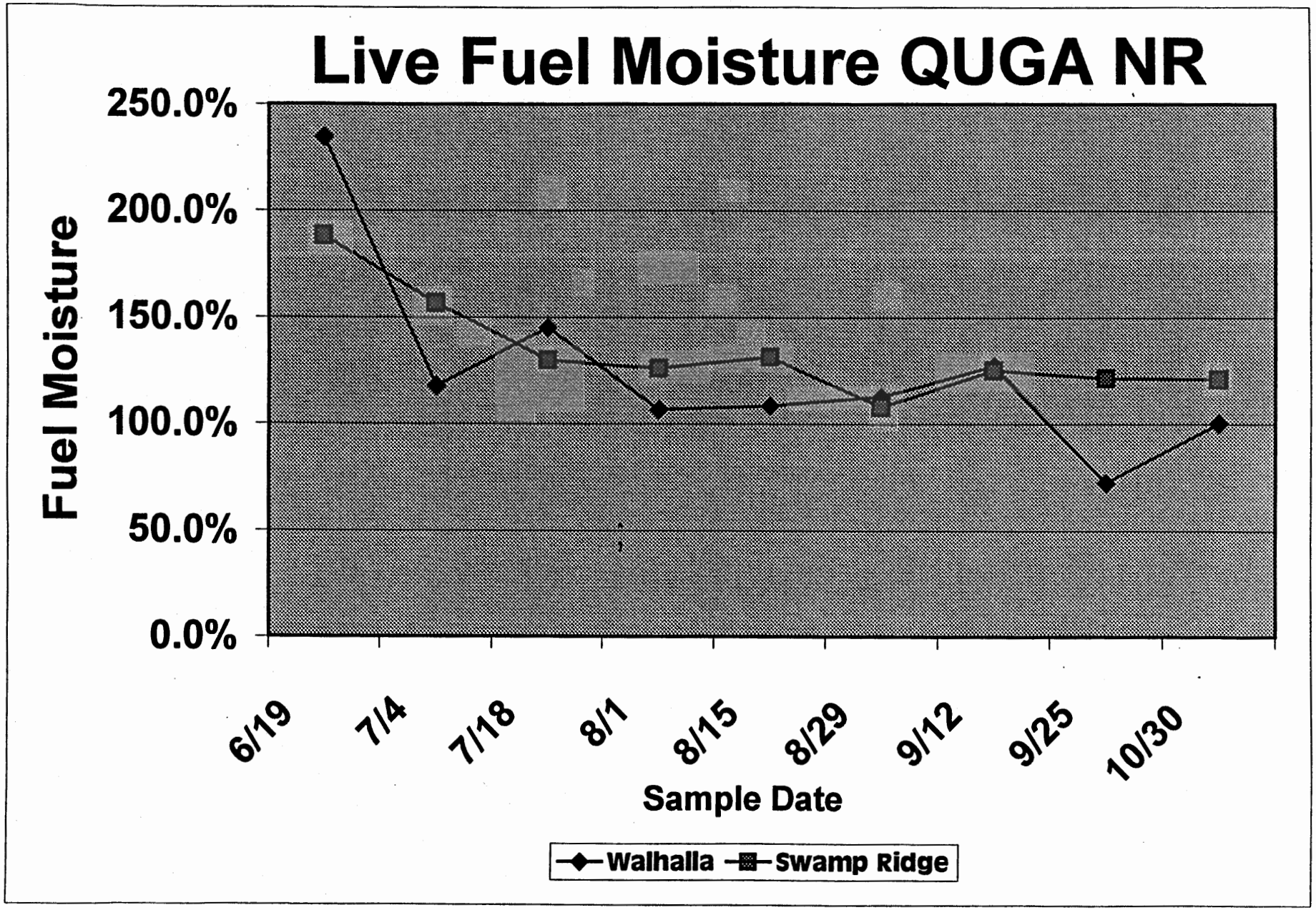
Fuel Moisture 1000-HR South Rim



Fuel Moisture 1000-HR North Rim




Duff Fuel Moisture North Rim
Duff Moisture
180.0%
160.0%
140.0%
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
6/19
7/4
7/18
8/1
8/15
8/29
9/12
9/25
10/30
Sample Date
Walhalla
SwampRidge
NR Tower


Live Fuel Moisture QUGA NR
Fuel Moisture
250.0%
200.0%
150.0%
100.0%
50.0%
0.0%
6/19
7/4
7/18
8/1
8/15
8/29
9/12
9/25
10/30
Sample Date
Walhalla
Swamp Ridge

Appendix E: 5-Year Burn Plan and South Rim Burn Rotation Schedule

GRAND CANYON NATIONAL PARK
FIVE YEAR BURN PLAN

FISCAL YEAR	SACS #	ADEQ #	PROJECT NAME	PRIORITY	ACRES TO BE TREATED	SEASON OF BURN	WILDLIFE CLEARANCE	ARCHEOLOGY CLEARANCE
1999	9901	O220	NORTH RIM MECHANICAL	1	150	ALL	UPDATE	UPDATE
1999	9902	O219	WALHALLA	2	1500	SP/S/F	MSO	UPDATE
1999	9903	O209	WIDFORSS	3	800	S/F	MSO	UPDATE
1999	9904	O208	TIYO 1	4	400	S/F	MSO	UPDATE
1999	9905	O125	HORSETHIEF	5	500	ALL	UPDATE	TBC
1999	9906	O129	SHOSHONE	6	1300	SP/S/F	UPDATE	TBC
1999	9907	O121	LONETREE	7	400	SP/S/F	UPDATE	UPDATE
1999	9908	O128	SOUTH RIM MECHANICAL	8	100	ALL	UPDATE	TBC
1999	9909	O206	NORTHWEST IV	9	314	S/F	UPDATE	UPDATE
TOTAL ACRES					**6464**			

NOTES:

1. **SEASON OF BURN: SP - SPRING; S = SUMMER; F = FALL; ALL = ALL SEASONS**
2. **WILDLIFE CLEARANCES: MSO = MEXICAN SPOTTED OWL; U = UPDATE SURVEYS FOR SPECIES OF CONCERN**
3. **ARCHEOLOGICAL CLEARANCES: U = UPDATE OF PAST CLEARANCE; TBC = TO BE COMPLETED**
4. THIS PLAN WILL SERVE AS A GUIDE FOR PLANNING PRESCRIBED FIRE PROJECTS AT GRAND CANYON NATIONAL PARK. THE ACTUAL YEAR A PROJECT IS COMPLETED WILL BE DEPENDENT ON A VARIETY OF FACTORS INCLUDING CURRENT WILDLAND FIRE LOAD, PROJECT PRESCRIPTION PARAMETERS, AND COMPLETION OF NEPA PROJECT CLEARANCES.
5. PRIORITIES FOR CLEARANCES WILL BE COORDINATED THROUGH THE PRESCRIBED FIRE MANAGER
6. INCOMPLETE PROJECTS WILL BE MOVED TO THE NEXT FISCAL YEAR

FISCAL YEAR	SACS #	ADEQ #	PROJECT NAME	PRIORITY	ACRES TO BE TREATED	SEASON OF BURN	WILDLIFE CLEARANCE	ARCHEOLOGY CLEARANCE
2000	OOO1	O220	NORTH RIM MECHANICAL	1	150	ALL	U	U
2000	OOO2	O219	WALHALLA	2	2000	SP/S/F	U	U
2000	OOO3	O128	SOUTH RIM MECHANICAL	3	100	ALL	U	TBC
2000	OOO4	O125	HORSETHIEF	4	500	SP/S/F	U	TBC
2000	OOO5	0XXX	SOUTH RIM PINE PROJECT	5	1500	SP/S/F	U	TBC
2000	OOO6	O222	OUTLET	6	2000	SP/S/F	U	TBC
2000	OOO7	O223	CC HILL	7	80	S/F	U	U
2000	OOO8	O224	COVINGTON NORTH RIM	8	60	S/F	U	U
2000	OOO9	O130	COVINGTON SOUTH RIM	9	60	S/F	U	U
2000	OO10	O225	BOUNDARY	10	250	ALL	U	TBC
2000	OO11	O207	VISTA IV/KIBBEY/HAYDEN	11	902	S/F	U	TBC
TOTAL ACRES					**7602**			

OUTLET PROJECT CONSISTS OF SUBUNITS: TIYO II; DRAGON 1,2,3; OUTLET; WIDFORSS; TIYO1

GRAND CANYON NATIONAL PARK
FIVE YEAR BURN PLAN

FISCAL YEAR	SACS #	ADEQ #	PROJECT NAME	PRIORITY	ACRES TO BE TREATED	SEASON OF BURN	WILDLIFE CLEARANCE	ARCHEOLOGY CLEARANCE
2001	O101	O220	NORTH RIM MECHANICAL	1	150	ALL	U	U
2001	O102	O219	WALHALLA	2	2000	SP/S/F	U	U
2001	O103	O128	SOUTH RIM MECHANICAL	3	100	ALL	U	TBC
2001	O104	O225	BOUNDARY	4	250	S/F	U	U
2001	O105	O222	OUTLET	5	2000	SP/S/F	U	U
2001	O106	O125	HORSETHIEF	6	500	SP/S/F	U	U
2001	O107	0XXX	SOUTH RIM PINE PROJECT	7	1000	SP/S/F	U	U
2001	O108	O209	SUBLIME/WALLA VALLEY	8	1000	SP/S/F	U	U
2001	O109	O117	WATSON I	9	300	SP/S/F	U	U
2001	O110	O226	VISTA I/GREENLAND	10	679	S/F	U	TBC
2001	O111	O131	PASTURE	11	500	ALL	U	TBC
TOTAL ACRES					**8479**			

NOTES:

1. **SEASON OF BURN: SP - SPRING; S = SUMMER; F = FALL; ALL = ALL SEASONS**
2. **WILDLIFE CLEARANCES: MSO = MEXICAN SPOTTED OWL; U = UPDATE SURVEYS FOR SPECIES OF CONCERN**
3. **ARCHEOLOGICAL CLEARANCES: U = UPDATE OF PAST CLEARANCE; TBC = TO BE COMPLETED**
4. THIS PLAN WILL SERVE AS A GUIDE FOR PLANNING PRESCRIBED FIRE PROJECTS AT GRAND CANYON NATIONAL PARK. THE ACTUAL YEAR A PROJECT IS COMPLETED WILL BE DEPENDENT ON A VARIETY OF FACTORS INCLUDING CURRENT WILDLAND FIRE LOAD, PROJECT PRESCRIPTION PARAMETERS, AND COMPLETION OF NEPA PROJECT CLEARANCES.
5. PRIORITIES FOR CLEARANCES WILL BE COORDINATED THROUGH THE PRESCRIBED FIRE MANAGER
6. INCOMPLETE PROJECTS WILL BE MOVED TO THE NEXT FISCAL YEAR
7. SUBLIME/WALLA VALLEY UNIT CONSISTS OF SUBUNITS: SUBLIME I & II; WALLA VALLEY; EXCALIBUR; KANABOWNITS.

FISCAL YEAR	SACS #	ADEQ #	PROJECT NAME	PRIORITY	ACRES TO BE TREATED	SEASON OF BURN	WILDLIFE CLEARANCE	ARCHEOLOGY CLEARANCE
2002	O201	O220	NORTH RIM MECHANICAL	1	100	ALL	U	U
2002	O202	O128	SOUTH RIM MECHANICAL	2	100	ALL	U	TBC
2002	O203	O219	WALHALLA	3	2000	SP/S/F	U	U
2002	O204	O222	OUTLET	4	2000	SP/S/F	U	U
2002	O205	O225	BOUNDARY	5	500	S/F	U	U
2002	O206	O110	SUBLIME	6	1000	SP/S/F	U	U
2002	O207	O132	LONG JIM III	7	1962	SP/S/F	U	TBC
2002	O208	O103	ENTRANCE/QUARRY	8	904	SP/S/F	U	U
TOTAL ACRES					**8566**			

FMH-4 MONITORING TYPE DESCRIPTION SHEET
Grand Canyon National Park

Monitoring Type Code: FPIPN1D09

Monitoring Type Name: North Rim Ponderosa Pine

Prepared by: Tonja Opperman and Ken Kerr

Date: March 17, 1999

PHYSICAL DESCRIPTION

Located at 6,900 to 8,900 feet elevation on the North Rim with slopes from 0% to 60%, including all aspects and depending on elevation. Soils are moderately shallow on ridgetops with silty loams occurring in drainage bottoms. All soils are derived from Kaibab limestone parent material.

BIOLOGICAL DESCRIPTION

Total canopy cover is at least 25%. *Pinus ponderosa* dominates the overstory[1], comprising at least 80% of overstory species. Other possible overstory species include occasional *Abies concolor, Populus tremuloides, Pseudotsuga menziesii,* and *Picea engelmanni.* The understory is composed of mostly (75% or more) *Pinus ponderosa* poles. Common brush species are *Berberis repens, Rosa fendleri,* and *Ceanothus fendleri.* Common herbaceous plants include *Achillia lanulosa, Carex* spp., *Poa fendleriana, Sitanion hystrix,* and *Viguiera multiflora.*

REJECTION CRITERIA

Large rock outcroppings or barren areas >20% of the plot; areas with anomalous vegetation, boundary fences; areas within 30 meters of roads, utility corridors, human-created trails, human-created clearings, or slash piles; areas within 10 meters of significant historic or prehistoric sites or transitional ecotones; areas burned in the last 10 years; areas with >20% overstory cover of trees other than ponderosa pine; areas with pole densities including >25% species other than ponderosa pine.

DESIRED FUTURE CONDITION

At this time a literature search has been initiated to determine the desired future condition of North Rim *Pinus ponderosa* at Grand Canyon National Park, but it is not complete. These forests were likely open stands with relatively few, large overstory trees, dominated by an herbaceous understory. Research suggests in one study that there were 56 *Pinus ponderosa* trees per acre (138 trees/ha) in North Rim *Pinus ponderosa* stands (Covington 1992), and in another study that there were 40-55 trees/acre (99-136 trees/ha) on the Kaibab Plateau during presettlement times. Fuel loads ranged from 0.2 to 9.3 tons/acre (0.5-23 tons/ha) (Covington 1992). Pole-sized trees less than six inches in diameter (15 cm) were estimated to be in groups of 200-400 but no density figures are given (Rasmussen 1941). The fire frequency on the North Rim is estimated at 2 to 15 years for these elevations (Wolf and Mast 1998) but this study did not incorporate forests on the very southernmost parts of the plateaus. It is likely that the forests on the edges of the North Rim plateaus were less dense due to drier conditions and more frequent lightning-caused fires.

[1] Overstory trees are defined in the Fire Monitoring program as trees with a diameter at breast height of 15 cm (6 in) or greater. This definition does not take individual tree dominance or crown position into account.

Fire Prescription Elements	
RH = 10-80%	Live Fuel Moisture = n/a
Dry Bulb = 40-80 F	Average Flame Length = 1-10 feet
Average Mid-flame Winds=0-15mph G30mph	Average Rate of Spread = 1-40 chs/hour
10-hour TLFM = 3-15%	1000-hour TLFM = 9-25%

PRESCRIBED FIRE PROJECT OBJECTIVES—First Entry Burn

Immediately Post-Burn:

1. Reduce average woody (dead and down) preburn fuel load over landscape, with average percent reductions in the following size classes:
   a) 1-hour fuel size class reduction by 40-100% (currently 0.1 t/ac, 0.2 t/ha)
   b) 10-hour fuel size class reduction by 40-100% (currently 0.7 t/ac, 1.7 t/ha)
   c) 100-hour fuel size class reduction by 40-100% (currently 1.0 t/ac, 2.5 t/ha)
   d) 1000-hour fuel size class reduction by 40-80% (currently 2.3 t/ac, 5.8 t/ha)

2. Limit crown scorch to 30% on *Pinus ponderosa* with dbh greater than or equal to 16" (40 cm).

Two Years Post-Burn:

1. Reduce *Pinus ponderosa* poles with dbh of 1-6 inches (2.5-15 cm) to average 0-200 trees/acre (0-494 trees/ha). *This is a conservative target and more research is needed to define a better pole density target; there are currently 0-730 poles/ac (0-1800 poles/ha) of* Pinus ponderosa *in this size class.*

Five Years Post-Burn

1. Limit mortality of *Pinus ponderosa* with dbh greater than or equal to 16 inches (40 cm) to 20%. *Pre-burn densities for* Pinus ponderosa *in this size class average 20 trees/acre (49 trees/ha).*

PRESCRIBED FIRE PROJECT OBJECTIVES—Second Entry Burn

Objectives will be written for this section, once results from first entry burn are known.

PRESCRIBED FIRE PROJECT OBJECTIVES—Third Entry Burn

Objectives will be written for this section, once results from first and second entry burns are known.

FIRE MONITORING OBJECTIVES

1. Install enough plots to be 80% confident that overstory ponderosa pine density figures are within 20% of the true population mean.
2. Install enough plots to be 80% confident that total fuel load estimates are within 20% of the true population mean.
3. With less than 30 plots, estimate pole densities with the most confidence possible. At this time over 70 plots are needed to monitor poles due to a high variation in the preburn pole densities.

GRAND CANYON NATIONAL PARK
FIVE YEAR BURN PLAN

FISCAL YEAR	SACS #	ADEQ #	PROJECT NAME	PRIORITY	ACRES TO BE TREATED	SEASON OF BURN	WILDLIFE CLEARANCE	ARCHEOLOGY CLEARANCE
2003	O301	O220	NORTH RIM MECHANICAL	1	100	ALL	U	U
2003	O302	O128	SOUTH RIM MECHANICAL	2	100	ALL	U	TBC
2003	O303	O219	WALHALLA	3	2000	SP/S/F	U	U
2003	O304	O222	OUTLET	4	2000	SP/S/F	U	U
2003	O305	O225	BOUNDARY	5	1000	S/F	U	U
2003	O306	O209	SUBLIME	6	1000	SP/S/F	U	U
2003	O307	O132	LONG JIM I	7	1526	SP/S/F	U	TBC
2003	O308	O134	GRANDVIEW	8	800	SP/S/F	U	TBC
2003	O309	O122	WATSON IV	9	575	SP/S/F	U	U
2003	O310	O135	MESCALERO	10	500	SP/S/F	U	TBC
TOTAL ACRES					**9601**			

NOTES:

1. **SEASON OF BURN: SP - SPRING; S = SUMMER; F = FALL; ALL = ALL SEASONS**
2. **WILDLIFE CLEARANCES: MSO = MEXICAN SPOTTED OWL; U = UPDATE SURVEYS FOR SPECIES OF CONCERN**
3. **ARCHEOLOGICAL CLEARANCES: U = UPDATE OF PAST CLEARANCE; TBC = TO BE COMPLETED**
4. THIS PLAN WILL SERVE AS A GUIDE FOR PLANNING PRESCRIBED FIRE PROJECTS AT GRAND CANYON NATIONAL PARK. THE ACTUAL YEAR A PROJECT IS COMPLETED WILL BE DEPENDENT ON A VARIETY OF FACTORS INCLUDING CURRENT WILDLAND FIRE LOAD, PROJECT PRESCRIPTION PARAMETERS, AND COMPLETION OF NEPA PROJECT CLEARANCES.
5. PRIORITIES FOR CLEARANCES WILL BE COORDINATED THROUGH THE PRESCRIBED FIRE MANAGER
6. INCOMPLETE PROJECTS WILL BE MOVED TO THE NEXT FISCAL YEAR

FISCAL YEAR	SACS #	ADEQ #	PROJECT NAME	PRIORITY	ACRES TO BE TREATED	SEASON OF BURN	WILDLIFE CLEARANCE	ARCHEOLOGY CLEARANCE
2004	O401	O220	NORTH RIM MECHANICAL	1	100	ALL	U	U
2004	O402	O128	SOUTH RIM MECHANICAL	2	100	ALL	U	TBC
2004	O403	O219	WALHALLA	3	2000	SP/S/F	U	U
2004	O404	O222	OUTLET	4	2000	SP/S/F	U	U
2004	O405	O225	BOUNDARY	5	2000	S/F	U	U
2004	O406	O110	SUBLIME	6	1000	SP/S/F	U	U
2004	O407	O132	LONG JIM II	7	1264	SP/S/F	U	TBC
2004	O408	O227	RANGE	8	500	S/F	U	TBC
2004	O409	O119	GRAPEVINE/RX-300	9	922	SP/S/F	U	U
2004	O410	O133	MESCALERO	10	500	SP/S/F	U	TBC
TOTAL ACRES					**10386**			

Needed Information when Reviewing South Rim Burn Rotation

1. Desired Future Conditions (DFC) have not yet been established for GRCA monitoring types for South Rim Ponderosa Pine or Pinyon Juniper Fuel Types. When adopted, this burn plan will reflect these DFC.
2. Objectives/standards for Pinyon Juniper plots have not been developed yet. Current agreements with park botanist state that only 10 – 15% mortality of brush/grass species in PJ fuel type is acceptable. Burn rotation reflects this.
3. This burn rotation is set for FY99. It is flexible for all other FY.
4. Highlighted and Italic texts are for plans that are not yet written. Highlighted names of plans are plans that have been assigned to personnel.
5. Season of Burn: SP = Spring; S = Summer; F = Fall; All = All seasons
6. Wildlife Clearances: MSO = Mexican Spotted Owl; U = Update surveys for species of concern
7. Archeological clearances: U= Update of past clearance; TBC = To Be Completed
8. This plan will serve as a guide for planning prescribed fire projects at GRCA NP. The actual year a project is completed will be dependent on a variety of factors including current wildland fire load, project prescription parameters, and completion of NEPA project clearances.
9. Priorities for clearances will be coordinated through the Prescribed Fire Manager.
10. Incomplete projects will be moved to the next Fiscal Year.
11. Names of burn projects reflect current project map.

Name of Prescribed Fire Burn Plan	*Whom the Plan is assigned to*
South Rim Mechanical	D.Ottosen
Shoshone	K.Van Hemelryck
Picnic/Long Jim I,II,III	D.Hamrick
Village	T.Oppelman

South Rim 18-year Burn Plan *MASTER (PP & PJ)*	Fiscal Year	SACS#	ADEQ#	Project Name	Fuel Type	Acres to be treated	Season of Burn	Wildlife Clearance	Archeology Clearance
	1999	9905	0125	Horsethief	PP	500	ALL	Update	TBC
	1999	9906	0129	*Shoshone*	PP	1300	SP/S/F	Update	TBC
	1999	9907	0121	Lonetree	PP	400	SP/S/F	Update	Update
	1999	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
FY99 TOTAL ACRES						**2300**			
	2000	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2000			*Picnic*	*PP*	231	SP/S/F	Update	Update
	2000			*Entrance*	*PP*	693	SP/S/F	Update	Update
	2000			*Quarry*	*PP*	341	SP/S/F	Update	Update
	2000			*Village*	*PP*	110	SP/S/F	Update	Update
	2000	9905	0125	Horsethief	PP	1000	ALL	Update	TBC
FY00 TOTAL ACRES						**2475**			
	2001	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2001	9905	0125	Horsethief	PP	500	ALL	Update	TBC
	2001			*Hance*	PP	406	SP/S/F	Update	Update
	2001		0117	Watson 1	PP	297	SP/S/F	Update	Update
	2001			*Long Jim III*	PP	1675	SP/S/F	Update	TBC
	2001		0131	*Pasture*	PJ	1000	ALL	Update	TBC
FY01 TOTAL ACRES						**3978**			
	2002	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2002			*Watson iii*	PP	712			Update
	2002		0134	*Grandview*	PP	1129	SP/S/F	Update	TBC
	2002		0119	*Rx-300/GrapeVine*	PP	1243	SP/S/F	Update	Update
	2002			*Watson II*	PP	861	SP/S/F	Update	Update
	2002			*Lipan*	PJ	221	SP/S/F	Update	TBC
FY02 TOTAL ACRES						**4266**			

South Rim 18-year Burn Plan *MASTER (PP & PJ)*	Fiscal Year	SACS#	ADEQ#	Project Name	Fuel Type	Acres to be treated	Season of Burn	Wildlife Clearance	Archeology Clearance
	2003	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2003		0132	*Long Jim I*	PP	1695	SP/S/F	Update	Update
	2003		0122	*Watson IV*	PP	857	SP/S/F	Update	Update
	2003		0132	*Long Jim II*	PP	1730	SP/S/F	Update	Update
	2003		0135	*Mescalero*	PJ	1000	SP/S/F	Update	TBC
FY03 TOTAL ACRES						**5382**			
	2004	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2004			*Topeka*	PP	2115	SP/S/F	Update	Update
	2004			*Tusayan*	PP	572	SP/S/F	Update	Update
	2004	9907	0121	Lonetree	PP	892	SP/S/F	Update	Update
	2004			*Papago*	PJ	649	SP/S/F	Update	TBC
	2004			*Zuni*	PJ	334	SP/S/F	Update	TBC
FY04 TOTAL ACRES						**4662**			
	2005	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2005		0129	*Shoshone*	PP	1300	SP/S/F	Update	Update
	2005			*Moqui*	PP	841	SP/S/F	Update	Update
	2005			*Palasides*	PJ	1000	SP/S/F	Update	TBC
	2005			*Pit*	PJ	500	SP/S/F	Update	TBC
	2005			*Moran*	PJ	262	SP/S/F	Update	TBC
FY05 TOTAL ACRES						**4003**			

South Rim 18-year Burn Plan *MASTER (PP & PJ)*	Fiscal Year	SACS#	ADEQ#	Project Name	Fuel Type	Acres to be treated	Season of Burn	Wildlife Clearance	Archeology Clearance
	2006	9908	0128	SRim Mechanical	PP	100	ALL	Update	TBC
	2006			Picnic	PP	231	SP/S/F	Update	Update
	2006			Entrance	PP	693	SP/S/F	Update	Update
	2006			Quarry	PP	341	SP/S/F	Update	Update
	2006			Village	PP	110	SP/S/F	Update	Update
	2006		0125	Horsethief	PP	1000	ALL	Update	Update
	2006			Buggelin	PJ	507	SP/S/F	Update	TBC
FY06 TOTAL ACRES						2982			
	2007	9908	0128	SRim Mechanical	PP	100	ALL	Update	TBC
	2007	9905	0125	Horsethief	PP	1500	ALL	Update	Update
	2007			Hance	PP	406	SP/S/F	Update	Update
	2007		0117	Watson 1	PP	297	SP/S/F	Update	Update
	2007			Long Jim III	PP	1675	SP/S/F	Update	Update
	2007			SR PJ BURN	PJ	1000	ALL	Update	TBC
FY07 TOTAL ACRES						4978			
	2008	9908	0128	SRim Mechanical	PP	100	ALL	Update	TBC
	2008			Watson III	PP	712			Update
	2008		0134	Grandview	PP	1129	SP/S/F	Update	Update
	2008		0119	Rx-300/GrapeVine	PP	1243	SP/S/F	Update	Update
	2008			Watson II	PP	861	SP/S/F	Update	Update
	2008			SR PJ BURN	PJ	1000	ALL	Update	TBC
FY08 TOTAL ACRES						5045			
	2009	9908	0128	SRim Mechanical	PP	100	ALL	Update	TBC
	2009		0132	Long Jim I	PP	1695	SP/S/F	Update	Update
	2009		0122	Watson IV	PP	857	SP/S/F	Update	Update
	2009		0132	Long Jim II	PP	1730	SP/S/F	Update	Update
	2009			SR PJ BURN	PJ	1000	ALL	Update	TBC
FY09 TOTAL ACRES						5382			

South Rim 18-year Burn Plan *MASTER (PP & PJ)*	Fiscal Year	SACS#	ADEQ#	Project Name	Fuel Type	Acres to be treated	Season of Burn	Wildlife Clearance	Archeology Clearance
	2010	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2010			*Topeka*	PP	2115	SP/S/F	Update	Update
	2010			*Tusayan*	PP	572	SP/S/F	Update	Update
	2010	9907	0121	Lonetree	PP	892	SP/S/F	Update	Update
	2010			*SR PJ BURN*	PJ	1000	SP/S/F	Update	TBC
FY10 TOTAL ACRES						**4679**			
	2011	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2011		0129	*Shoshone*	PP	1300	SP/S/F	Update	Update
	2011			*SR PJ BURN*	PJ	1000	SP/S/F	Update	TBC
FY11 TOTAL ACRES						**2400**			
	2012	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2012			*Picnic*	PP	231	SP/S/F	Update	Update
	2012			*Entrance*	PP	693	SP/S/F	Update	Update
	2012			*Quarry*	PP	341	SP/S/F	Update	Update
	2012			*Village*	PP	110	SP/S/F	Update	Update
	2012		0125	Horsethief	PP	1000	ALL	Update	Update
	2012			*SR PJ BURN*	PJ	1000	ALL	Update	TBC
FY12 TOTAL ACRES						**3475**			

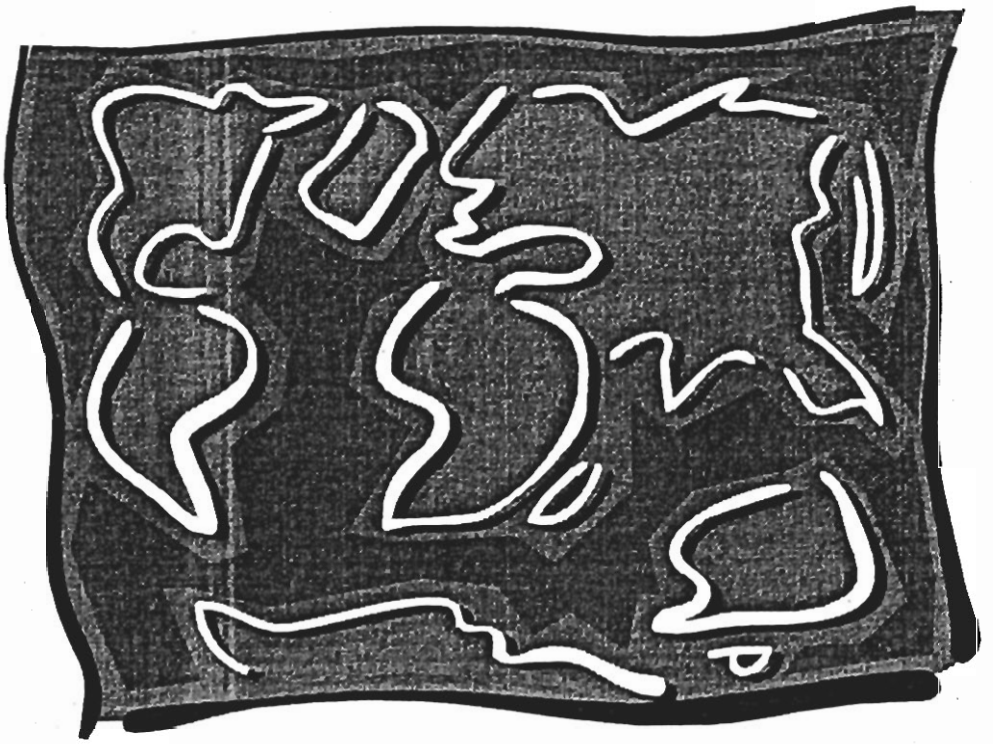
South Rim 18-year Burn Plan *MASTER (PP & PJ)*	Fiscal Year	SACS#	ADEQ#	Project Name	Fuel Type	Acres to be treated	Season of Burn	Wildlife Clearance	Archeology Clearance
	2013	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2013	9905	0125	Horsethief	PP	1500	ALL	Update	Update
	2013			***Hance***	PP	406	SP/S/F	Update	Update
	2013		0117	Watson 1	PP	297	SP/S/F	Update	Update
	2013			*Long Jim III*	PP	1675	SP/S/F	Update	Update
	2013			***SR PJ BURN***	PJ	1000	ALL	Update	TBC
FY13 TOTAL ACRES						**4978**			
	2014	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2014			***Watson III***	PP	712			Update
	2014		0134	***Grandview***	PP	1129	SP/S/F	Update	Update
	2014		0119	***Rx-300/GrapeVine***	PP	1243	SP/S/F	Update	Update
	2014			***Watson II***	PP	861	SP/S/F	Update	Update
	2014			***SR PJ BURN***	PJ	1000	ALL	Update	TBC
FY14 TOTAL ACRES						**5045**			
	2015	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2015		0132	*Long Jim I*	PP	1695	SP/S/F	Update	Update
	2015		0122	***Watson IV***	PP	857	SP/S/F	Update	Update
	2015		0132	*Long Jim II*	PP	1730	SP/S/F	Update	Update
	2015			***SR PJ BURN***	PJ	1000	ALL	Update	TBC
FY15 TOTAL ACRES						**5382**			

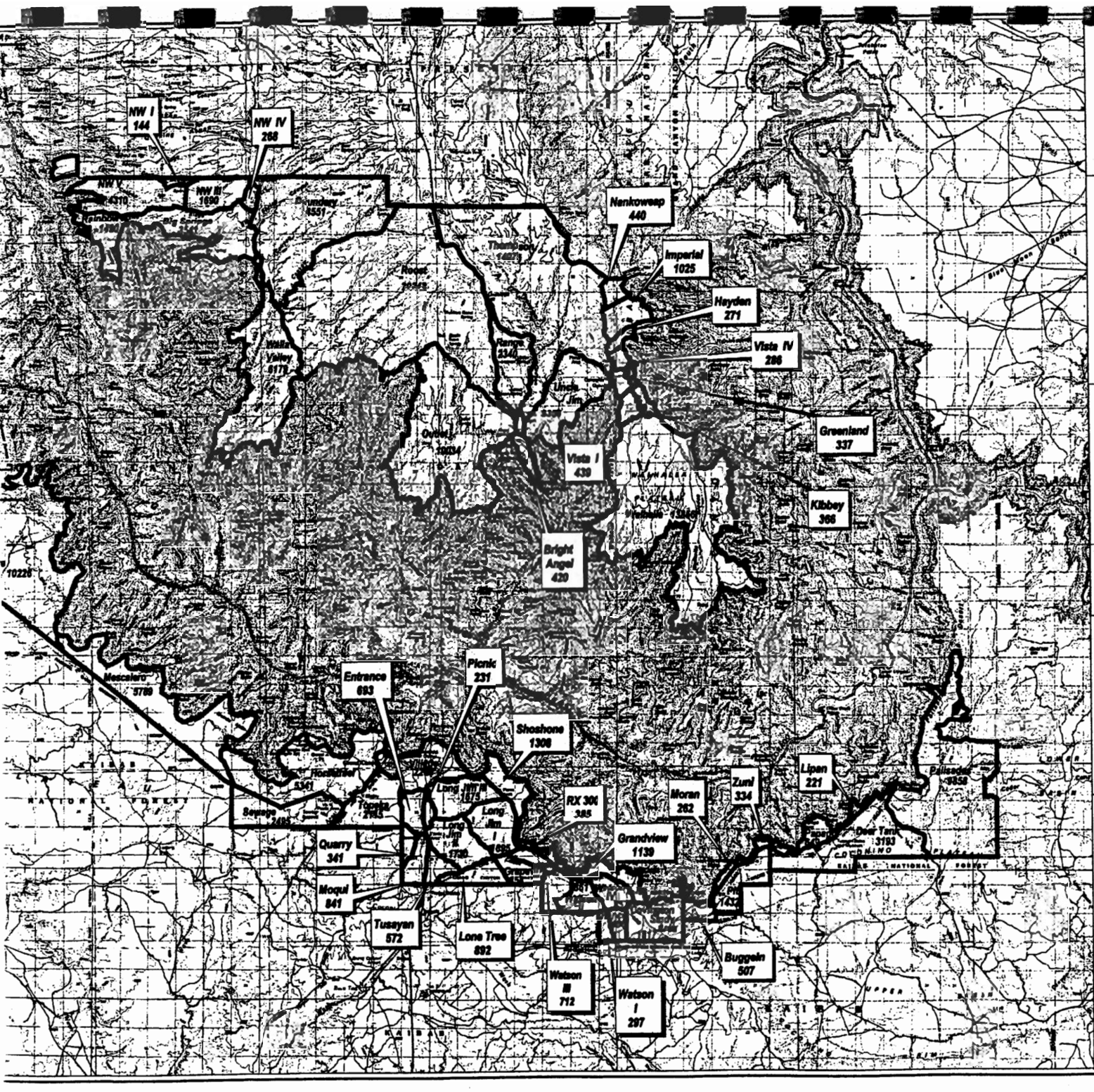
SRim Burn Rotation MASTER

South Rim 18-year Burn Plan *MASTER (PP & PJ)*	Fiscal Year	SACS#	ADEQ#	Project Name	Fuel Type	Acres to be treated	Season of Burn	Wildlife Clearance	Archeology Clearance
	2016	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2016			*Topeka*	PP	2115	SP/S/F	Update	Update
	2016			*Tusayan*	PP	572	SP/S/F	Update	Update
	2016	9907	0121	Lonetree	PP	892	SP/S/F	Update	Update
	2016			*SR PJ BURN*	PJ	1000	SP/S/F	Update	TBC
FY16 TOTAL ACRES						**4679**			
	2017	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2017		0129	*Shoshone*	PP	1300	SP/S/F	Update	Update
	2017			*SR PJ BURN*	PJ	1000	SP/S/F	Update	TBC
FY17 TOTAL ACRES						**2400**			
	2018	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2018			*Picnic*	PP	231	SP/S/F	Update	Update
	2018			*Entrance*	PP	693	SP/S/F	Update	Update
	2018			*Quarry*	PP	341	SP/S/F	Update	Update
	2018			*Village*	PP	110	SP/S/F	Update	Update
	2018		0125	Horsethief	PP	1500	ALL	Update	Update
	2018			*SR PJ BURN*	PJ	1000	SP/S/F	Update	TBC
FY18 TOTAL ACRES						**3975**			
	2019	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2019	9905	0125	Horsethief	PP	500	ALL	Update	Update
	2019			*Hance*	PP	406	SP/S/F	Update	Update
	2019		0117	Watson 1	PP	297	SP/S/F	Update	Update
	2019			*Long Jim III*	PP	1675	SP/S/F	Update	Update
	2019			*SR PJ BURN*	PJ	1000	ALL	Update	TBC
FY19 TOTAL ACRES						**3978**			

South Rim 18-year Burn Plan *MASTER (PP & PJ)*	Fiscal Year	SACS#	ADEQ#	Project Name	Fuel Type	Acres to be treated	Season of Burn	Wildlife Clearance	Archeology Clearance
	2020	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2020			*Watson III*	PP	712			Update
	2020		0134	*Grandview*	PP	1129	SP/S/F	Update	Update
	2020		0119	*Rx-300/GrapeVine*	PP	1243	SP/S/F	Update	Update
	2020			*Watson II*	PP	861	SP/S/F	Update	Update
	2020			*SR PJ BURN*	PJ	1000	ALL	Update	TBC
FY20 TOTAL ACRES						**5045**			
	2021	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2021		0132	*Long Jim I*	PP	1695	SP/S/F	Update	Update
	2021		0122	*Watson IV*	PP	857	SP/S/F	Update	Update
	2021		0132	*Long Jim II*	PP	1730	SP/S/F	Update	Update
	2021			*SR PJ BURN*	PJ	1000	ALL	Update	TBC
FY21 TOTAL ACRES						**5382**			
	2022	9908	0128	*SRim Mechanical*	PP	100	ALL	Update	TBC
	2022			*Topeka*	PP	2115	SP/S/F	Update	Update
	2022			*Tusayan*	PP	572	SP/S/F	Update	Update
	2022	9907	0121	Lonetree	PP	892	SP/S/F	Update	Update
	2022			*SR PJ BURN*	PJ	221	SP/S/F	Update	TBC
FY22 TOTAL ACRES						**3900**			

Appendix F: Grand Canyon Prescribed Burn Units Map





GRAND CANYON NATIONAL PARK

PRESCRIBED FIRE UNITS

Papago — Unit Name

649 — Unit Acreage

N

W E

S

5 0 5 Miles

Scale = 1 : 250,000 with 11 x 17 Page Size

This GRCA Science Center GIS Map was made for Prescribed Fire Mgmt. at Colorado Plateau Field Station, by Don Bertolette on February 12, 1999.

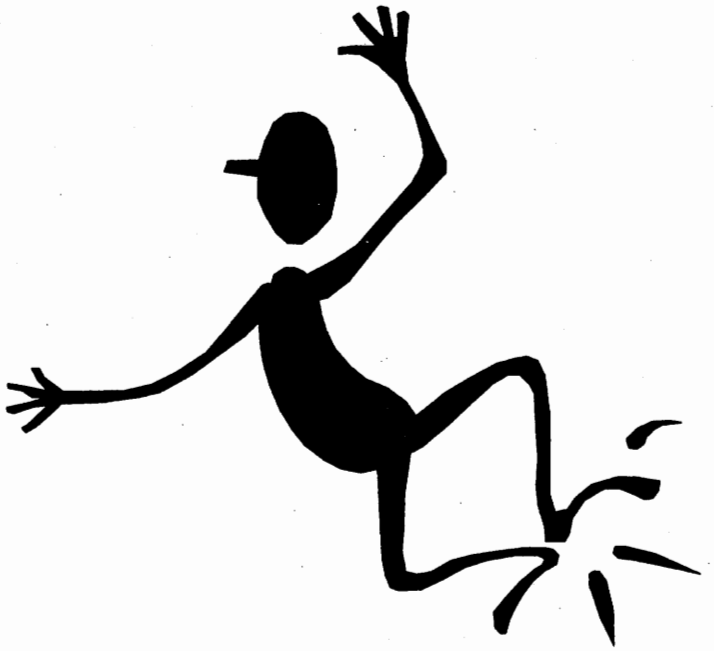
Appendix G: FY98 Cost Tracking Form

Burn Name	Fuel Treatment-to-date by Acre			Total Acres	Cost to date	Projected Cost	Total Cost Over Time	Authorized Amount	*Difference*	Project Cost/Acre
FY98	*Rx Fire*	*Mech.*	*Combo (pile burning)*							
Topeka	2532			2532	$104,843.71		$104,843.71	$56,520.00	-$48,323.71	$41.41
Walhalla	1012			1012	$67,910.19		$67,910.19	$53,270.00	-$14,640.19	$67.10
Watson 4	632			632	$16,912.15		$16,912.15	$15,814.00	-$1,098.15	$26.76
NR Mechanical		34		34	$37,379.40		$37,379.40	$69,488.00	$32,108.60	$1,099.39
NW 4			14	14	$1,035.97		$1,035.97	$46,118.00	$45,082.03	$74.00
NR Piles			10	10			$0.00		$0.00	$0.00
Village Fuel Break		20	40	60	$8,887.62		$8,887.62	$14,300.00	$5,412.38	$148.13
Widforss	221			221	$7,566.91		$7,566.91	$49,240.00	$41,673.09	$34.24
Tiyo I					$30,052.07		$30,052.07	$71,070.00	$41,017.93	#DIV/0!
Vista III					$16,514.54		$16,514.54	$68,010.00	$51,495.46	#DIV/0!
Lonetree	35			35	$412.81		$412.81	$0.00	-$412.81	$11.79
Totals	4432	54	64	**4550**	$291,515.37	$0.00	**$291,515.37**	$443,830.00	$152,314.63	$64.07

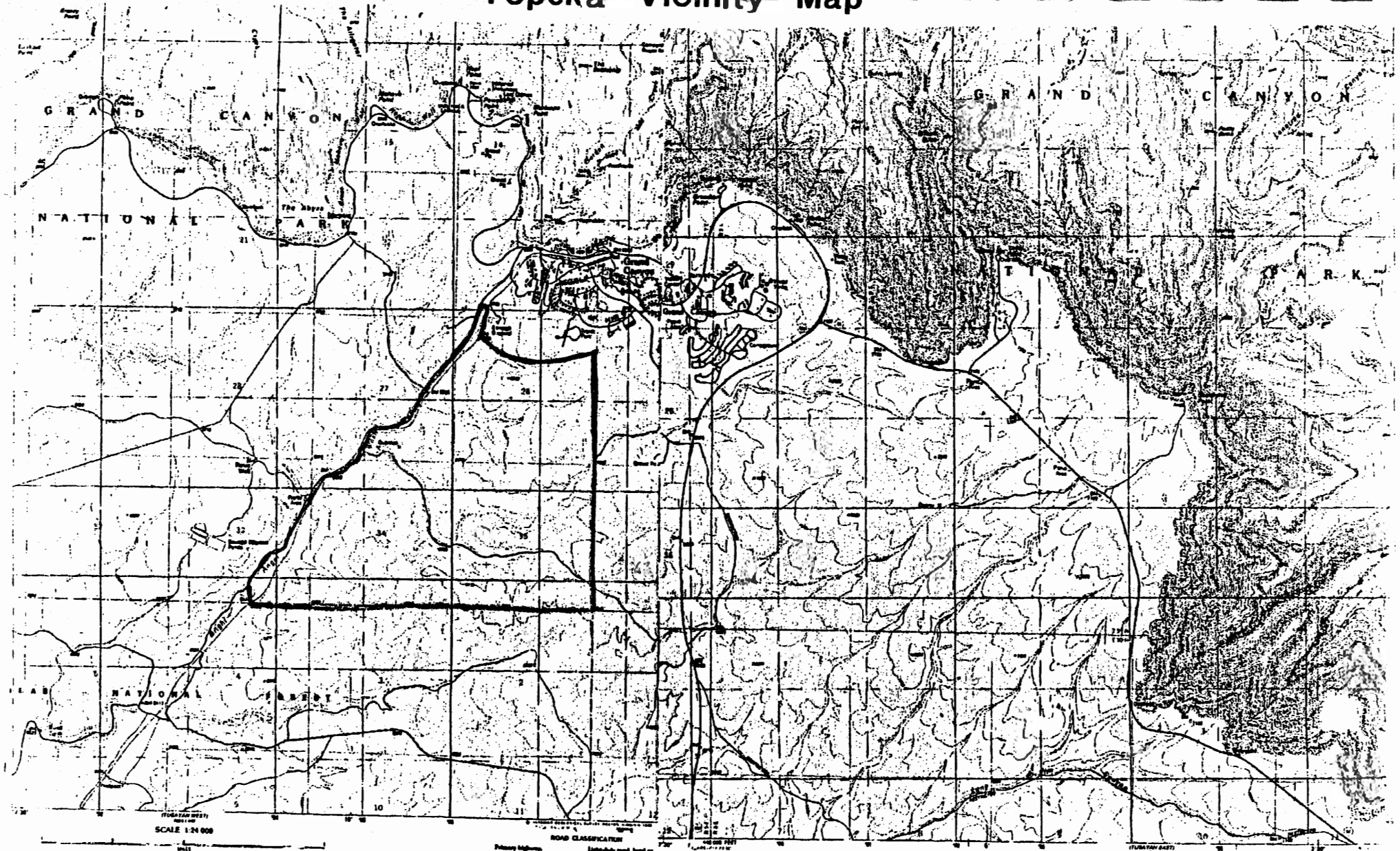
Cost per Acre
11/03/1998

$64.07

Appendix H: Prescribed Burn Unit Maps



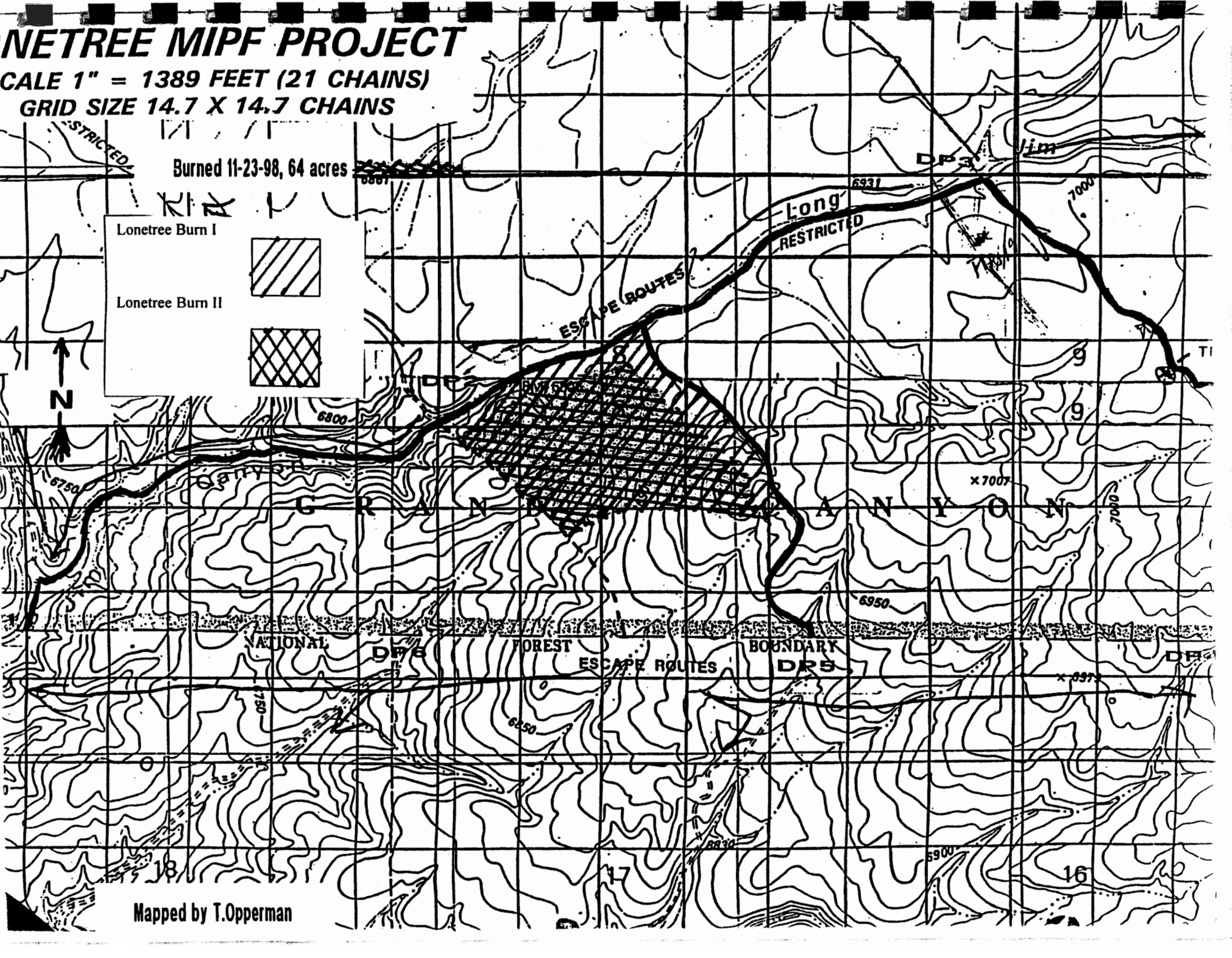
Topeka Vicinity Map



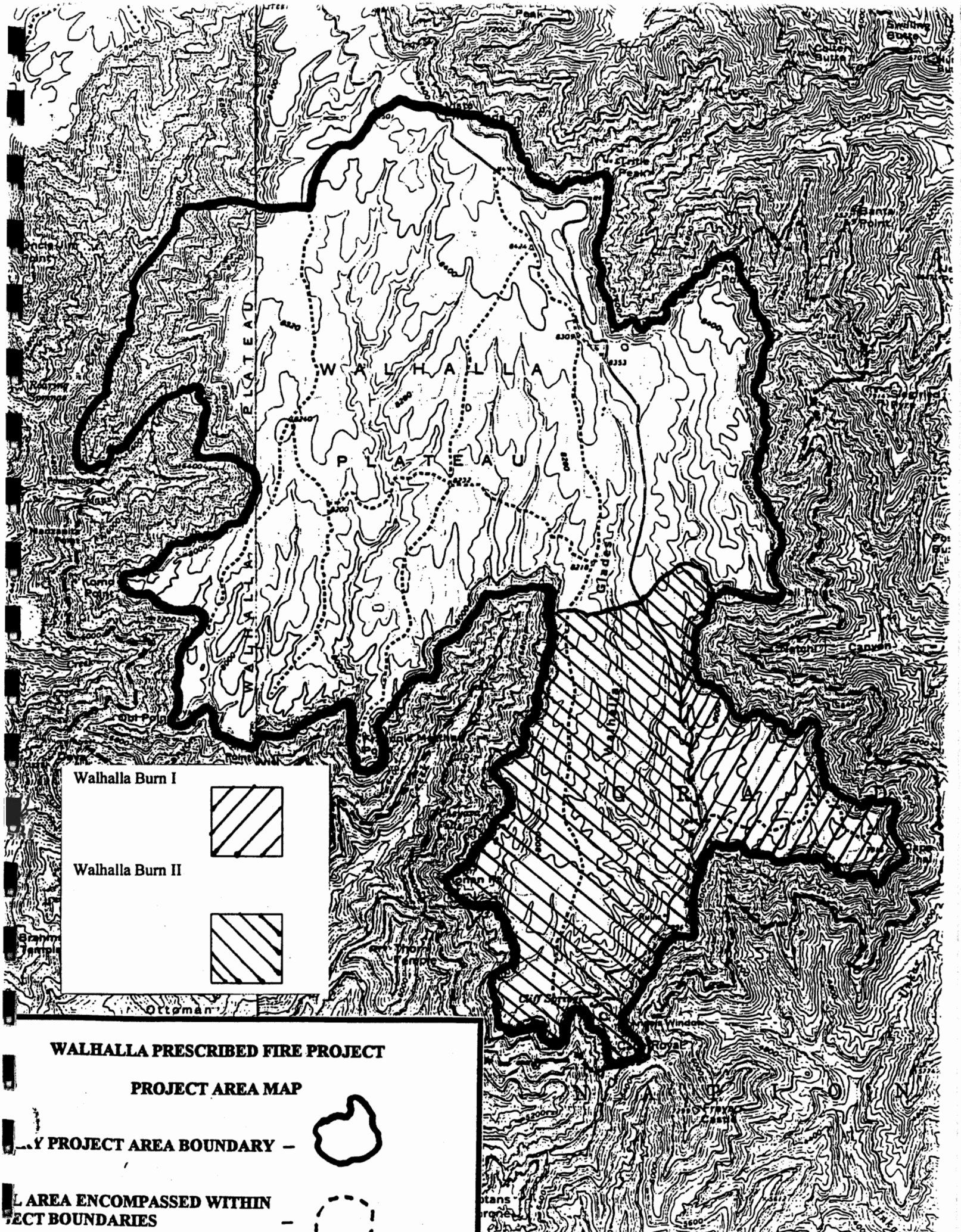
NETREE MIPF PROJECT

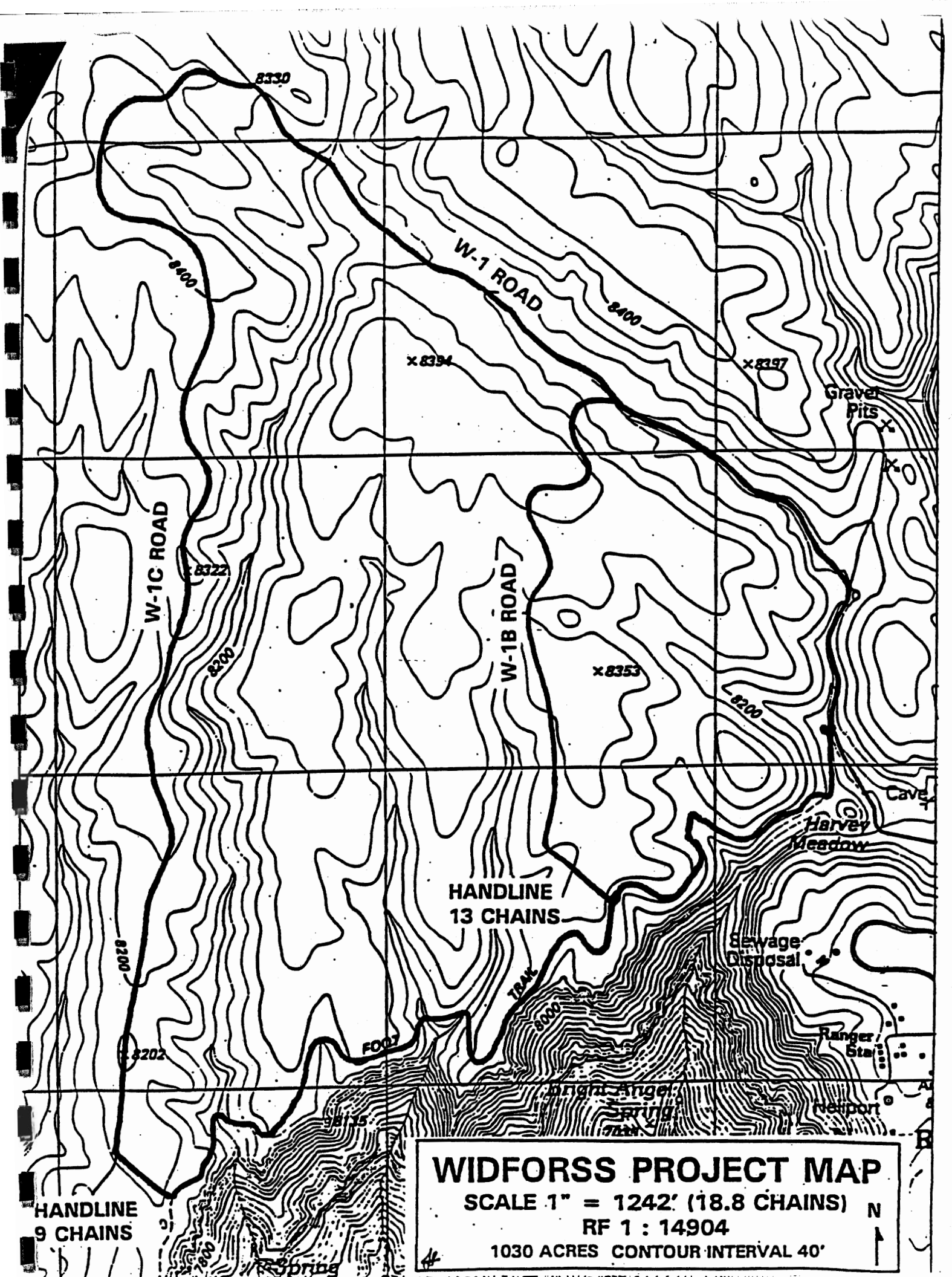
CALE 1" = 1389 FEET (21 CHAINS)

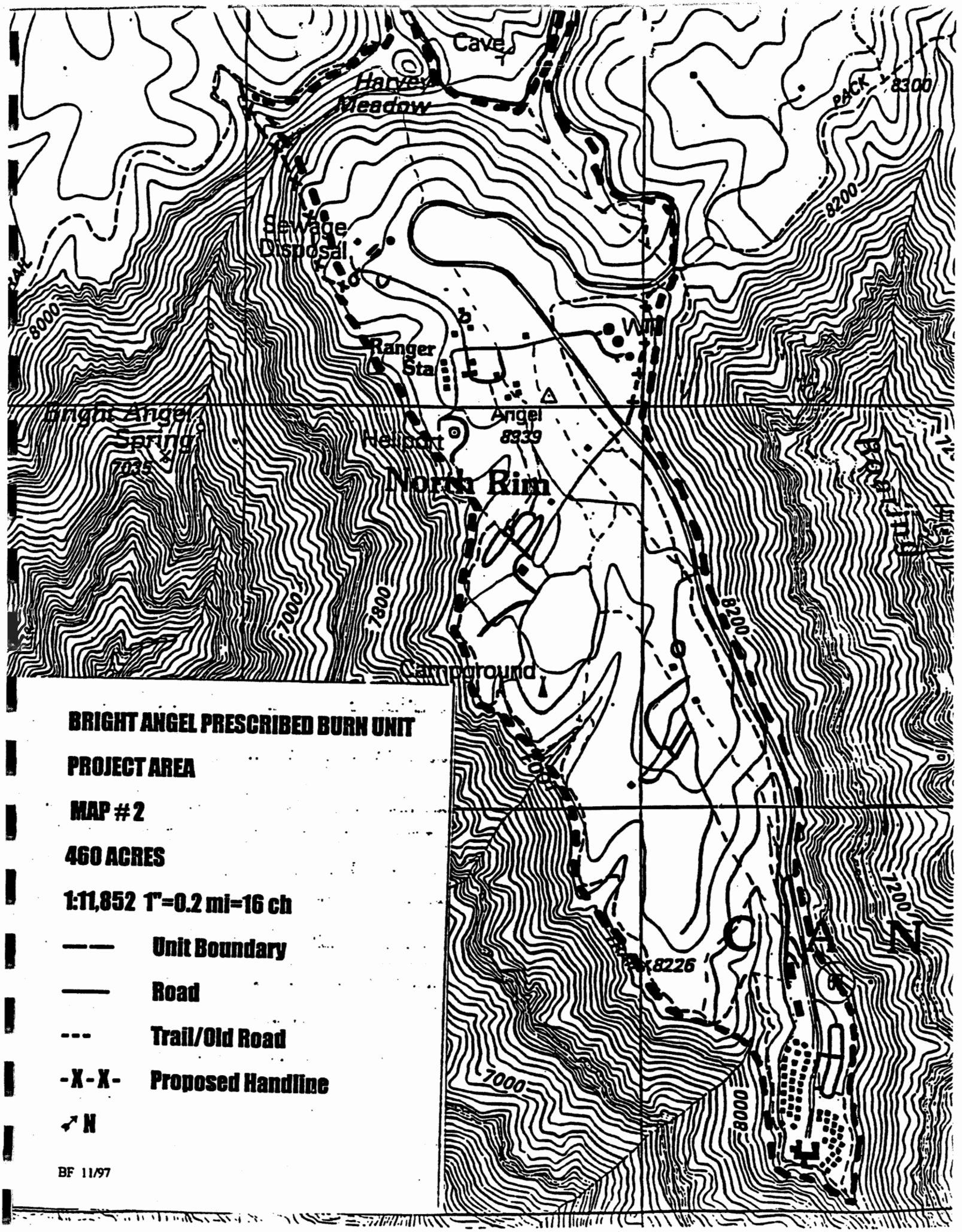
GRID SIZE 14.7 X 14.7 CHAINS



Mapped by T.Opperman


WALHALLA PLATEAU
WALHALLA PLATEAU
Walhalla Burn I
Walhalla Burn II
WALHALLA PRESCRIBED FIRE PROJECT
PROJECT AREA MAP
Y PROJECT AREA BOUNDARY –
L AREA ENCOMPASSED WITHIN
ECT BOUNDARIES –


8330
8400
W-1 ROAD
8400
×8394
×8397
Gravel Pits
W-1C ROAD
×8322
8200
W-1B ROAD
×8353
8200
Cave
Harvey Meadow
HANDLINE
13 CHAINS
Sewage Disposal
TRAIL
8000
FOOT
8200
×8202
Ranger Sta.
Bright Angel Spring
Heliport
HANDLINE
9 CHAINS
Spring
WIDFORSS PROJECT MAP
SCALE 1" = 1242' (18.8 CHAINS)
RF 1 : 14904
1030 ACRES CONTOUR INTERVAL 40'
N



BRIGHT ANGEL PRESCRIBED BURN UNIT

PROJECT AREA

MAP # 2

460 ACRES

1:11,852 1"=0.2 mi=16 ch

——— **Unit Boundary**

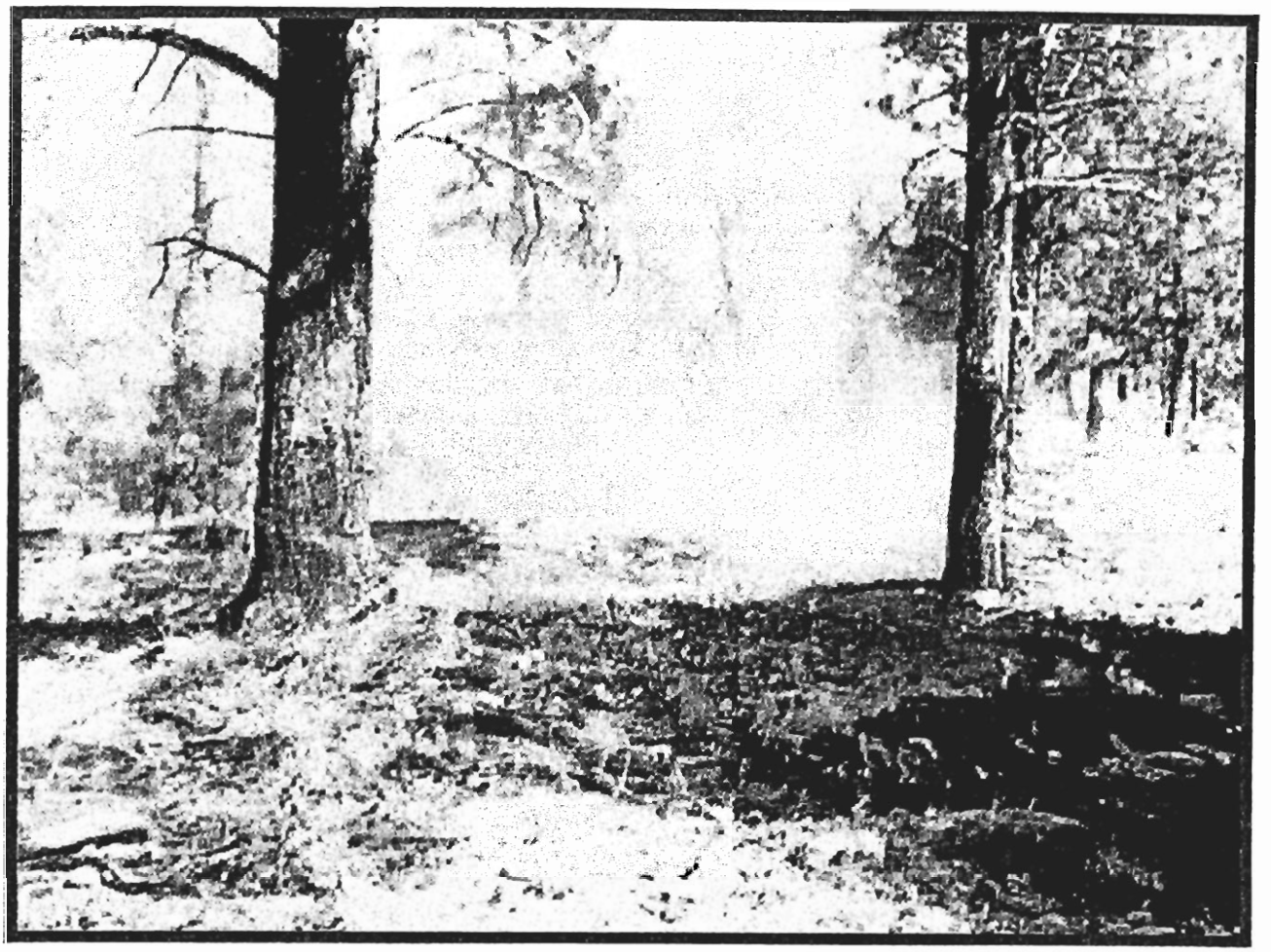
—— **Road**

--- **Trail/Old Road**

-X-X- **Proposed Handline**

N

BF 11/97



GRAND CANYON NATIONAL PARK
FIRE MONITORING PROGRAM SUMMARY
1998 FIELD SEASON

TONJA OPPERMAN, FIRE EFFECTS SPECIALIST
KARA LEONARD, FIRE EFFECTS CREW LEADER

JANUARY 30, 1999

Executive Summary

This annual report serves as a summary of Fire Monitoring program activities as well as an analysis of fire monitoring information collected as of December 31, 1998.

The first half of the report details crew activities and accomplishments, explains the plot network, and outlines changes in plot protocols. Crew members were involved in many out-of-park and in-park fire assignments, including the North Rim Complex, Topeka prescribed burn, Lonetree prescribed burn, Walhalla prescribed burn at Grand Canyon, and Chimenea prescribed burn at Saguaro National Park. The crew of four made 35 plot visits in 1998 and checked 9 additional sites for future inclusion in monitoring types. Minor changes were made in protocols to ensure the data are gathered in the best possible manner. The most important conclusion concerning crew members is the fact that they need more training in the Fire Monitoring protocols in order to collect data properly and avoid costly mistakes that may not be noticed until data are analyzed years later.

The second half of the report summarizes monitoring results and ties them directly to prescribed fire objectives by monitoring type. Table 10 on page 44 provides a brief summary of whether or not each objective has been met by monitoring type. However, use caution when interpreting this table to assess the overall success of the prescribed fire program. Some factors cannot be analyzed with much accuracy until more plots are added to the analysis. Other factors will never be analyzed with the desired confidence as the number of plots needed would be prohibitive in cost. The tables and graphs provided in the analysis section of this report should be studied carefully in order to fully assess how well prescribed fire objectives are being met. Additional statistical software is needed in order to ascertain if a real change has occurred in many instances. Such details are provided in the text of the analysis section. As plots are added to the network and postburn data are gathered in 1999, more accurate information will be available to prescribed fire and resource managers at Grand Canyon National Park.

Table of Contents

Introduction

This report summarizes 1998 calendar year accomplishments of the Fire Monitoring program. The aim is to document crew activities and provide an analysis of fire effects information for the fire management staff and to ensure a smooth transition for newcomers to the program. It also provides the NPS Regional Office with a progress report on the Fire Monitoring Program.

The Fire Monitoring program is undergoing significant change at Grand Canyon National Park. The program has been greatly improved through new equipment purchases such as vehicles, computers, software, cameras, an herbarium cabinet, and filing materials. Throughout the past year, new protocols have been established and old ones revised. We have established a new monitoring type on the North Rim and taken a critical look at all North Rim plots to determine which ones accurately fit Grand Canyon's monitoring type descriptions. Two new monitoring types may be established soon on the South Rim, expanding the program considerably.

This year, extensive out-of-park contacts were made to help guide this program. This includes professionals from Northern Arizona University in Flagstaff and numerous vegetation and fire experts from the National Park Service and the Forest Service. A comprehensive regional program review is scheduled for 1999 to evaluate objectives and program direction in January and field operations in June.

Goals

The goals of the fire monitoring program at Grand Canyon National Park are to:

1. Verify that prescribed fire program objectives are being met through documentation and analysis of fire effects.
2. Increase knowledge of fire behavior and effects on park ecosystems.
3. Document basic information for all prescribed fires and keep all monitoring information organized and properly backed-up.
4. Adhere to standardized data collection techniques for FMH plots.
5. Use information to help others develop interpretive information for the public.
6. Identify areas in which research should be initiated.
7. Provide adequate training opportunities to crewmembers to further their career development.
8. Follow trends in plant communities as related to fire effects.

Staffing

This summer, the crew consisted of a Lead Biotech (GS-7 career seasonal) with two seasonal employees for six months, a student employee for three months, and a term employee who started in August (Table 1). In addition to fire effects plot monitoring, we participated in prescribed burning of Topeka, Lonetree, Widforss, Walhalla, and Outlet units. We are also responsible for bi-weekly fuel sampling on the South Rim. There was extensive participation in the North Rim Complex Fire Use fire this summer which totaled approximately 5000 acres and lasted 2 months. We served as firefighters, squad bosses, fire behavior monitors, smoke monitors, engine crewmembers, helitack crewmembers, plastic sphere dispenser operators, and display processors both in Grand Canyon and on out-of-park assignments. We also participated in both formal and informal training opportunities related to fire effects monitoring and firefighting, and the Lead Biotech participated on cadres for the firefighter refresher and the RX-80 monitoring course.

TABLE 1. Staff participants and number of pay periods worked in 1998.

Monitor	Starting Date	Ending Date	# of Pay Periods
Tonja Opperman	1/1/98	12/19/98	26.0
Kara Leonard	8/10/98	12/19/98	9.5
Chris Moore	4/20/98	11/19/98	15.5
Hillary Cooley	5/18/98	11/19/98	13.5
Sandra Keil	5/25/98	8/14/98	6.0

Crewmembers kept a summer log to record activities for each day of the summer season (May through November). For the most part, it was not very specific, but was a record of where the majority of time was spent for the day. Information was compiled by counting each day as a unit of 1.0 time and dividing that time accordingly into categories. Therefore, no matter if one person worked, or 5 people worked, the day counted as 1.0 time. If 2 people went to a plot and 2 others did fuel sampling, the time was divided in half with 0.5 in each category. Categories are shown in Table 2. With the information available, this was the only way to indicate how the crew's time was allocated for the summer. It does not take into account days that were worked as overtime and *does not track the number of hours spent on any particular task*—it is just a rough breakdown of activities day by day. Plans are in place to track this more accurately in 1999.

Table 2. Breakdown of Crew Time from May-November 1998.

Category	FMH Plots	FMH Office	Data RAM	Rx Fire	Fire Use	Fuel Samp.	Train-ing	Sup-pres-sion	TOTAL DAYS
Day Units	41.9	39.5	6.6	14.0	17.5	3.2	15.1	11.5	149
Percent	28.1	26.5	4.4	9.4	11.7	2.1	10.1	7.7	100%
Total FMH Office +Field	54.5% of each day								
All Other			45.5% of each day						

Monitoring Type Descriptions

There are 5 Monitoring Type Descriptions currently in use at Grand Canyon. Two are located on the South Rim and three on the North Rim (Table 3). Each is described in more detail below. See Appendix A for FMH-4 Monitoring Type Descriptions.

The **South Rim Ponderosa Pine (PIPO)** network needs only one more plot installed in Spring 1999 for the network to be complete. Spring burning plans will dictate where to place the plot so that it is burned as soon as possible.

The **Great Basin Conifer Woodlands (PIED)** plot network may soon be discontinued. During 1999 there are only 2 more plots on which to gather post 5-year burn data. There are no installations scheduled for this monitoring type. Once all the 5-year data are summarized, these plots

may no longer be read. This is because these plots were installed in burn units very close to the South Rim Village where fuels were often piled and jackpotted, rendering the usefulness of this information questionable. However, this action will be evaluated by interested parties at the park and regional levels to determine if a 10-year post read may be worthwhile. These plots were among the first to be installed at Grand Canyon in 1989, and protocols have changed since then. Some of the PIED plot data cannot be evaluated properly because of early misreads.

The **North Rim Ponderosa Pine (PIPN)** plot network needs more installations before accurate minimum plot calculations can be made. There are six plots installed to date. During 1998 many potential plot sites were visited, however, only plots that would burn in late 1998 or in 1999 were actually pre-read. Four sites had origin stakes installed and directions made for a plot folder. These plots will be pre-read within the next two years in accordance with the 5-year burn plan. The "original" North Rim Ponderosa Pine Forest type included both plots that were pure stands of open ponderosa and plots that had overstory aspen and white fir. We thought that the burn objectives and expected fire behavior were different enough that a split in monitoring types was warranted. Therefore, plots that were not open ponderosa were taken out of this PIPN monitoring type for inclusion in a new type called Ponderosa Pine/White Fir Encroachment (PIAB). Some of the plots from the Northern Arizona University fire history research study are included in this PIPN type. The goal for PIPN stands is to maintain the open ponderosa pine forest.

The **Ponderosa Pine/White Fir Encroachment (PIAB)** monitoring type was established in 1998 because objectives and expected fire behavior are different in areas further north along the plateaus of the North Rim. The southern ends of the plateaus have more open, drier ponderosa pine stands, while these northern areas have elements of overstory white fir and aspen, and a more developed understory layer with ladder fuels. The objectives in this type are focused on reducing total fuel load and white fir poles. Some of these plots were originally installed as PIPN plots, some were installed as Northern Arizona University research plots, and some were installed by the 1998 FMH crew. There are 22 plots in this type to date.

The three plots in the **Rocky Mountain Subalpine Conifer (PIEN)** Forest monitoring type were installed in 1993 and 1994 but were never burned. Two of these plots are in the Boundary burn unit scheduled to burn in 2000. The other plot is not scheduled on the 5-year burn plan (Nankoweep). We are considering eight installations over the next 2 years now that some higher elevation conifer forests are scheduled to burn.

A **Miscellaneous Monitoring Type (XXXX)** now exists. After evaluating the plot network and determining what monitoring types Grand Canyon need monitoring, some plots were taken out of the network. Researchers from Northern Arizona University conducting a fire history study originally installed many of these plots. Although they took care to install plots according to NPS protocols so we could potentially use the plots afterwards, they were not installed in the same monitoring types we use at Grand Canyon. The stakes will remain in the ground and the files will remain in the database, but they are no longer part of the current FMH network and will not be visited. These plots can always be read at a later date if the information proves valuable, but we cannot afford to collect information for information's sake.

It is likely that a monitoring type description will be written for **South Rim Pinyon-Juniper Woodlands (JUOS)** and **South Rim Artemisia tridentata (ARTR)** brush type by the end of 1999. At this time, fire management is meeting with the park botanist and wildlife biologist to determine how fire will be used in the Pasture Wash area. Once a decision is made, plot installation can begin in late 1999 or 2000. Initially, 10 plots will be installed in a forest monitoring type and 10 plots in a brush type for sagebrush monitoring.

Table 3. Monitoring types at Grand Canyon National Park.

Abbreviated Name	Full Name	Rim	Description	Installed Plots
PIED	FPIED1D09	S	Great Basin Conifer Woodland	15
PIPO	FPIPO1D09	S	South Rim Ponderosa Pine Forest	21
JUOS	FJUOS	S	South Rim Pinyon-juniper Forest	0
ARTR	BARTR	S	South Rim Big Sagebrush	0
PIPN	FPIPN1D09	N	North Rim Ponderosa Pine Forest	6
PIAB	FPIAB1D09	N	Ponderosa Pine/White Fir Encroachment	22
PIEN	FPIEN1D10	N	Rocky Mountain Subalpine Conifer Forest	3
XXXX	FXXXX	N	Do not currently fit in any Monitoring Type	10
TOTAL				**77**

Plot Network Information

Tables 4-8 summarize plot network information. We made 35 plot visits to reread or install plots, and made 9 additional visits to determine if a point was acceptable for installation within the next 2 years. Plots that were not pre-read are not counted in the following tables. For these plots, origin stakes were installed and directions made for a plot folder. In addition, we visited 6 previously installed plots on the North Rim to determine if they fit the revised monitoring type descriptions for either a pure ponderosa pine type and a ponderosa pine type with white fir encroachment. Those plots that fit neither description were taken out of the plot network. This explains why our plot network has decreased from 74 to 67 even though we installed new plots in 1998.

All plots were re-read by October 1 except for some immediate post reads that will be read in Spring 1999 after snow melts on the North Rim. Prescribed burning continued through mid-October on the North Rim and through mid-November on the South Rim. Some element of guesswork is included in the 1999 re-read schedule since we won't know which plots burned until Spring 1999. We made some best-guesses based on burn maps but plots fall close to the burn boundaries.

TABLE 4. Plot installation by monitoring type and year.

	PIED	PIPO	JUOS	ARTR	PIPN	PIAB	PIEN	ALL
1989	0	0	0	0	0	0	0	**0**
1990	1	1	0	0	0	0	0	**2**
1991	5	1	0	0	0	0	0	**6**
1992	3	8	0	0	2	0	0	**13**
1993	4	4	0	0	0	12	1	**21**
1994	2	1	0	0	0	0	2	**5**
1995	0	0	0	0	0	1	0	**1**
1996	0	2	0	0	0	9	0	**11**
1997	0	4	0	0	0	0	0	**4**
1998	0	0	0	0	4	0	0	**4**
TOTAL	**15**	**21**	**0**	**0**	**6**	**22**	**3**	**67**

TABLE 5. Plots classified by burn unit, monitoring type, and plot ID number.

	Boundary	Entrance	Hance	Lone Tree	Nankoweep	NW I	NW III	NW V	Outlet	Picnic	Quarry	Shoshone	Tiyo I	Topeka	Village	Vista IV	Walhalla	Walla Valley	Watson IV	Widforss
PIAB							07	06	08				12			03	13			02
							25		10				22			04	14			11
									23							05	15			
																09	16			
																	17			
																	18			
																	19			
																	20			
PIED		01								02	09			06						
		03								07	10			08						
		04									11			13						
		05												14						
		12												15						
PIEN	02				01															
	04																			
PIPN						01											03			
						02											04			
																	07			
																	10			
PIPO		01	15	19						04	06			02	08				17	
		07								05	10			03					20	
										11				09					21	
										12				13					22	
														14					24	

TABLE 6. Minimum plots needed, by monitoring type and variable, for higher precision (80%, R=20) estimates. Plots needed for lower precision (80%, R=25) are given in parentheses. The number of plots used to calculate minimum plot numbers needed is n.

	Primary Variable	**Secondary Variable**	**Tertiary Variable**	**Minimum Plot Goal**
PIED	**Fuels:** Total Load: 7(5) n=15	**Overstory:** JUOS: 15(10) PIED: 7(4) n=15	N/A	15
PIPO	**Overstory:** PIPO: 16(10) n=21	**Fuels:** Total Load: 8(5) n=21	**Poles:** PIPO: 73(47) n=18	16
JUOS	N/A	N/A	N/A	
ARTR	N/A	N/A	N/A	
PIPN	**Overstory:** PIPO: 8(5) n=6	**Fuels:** Total Load: 14(9) n=6	**Poles:** PIPO: 31(20) n=6	31*
PIAB	**Overstory:** ABCO: 17(11) PIPO: 11(7) n=22	**Fuels:** Total Load: 7(5) n=22	**Poles:** PIPO: 146(94) ABCO: 24(15) n=22	17
PIEN	**Fuels:** Total Load: 40(26) n=3	N/A	N/A	26*

*Calculations were done with less than the 10 plot minimum suggested. As more plots are installed, these numbers will decrease.

TABLE 7. All plot visits (including INSTALL, PRE, POST, & YR0X) by monitoring type and year.

	1998					1999					2000					2001					2002					2003				
	Install?	PRE?	Burn?	POST?	YR0X?	Install?	PRE?	Burn?	POST?	YR0X?	Install?	PRE?	Burn?	POST?	YR0X?	Install?	PRE?	Burn?	POST?	YR0X?	Install?	PRE?	Burn?	POST?	YR0X?	Install?	PRE?	Burn?	POST?	YR0X?
PIED SUBTOTALS	0	1	0	0	5	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PIED GRAND TOTAL	6					2					0					0					0					0				
PIPO SUBTOTALS	0	1	4	4	10	0	1	1	1	12	0	0	0	0	6	0	0	0	0	2	0	11	0	0	0	0	8	0	0	0
PIPO GRAND TOTAL	15					14					6					2					11					8				
JUOS SUBTOTALS	0	0	0	0	0	0	0	0	0	0	10	10	0	0	0	0	0	0	0	0	0	0	10	10	0	0	10	0	0	0
JUOS GRAND TOTAL	0					0					20					0					10					10				
ARTR SUBTOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0	0	0	0	0	10	10	0	0	10	0	0	0
ARTR GRAND TOTAL	0					0					0					20					10					10				
PIPN SUBTOTALS	4	4	4	0	0	7	9	7	11	4	0	2	2	2	11	0	0	2	2	9	0	6	0	0	0	0	6	0	0	0
PIPN GRAND TOTAL	8					31					15					11					6					6				
PIAB SUBTOTALS	0	0	2	2	4	5	14	7	7	4	0	0	13	13	9	0	0	0	0	19	0	14	0	0	0	0	4	0	0	0
PIAB GRAND TOTAL	6					30					22					19					14					4				
PIEN SUBTOTALS	0	0	0	0	0	9	7	0	0	0	0	5	7	7	0	0	0	5	5	7	0	12	0	0	0	0	5	0	0	0
PIEN GRAND TOTAL	0					16					12					12					12					5				
ALL TYPE SUBTOTALS	4	6	10	6	19	21	31	15	19	22	10	17	22	22	26	10	10	7	7	37	0	43	20	20	0	0	43	0	0	0
ALL TYPE GRAND TOTAL	35					93					75					64					63					43				

Grand Totals include all Install, Pre, Post, and Yr0x reads.
"Install" means that all the rebar was installed and squared.
"Preread" means that the data is collected for preburn time period.
"Burn" is the number of plots in the network that have burned.
"Post" is the immediate postburn plot visit for data collection
"YR0x" is for any subsequent postburn plot visit.

TABLE 8. Numbers of plots burned.

	PIED	PIPO	JUOS	ARTR	PIPN	PIAB	PIEN	TOTAL
PLOTS INSTALLED TO DATE	15	21	0	0	6	22	3	**67**
ALL PLOT BURNS IN 1998	0	4	0	0	4	2	0	**10**
TOTAL PLOTS BURNED 1ST TIME	13	19	0	0	6	5	0	**43**
TOTAL PLOTS BURNED 2ND TIME	0	3	0	0	0	0	0	**3**
TOTAL PLOT BURNS TO DATE	**13**	**22**	**0**	**0**	**6**	**5**	**0**	**46**

The Five Year Burn Plan

The five year burn plan is listed in Table 9. Keep in mind that the current year is the most accurate, with each projected year becoming less sure. The five-year burn plan has undergonemany changes in the past two years, with a shift to landscape scale burning. Therefore, many burn units have been combined and re-named. This does not really influence the plot network except in keeping track of which plots are located in which units.

Plots are randomly located in areas scheduled to burn within at least the next 5 years. For ponderosa forests on the south rim, plots are installed in the units scheduled to burn in 1999 because the plot network is almost finished. Plots in the mixed conifer type on the North Rim are randomly located in areas scheduled for burning in the next 5 years. Grand Canyon's plots are very spread out with only a few plots in each large burn unit.

TABLE 9. Status of five year burn plan.

FISCAL YEAR	PROJECT NAME	PRIORITY	ACRES TO BE TREATED	SEASON OF BURN
1999	North Rim Mechanical	1	150	All
1999	Walhalla	2	1500	Spring/Summer/Fall
1999	Widforss	3	800	Summer/Fall
1999	Tiyo I	4	400	Summer/Fall
1999	Horsethief	5	500	All
1999	Shoshone	6	1300	Spring/Summer/Fall
1999	Lonetree	7	400	Spring/Summer/Fall
1999	South Rim Mechanical	8	100	All
1999	Northwest IV	9	314	Summer/Fall
2000	North Rim Mechanical	1	150	All
2000	Walhalla	2	2000	Spring/Summer/Fall
2000	South Rim Mechanical	3	100	All
2000	Horsethief	4	500	Spring/Summer/Fall
2000	South Rim Pine Project	5	1500	Spring/Summer/Fall
2000	Outlet	6	2000	Spring/Summer/Fall
2000	CC Hill	7	80	Summer/Fall
2000	Covington North Rim	8	60	Summer/Fall
2000	Covington South Rim	9	60	Summer/Fall
2000	Boundary	10	250	All
2000	Vista IV/Kibbey/Hayden	11	902	Summer/Fall
2001	North Rim Mechanical	1	150	All
2001	Walhalla	2	2000	Spring/Summer/Fall

2001	South Rim Mechanical	3	100	All
2001	Boundary	4	250	Summer/Fall
2001	Outlet	5	2000	Spring/Summer/Fall
2001	Horsethief	6	500	Spring/Summer/Fall
2001	Shoshone	7	500	Spring/Summer/Fall
2001	Sublime/Walla Valley	8	1000	Spring/Summer/Fall
2001	Watson I	9	300	Spring/Summer/Fall
2001	Vista I/Greenland	10	679	Summer/Fall
2001	Pasture	11	500	All
2002	North Rim Mechanical	1	100	All
2002	South Rim Mechanical	2	100	All
2002	Walhalla	3	2000	Spring/Summer/Fall
2002	Outlet	4	2000	Spring/Summer/Fall
2002	Boundary	5	500	Summer/Fall
2002	Sublime/Walla Valley	6	1000	Spring/Summer/Fall
2002	Long Jim III	7	1962	Spring/Summer/Fall
2002	Entrance/Quarry	8	904	Spring/Summer/Fall
2003	North Rim Mechanical	1	100	All
2003	South Rim Mechanical	2	100	All
2003	Walhalla	3	2000	Spring/Summer/Fall
2003	Outlet	4	2000	Spring/Summer/Fall
2003	Boundary	5	1000	Summer/Fall
2003	Sublime/Walla Valley	6	1000	Spring/Summer/Fall
2003	Long Jim I	7	1526	Spring/Summer/Fall
2003	Grandview	8	800	Spring/Summer/Fall
2003	Watson IV	9	575	Spring/Summer/Fall
2003	Mescalero	10	500	Spring/Summer/Fall
2004	North Rim Mechanical	1	100	All
2004	South Rim Mechanical	2	100	All
2004	Walhalla	3	2000	Spring/Summer/Fall
2004	Outlet	4	2000	Spring/Summer/Fall
2004	Boundary	5	2000	Summer/Fall
2004	Sublime/Walla Valley	6	1000	Spring/Summer/Fall
2004	Long Jim I1	7	1264	Spring/Summer/Fall
2004	Range	8	500	Summer/Fall
2004	Grapevine/RX-300	9	922	Spring/Summer/Fall
2004	Mescalero	10	500	Spring/Summer/Fall

1998 Changes in Protocol

The most significant changes in protocols this summer occurred for photographing plots and measuring juniper trees. For photos, we decided that we will take the photo with a standard procedure outlined in the GRCA FMH Cookbook (under revision for 1999 field season). Basically, a tripod will be used for all photos, all will be bracketed, and the placement of the identification card in the photo will be consistent. Camera settings ensure the largest view is photographed. 1998 plot photos are markedly improved from previous years using the standardized methods.

For juniper trees there were problems measuring diameters because the multiple-stemmed trees are so large and convoluted right at the dbh mark. Some trees with multiple stems had been tagged with boles as individuals, and some had one tag with a huge diameter. We decided that any juniper tree that was forked at or below dbh with more than 2 stems would be measured at the base of the bole about 10cm from the ground. The tag is placed at this point to ensure measurements are the same in the future. If a juniper has 2 stems or less below dbh, each bole is tagged and counted separately. This change has proved to work well for the 1998 season. Although this renders some data incomparable from year-to-year, monitoring juniper trees is not a priority, and we felt it was better to change the protocol now rather than continue collecting poor data.

In addition to these major changes, some protocols were clarified:

1. Duff and litter will be measured at 5' intervals no matter how long the fuels transect.
2. Don't enter NONE1 in the database for brush, just make sure the "data collected" box is marked "yes".
3. Poles are always measured in Q1 and Q2 for all monitoring types.
4. Seedlings are measured in Q1 except for PIAB which is a 5x10m section in Q1.

To avoid future confusion and improper sampling, all monitors will attend some informal FMH training prior to plot reading, and the FMH-4s will be studied in detail.

Data Analysis and Discussion

Introduction

This section is meant to provide the Grand Canyon prescribed fire program with feedback on how prescribed fire operations are meeting the goals and objectives outlined in the FMH-4 Monitoring Type Descriptions. Due to a previous lack of winter staffing, an analysis as extensive as this has never been available to Grand Canyon fire managers.

The first attempt at analyzing such a large data set was set back by constant red flags appearing in graphs and charts. These items were addressed individually in the original data sheets or in the database to understand if the change on the chart is due to "operator error". For example, when analyzing fuel loads for south rim ponderosa, one plot showed 45 tons of fuel—much higher than any other plot. After looking through the data sheets and database, it was discovered that the data were incorrectly entered in 1993, resulting in an inflated duff depth.

Because the process of dealing with these inconsistencies and creating new spreadsheets and charts was so time-consuming, we started with the most simple analyses. More analysis is possible and desirable, as there is a lot of information available in the database that is not being fully used. For example, some of the FMH-4's have objectives to monitor different diameter size classes from the pole and overstory size class cutoffs we currently use. These other size classes can be monitored, but will take more time than we have right now. Throughout the coming year we can work on more detailed analyses and charts that more completely answer the questions put forth in the FMH-4s.

Statistical Review—What You Need to Know

What is the mean?

First, we should distinguish between the sample mean and the true population mean. The sample mean is just the average value of the data we have collected for a particular variable. An example would be 187 overstory trees/hectare in preburn PIPO plots. We can get an exact, absolutely correct value of the sample mean, because we measure everything in our sample. In contrast, the true population mean is the average value of all possible data for a given variable, such as the average overstory trees/hectare in all preburn areas of the PIPO monitoring type. Usually, we don't know the true population mean because it would take too long to measure every tree – so we take a sample instead.

Reporting Variability with CI's

It is appropriate to report sample means with a measure of variability to explain how confident we are in our estimates. Otherwise, people tend to interpret the sample means as if they were the true population means. Unfortunately, we can't assume that our sample mean will be the same as the true population mean – that depends on how many samples we take, and how much variability there is in whatever we're measuring. So, we need a way to measure how well our sample mean estimates what's really out there (the true population mean). For this report, we chose to do this with 80% confidence intervals (C.I.'s). Confidence intervals are one way to report variability of results, and are calculated with different formulas depending on data variability and what we want to convey.

Interpreting CI's

Understanding how to interpret a confidence interval is best explained by example. Say, for example, that we reported a mean ponderosa pole density in YR01 plots of 375 trees per hectare, with an 80% confidence interval ranging from 200 to 550 (or 175 on either side of the mean). This says we are 80% confident that the true population mean lies somewhere between 193 and 287. It could fall anywhere in there, but we're 80% sure it's in there somewhere. Another way to look at this is that if we took 10 averages and put an 80% confidence interval on each of them, 8 of those intervals would really contain the true mean, but two would not. In other words, with 80% confidence intervals, there is a 20% chance that the true population mean falls outside of the interval. To be really sure (99%) of where the true mean lies, we would have to take a lot of samples. This, of course, is not practical.

Why CI's come in Different Sizes

The size of a confidence interval is determined by two factors. One of these is the sample standard deviation, which is a measure of the variability of the sample, and which is used as an estimate of the variability in the entire population. The more variation you have in your sample, the more difficult it is to get an estimate of the true mean, and the wider your confidence intervals will be. The other factor is sample size. The more samples you take, the closer you get to measuring the entire population, and the better your estimate of the true mean will be. As you take more samples, the size of your confidence intervals will decrease. Figure 1, which shows overstory Ponderosa density for all of the PIAB plots, is a good example of the relationship between sample size and the size of the confidence interval. We avoid comparing different sample sizes over time due to the confusion in interpreting the results when variation is introduced through changing sample sizes.

CI's Don't Tell the Whole Story

The current analysis consists only of confidence intervals placed on mean values. It would be incorrect to draw any conclusions about change over time from these confidence intervals alone. While these intervals can suggest trends, a more complex statistical test will be necessary before we can confidently draw defensible conclusions.

In cooperation with the Northern Arizona University Forestry Department, we consulted with an NAU statistician to determine the most appropriate type of analysis to perform. He suggested several tests, and recommended the Random Measures ANOVA in particular. We cannot perform this analysis with any of our current software, and it would be overly time-consuming to do by hand. We would like to purchase the appropriate software, but in the meantime, we may be able to work with the NAU Forestry Department to perform at least some of the analysis.

Performing this analysis would allow us to make better and more complete use of our data. For example, the confidence intervals we produced for this report treat the data from each plot visit as a totally independent, random sample. This does not allow us to take advantage of the fact that we are actually visiting the same plot at different times. The analysis that we propose to do would take this into account. It would produce tighter confidence intervals, and would allow us to determine whether significant changes have occurred, and in which time periods they occurred.

Interpreting Bar Charts

All bar charts in this analysis compare data from the same plots only through time. The preburn reads for which there were no later reads were not included in the analysis. This ensures that sample size (n) is the same for both means (columns), but may be small. The size of the error bars may change over time as the measured data becomes more or less variable. Fuels charts show a break down of fuel size classes with an error bar for the *total* fuel load only. Statistically significant changes cannot be evaluated without more powerful statistical software—remember, averages

represent only what was measured in the confines of individual plots.

Interpreting Scatter plots

The scatter plots show the actual values for each plot read. They show the amount of data that has been collected to date, and show what has happened in each plot. In the first scatter plot, Figure 1, plots 4 and 5 are examples of a steady decrease (diamond shapes move down), plot 15 is an example of an increase (diamond shapes move up), and plot 13 (bull's eye) shows no change. If there is only one diamond, it indicates that plot has not been burned.

The Fine Print

We created our C.I.'s using the following formula:

$$X \pm t_{\alpha(2),\nu} S_X$$

In which:

X = sample mean

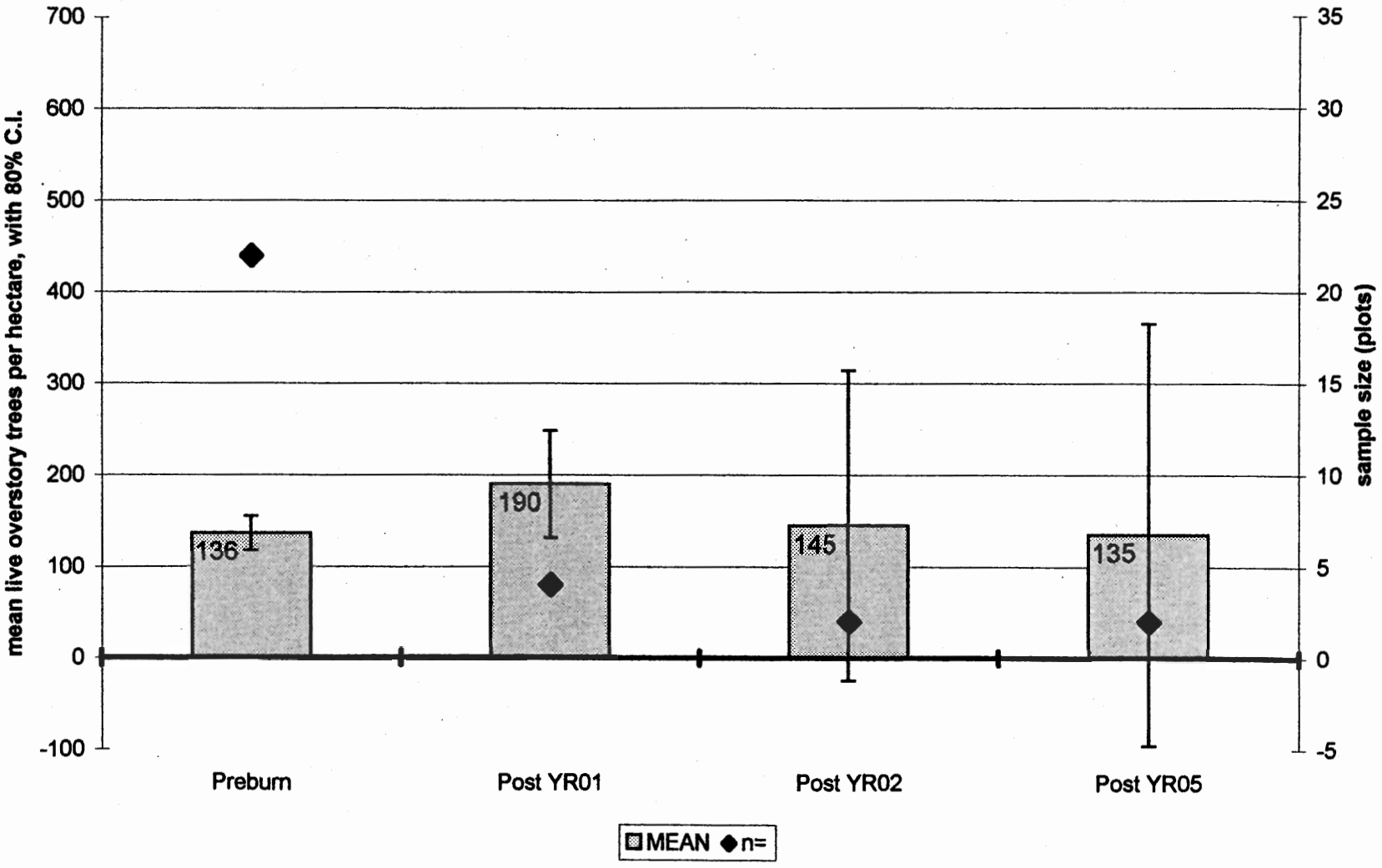
$t_{\alpha(2),\nu}$ = the value of the t distribution for $\alpha(2),\nu$

$\nu = n-1$

S_X = the sample standard error of the mean

We used the two-tailed value for $\alpha = 0.2$ for our analysis.
We used the t distribution because of our small sample size.

Figure 1. Example scatter plot
***Pinus ponderosa* overstory density, in all PIAB plots**



PIED Results and Discussion

Fuels

Objective: Reduce the total fuel load so as not to exceed an average of 20 tons/acre immediately postburn.

Results: Total fuel load was decreased on five measured plots by 21% from 15 tons/acre to 12 tons/acre immediately postburn (Figure 2). This does not indicate what actually may have happened over the entire pinyon-juniper landscape however, it is only an average of the five 20x50m plots measured. There has been no testing for a significant difference over time, therefore it cannot be said whether or not a *real* change in fuel load occurred—especially since all the error bars overlap. However, on these five plots, the only fuel class showing a significant change is the >3" woody material (sound and rotten combined), especially in YR02. Most other fuels remain the same over time.

Of the 15 plots installed in this monitoring type, only five plots are comparable from PRE to POST and PRE to YR02 because of past sampling errors. Some fuels transects had been read at 50' and others at 100', making fuel load comparisons between all plots impossible. However, this meets the level of confidence specified in the FMH-4 for PIED. Since this monitoring variable is not critical, we can accept an R of 25%. Transects read at 50' were likely under-sampled for 1000-hour fuels. All other fuel classes are not affected by this sampling problem.

The scatter plot (Figure 3) gives some indication as to where the YR02 fuel load increase occurs in the plot network. Plot 7 shows a total preburn fuel load of only 26 tons/acre, but a YR02 fuel load of 37 tons/acre. This is explained by going back to the original data sheets. A 37-inch tree is recorded on the YR02 fuel transect, and since the fuel load calculations use diameter as a major component, this increases the estimated fuel load considerably. Although 37 inches is large, it is *possible* to get this reading at the butt of a tree. It is more likely that there was a recording or measurement error, but it is impossible to know until we collect YR05 postburn data. The other four plots in the network do not show much change between preburn and YR02 total fuel load.

Was objective met? Yes.

Overstory

Objective: Limit overstory mortality of all species (including *Juniperus osteosperma*, *Pinus edulis*, and *Pinus ponderosa*) to 20% within 5 years post burn.

Results: In the plots only, overstory mortality was 13.6% from PRE to YR05. Although the mean for the YR05 reads is lower than the mean for the PRE reads, the C.I.'s overlap quite a bit (Figure 4). This overlap suggests that there may not be a difference between the 2 means, but we would need further analysis to be sure. Note that the sample size for the PIED plots is large enough (10) to give us reasonably small C.I.'s throughout, but minimum plot calculations suggest we analyze 15 plots to get an accurate picture of the overstory junipers. More five-year data will be collected in 1999.

Figure 5 shows that, of 13 plots with postburn data, overstory density decreased in 8. Plots 1, 4, 5, and 12 on the Entrance unit and plots 9, 10, 11 in the Quarry burn unit show a decrease in overstory density. Plots 6, 8, 13, 14, and 15 are located on the Topeka burn unit and were burned in 1993. They do not show as much change in overstory as Entrance plots.

Was objective met? Yes.

Figure 2. Total Fuel Reduction for South Rim Pinyon-Juniper (PIED)

December 1998

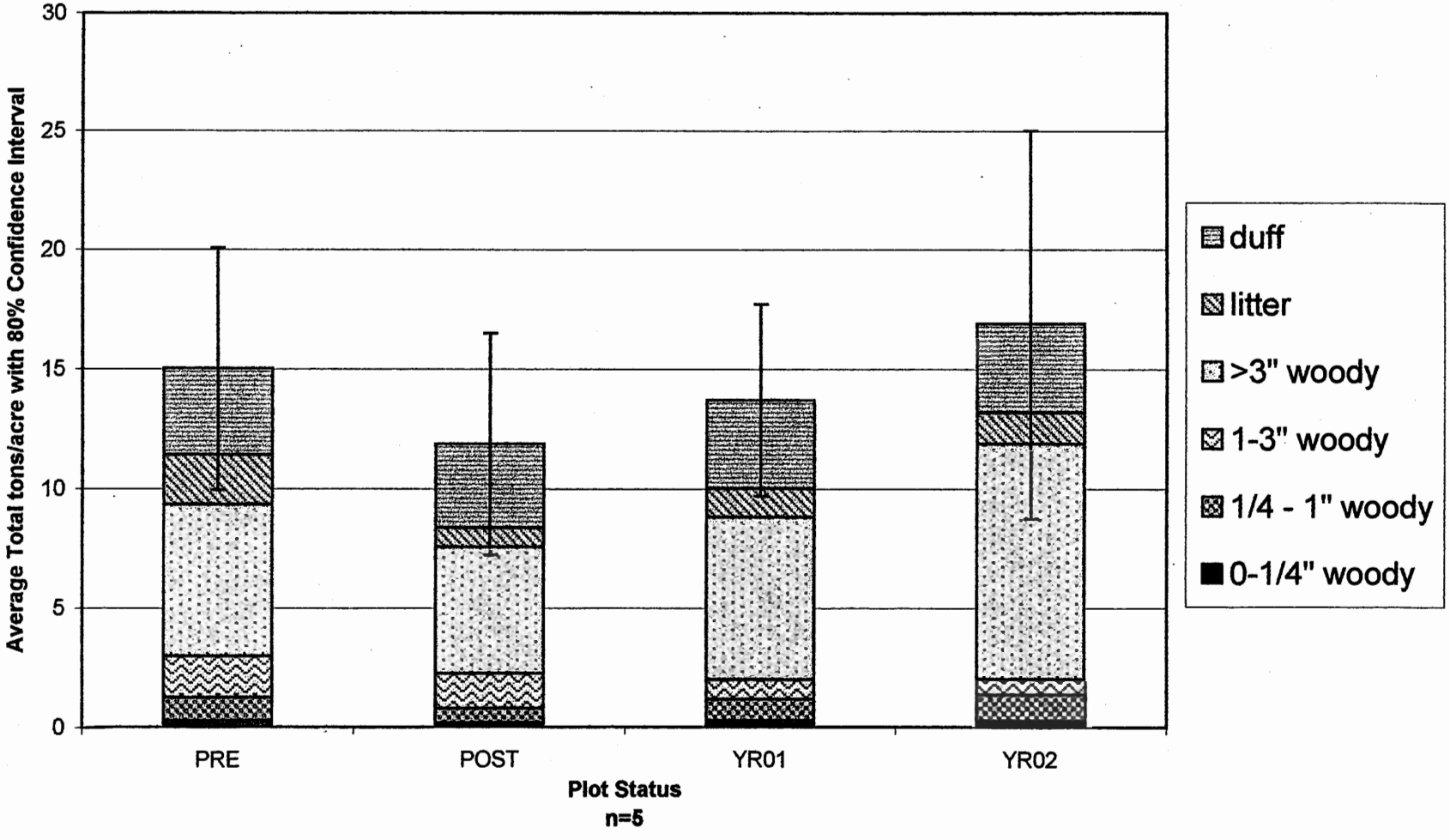


Figure 3. Change in PIED Total Fuel Load by Plot

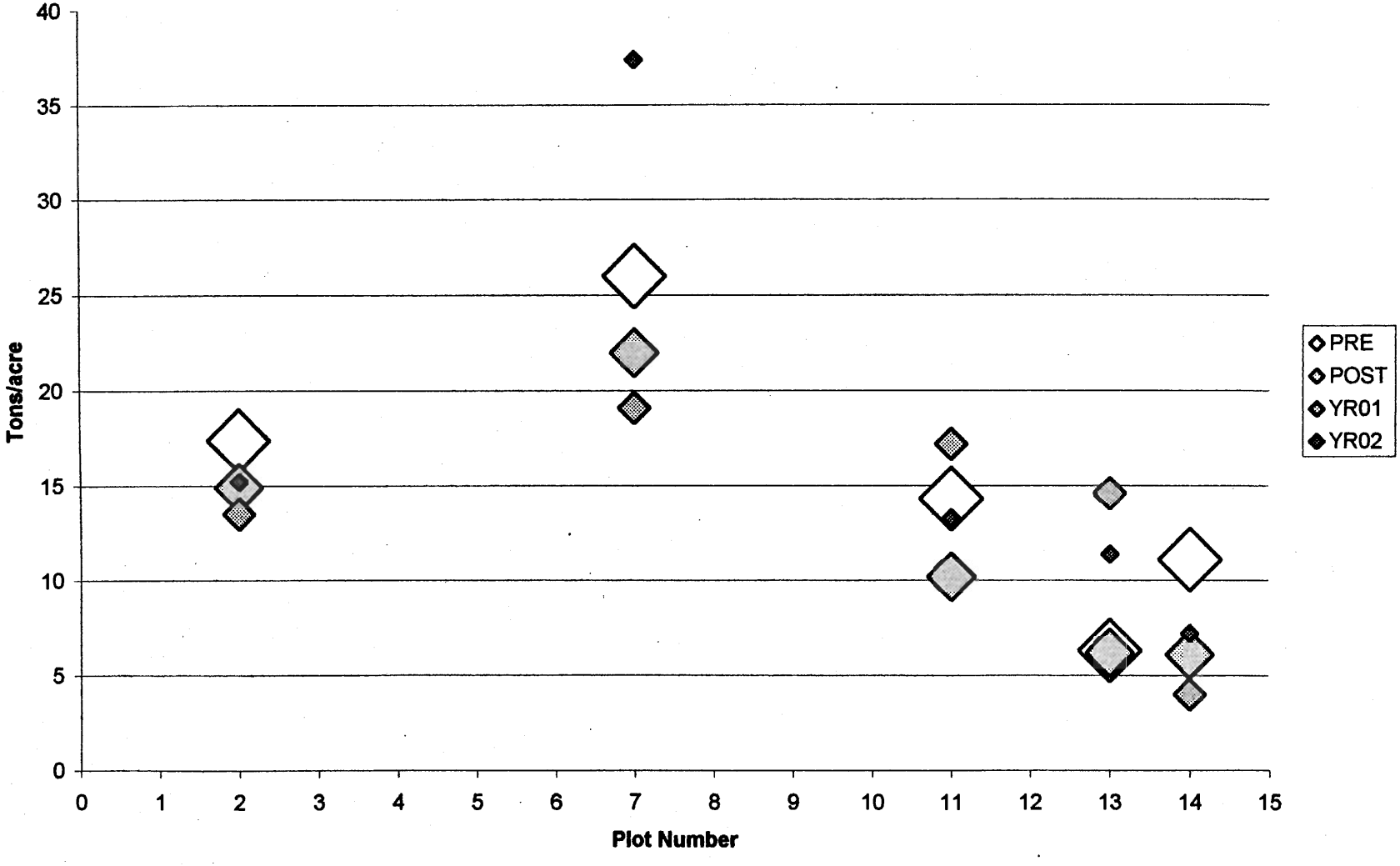


Figure 4. Overstory density, in PIED PRE and YR05 plots (same plots only)

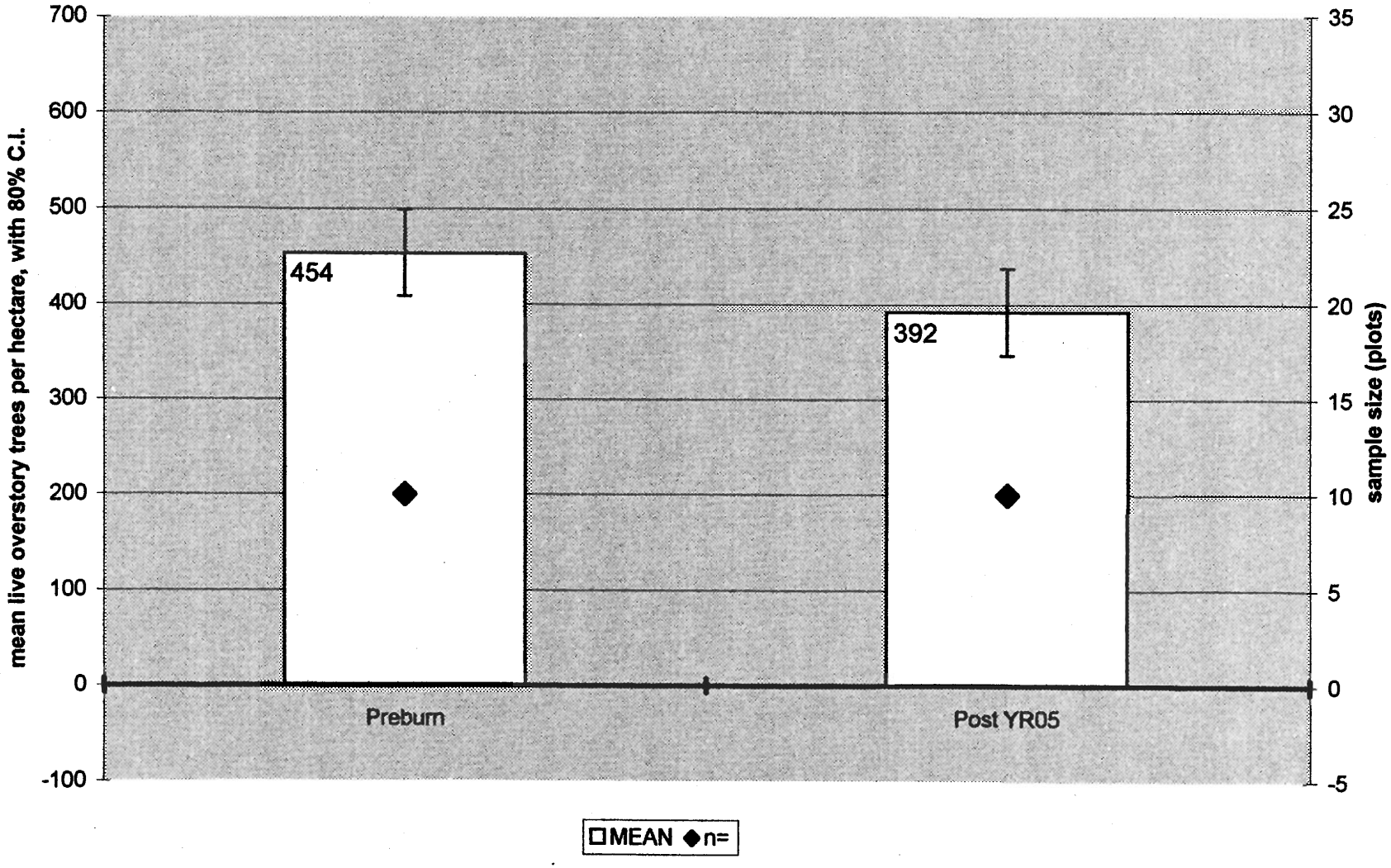
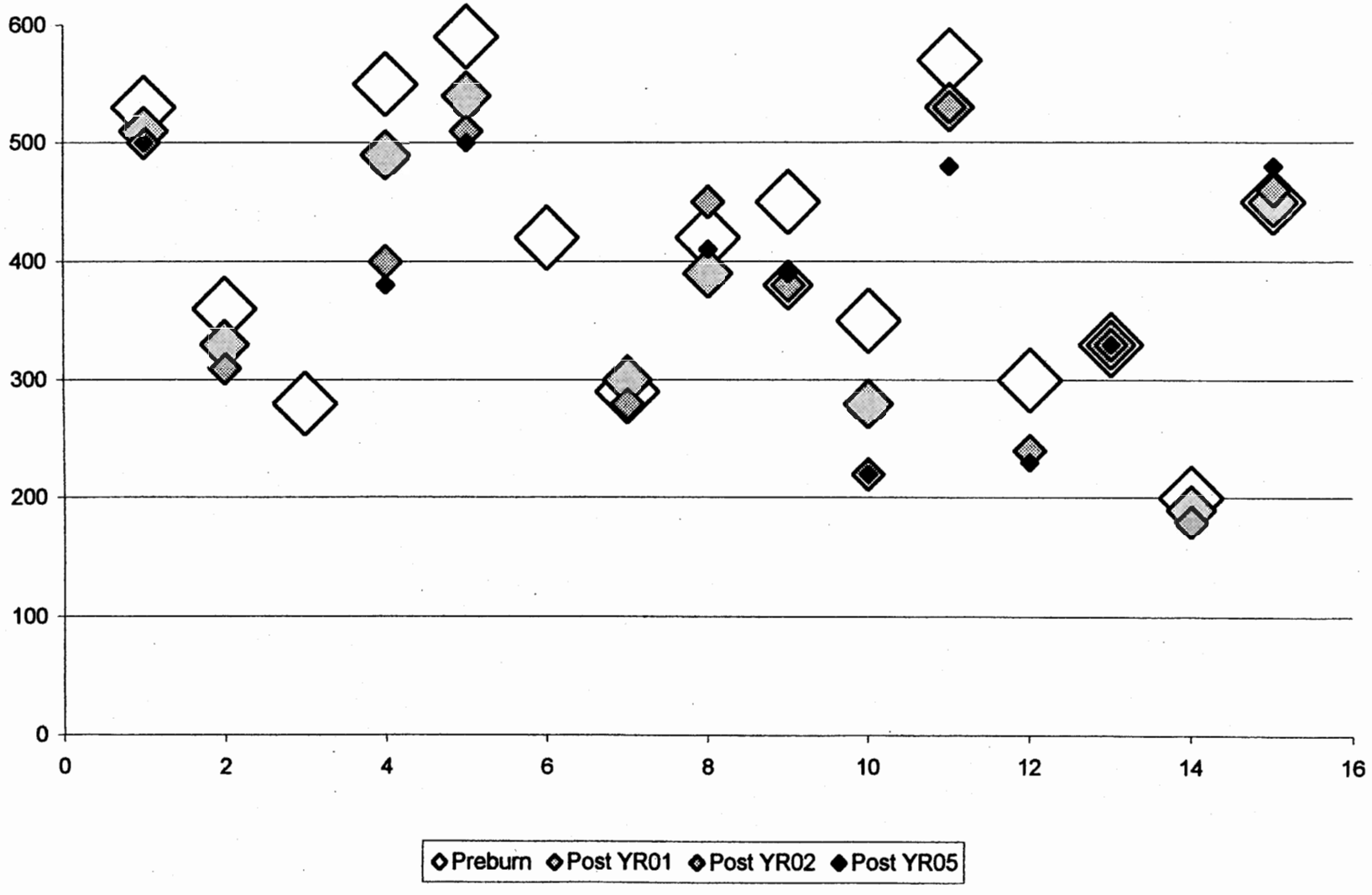


Figure 5. Change in overstory density in PIED plots, by plot



PIPO Results and Discussion

Overstory

Objective 1: For the current FMH-4s (1999) the objective is to limit overstory mortality of ponderosa pine ≥ 16" dbh to ≤ 20% within 5 years postburn. However, the following analyses were performed using old FMH-4s where all overstory (>6" dbh) ponderosa trees were considered. At a later date, the calculations will be performed separately for trees greater than 16" dbh.

Results: Figure 6 visually suggests a slight increase in overstory density. We would need to perform a statistical test to determine if there really was a significant change. In the plots only, ponderosa pine overstory density has increased by 5.2%.

The scatter plot in Figure 7 shows most of the diamonds arranged in bull's eye patterns. This immediately suggests that little change has occurred in the overstory density. Increases are likely due to pole-sized trees growing into the overstory size class. Plots 15 and 17 show a decrease. These plots are located in the Hance and Watson burn units.

Was objective met? Yes.

Objective 2: Limit scorch of overstory ponderosa pine ≥ 16" dbh to 30% of crown immediately postburn.

Results: This objective was not evaluated for 1998 since this is a new objective in the 1999 FMH-4s. It will be evaluated for the 1999 report.

Was Objective met? Unknown.

Fuels

Objective: Reduce woody fuel load by 40-100% immediately postburn for 1, 10, and 100-hour fuels, and to reduce 1000-hour fuels by 40-80% immediately postburn. Eight plots are needed to meet confidence levels specified in the FMH-4 for PIPO but analyses were performed with 9 plots.

Results: Figure 8 shows total fuel reduction by category. On the nine averaged plots measured, the woody fuel reduction from preburn to immediately postburn was:

Woody Size Class	Goal	Actual
1-hour fuels	40-100% reduction	100% reduction
10-hour fuels	40-100% reduction	25% reduction
100-hour fuels	40-100% reduction	55% reduction
1000-hour fuels	40-80% reduction	68% reduction

The preburn error bar in Figure 8 is large because the data are more variable during preburn levels and we are less sure of the true mean value. An immediate reduction in fuel load is expected, and a subsequent increase is likely as dead fuel accumulates postburn, however the rise in total fuel load between YR01 and YR05 is not explainable. It is possible that there is really no change among the three years sampled, but this cannot be known without further tests. It is also not clear why there is a decrease in >3" woody material between POST and YR01. It could be due to rotting logs, but it does not seem plausible to see this amount of reduction in a one-year time span.

Figure 9 illustrates the changing fuel loads over time on each plot and gives a good overall picture of

how fuel loads are changing in the entire plot network. Ideally, we want to see the largest white diamonds at the top of the chart to indicate preburn fuel load, and postburn diamonds below to indicate a fuel reduction. If the YR05 diamonds are closer to the preburn diamonds than YR01 or YR02, it means the fuel load is on the rise on this plot. Plot 10 has a very high fuel load due to one transect showing a deep duff layer. The duff layer on this plot contributes to almost half of the total fuel load. After the burn, the fuel load on this plot was closer to the average. This single high preburn fuel load probably accounts for the large preburn error bar in Figure 8.

Was objective met?
1-hour fuels, yes.
10-hour fuels, no.
100-hour fuels, yes.
1000-hour fuels, yes.

Poles

Objective: Reduce Ponderosa of 1-6" dbh to average 0-200 poles/ac (0-494 poles/ha) within 2 years postburn.

Results: Figure 10 suggests a decrease in pole density, but the large size of the C.I.'s indicates that such a decrease may or may not have occurred. In the plots only, ponderosa pole density decreased by 22.5% for a YR02 postburn average of 297 poles/ha.

The variability in pole densities illustrated in Figure 11 shows why so many plots are needed to get an accurate estimate of pole densities (refer to Table 6). All plots but one showed either a decrease, or no change. Pole densities on these plots range from 0 to almost 1800 per hectare, therefore many plots are needed to capture this kind of variability.

Was objective met? No, but to monitor poles accurately we need to have 73 plots, which is out of the question.

Figure 6. *Pinus ponderosa* overstory density, in PIPO PRE and YR05 plots (same plots only)

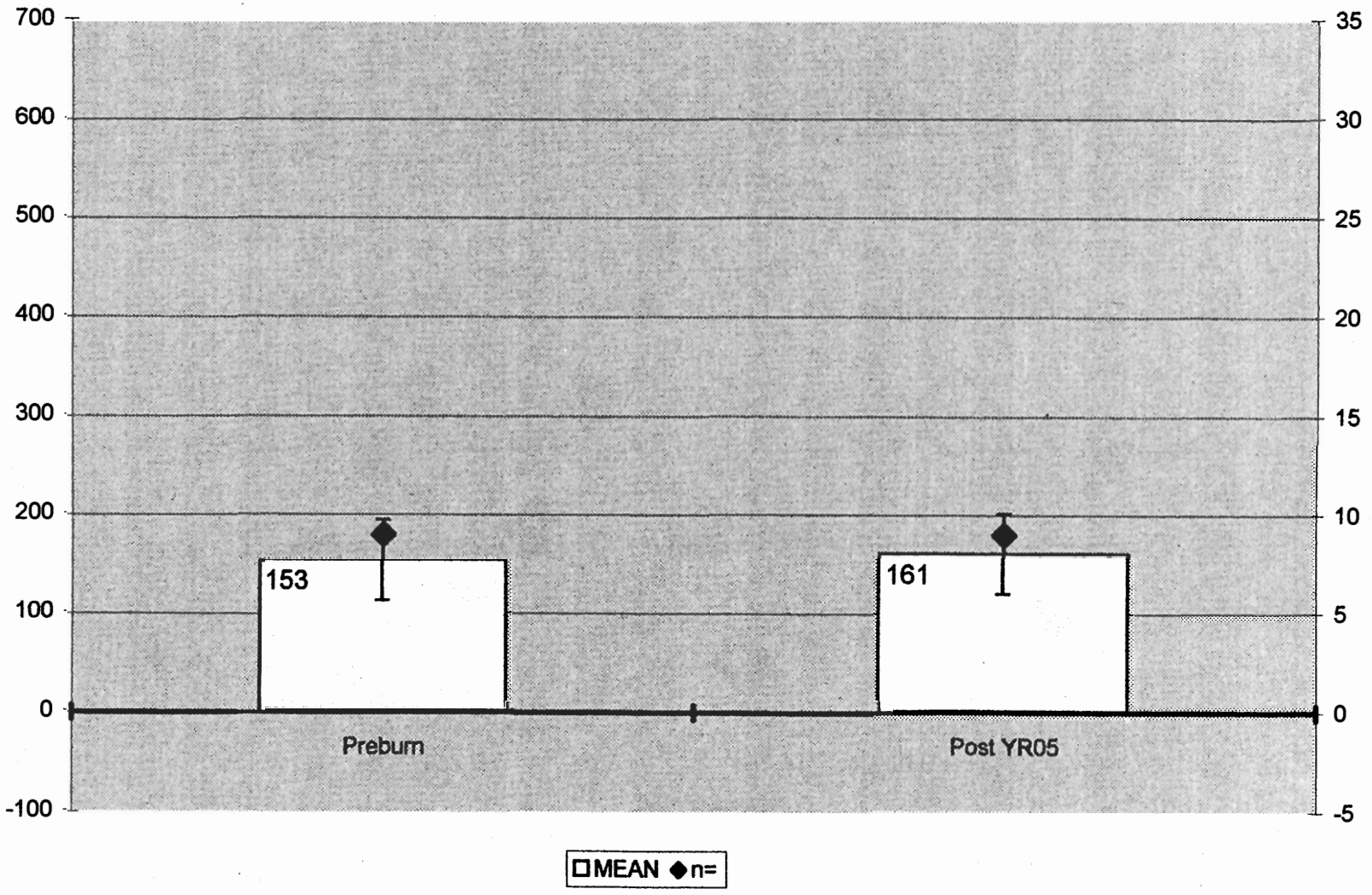


Figure 7. Change in *Pinus ponderosa* overstory density in PIPO plots, by plot

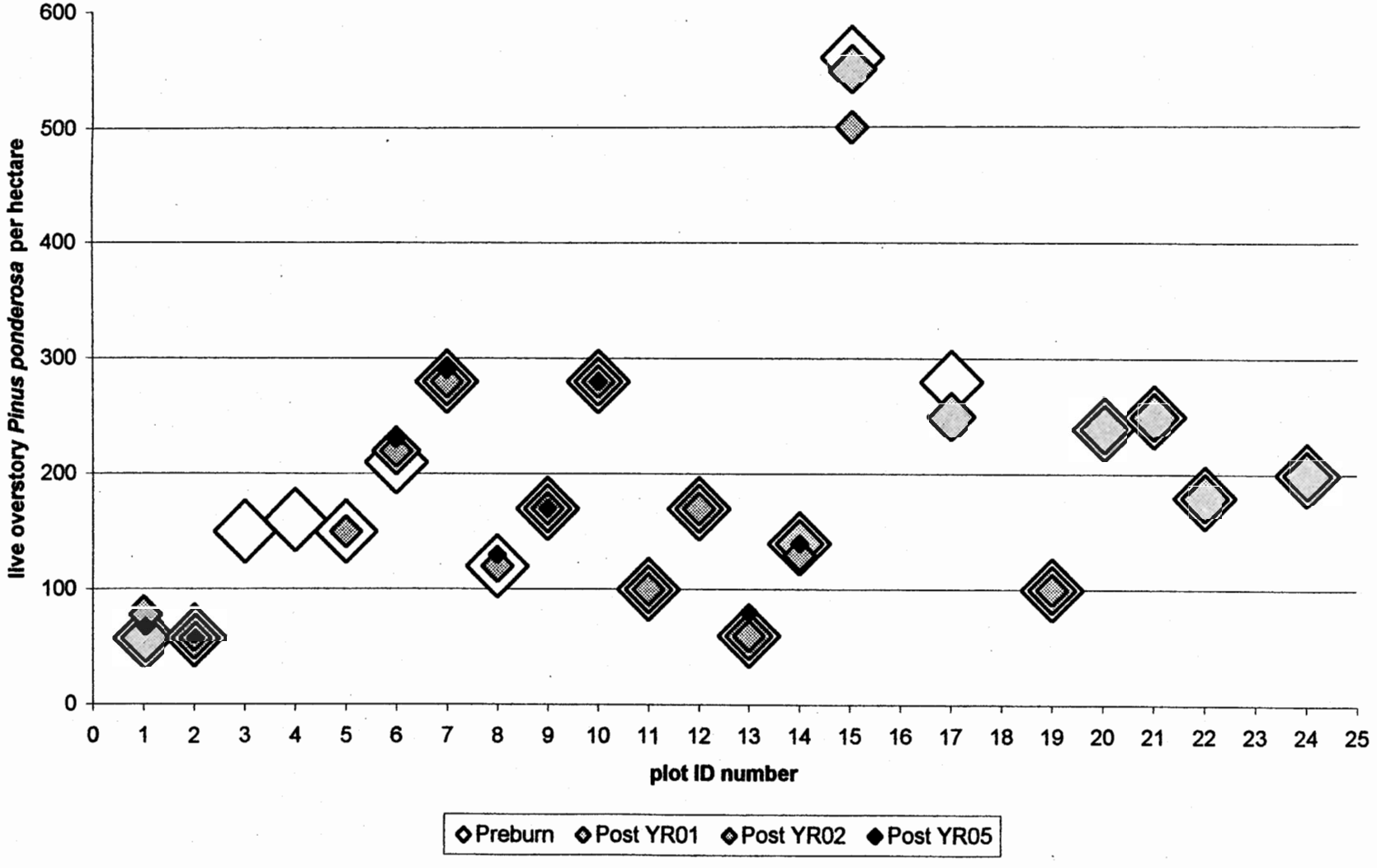


Figure 8. Total Fuel Reduction for South Rim Ponderosa Pine (PIPO)
December 1998

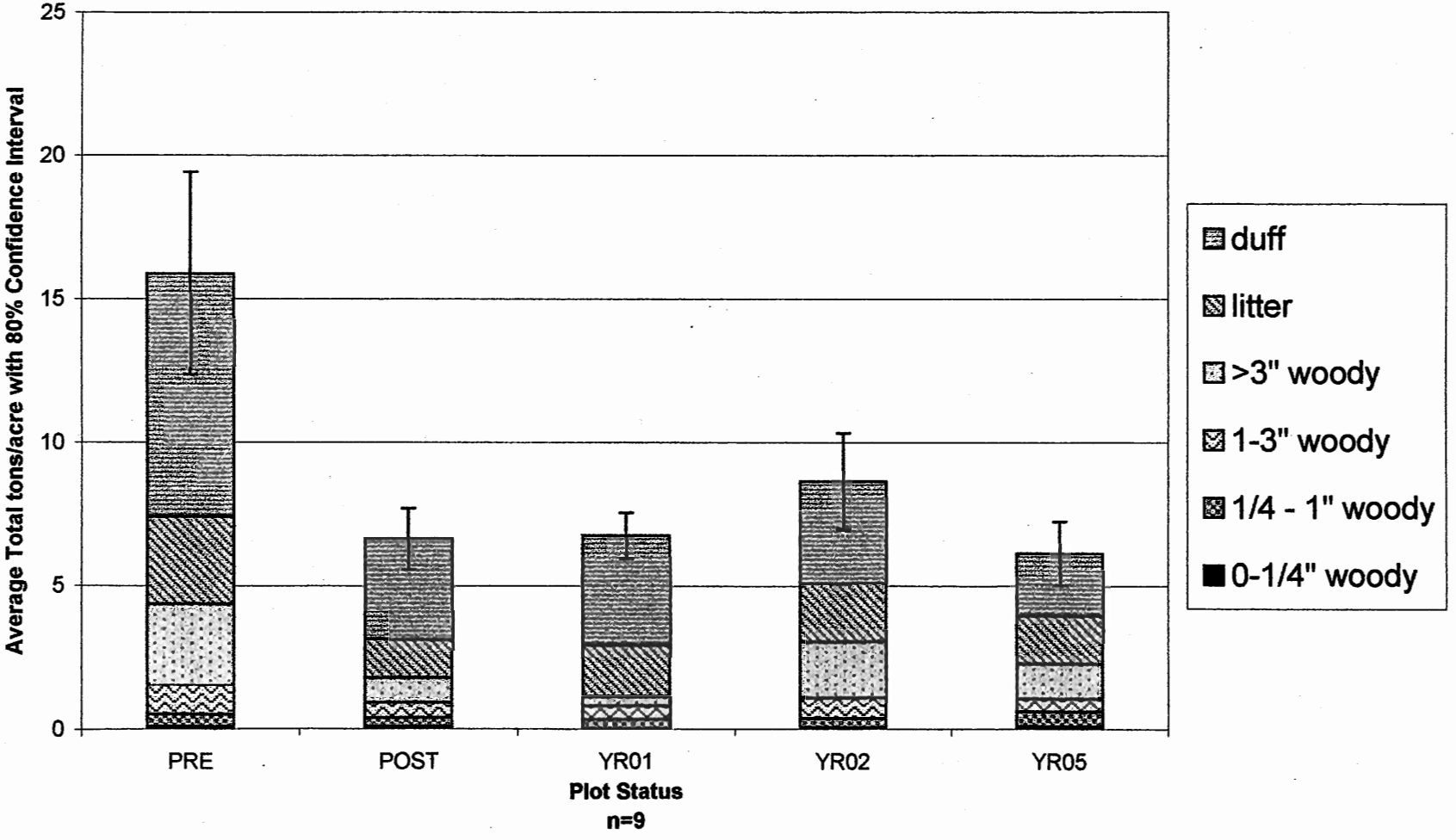


Figure 9. Change in Total PIPO Fuel Load by Plot

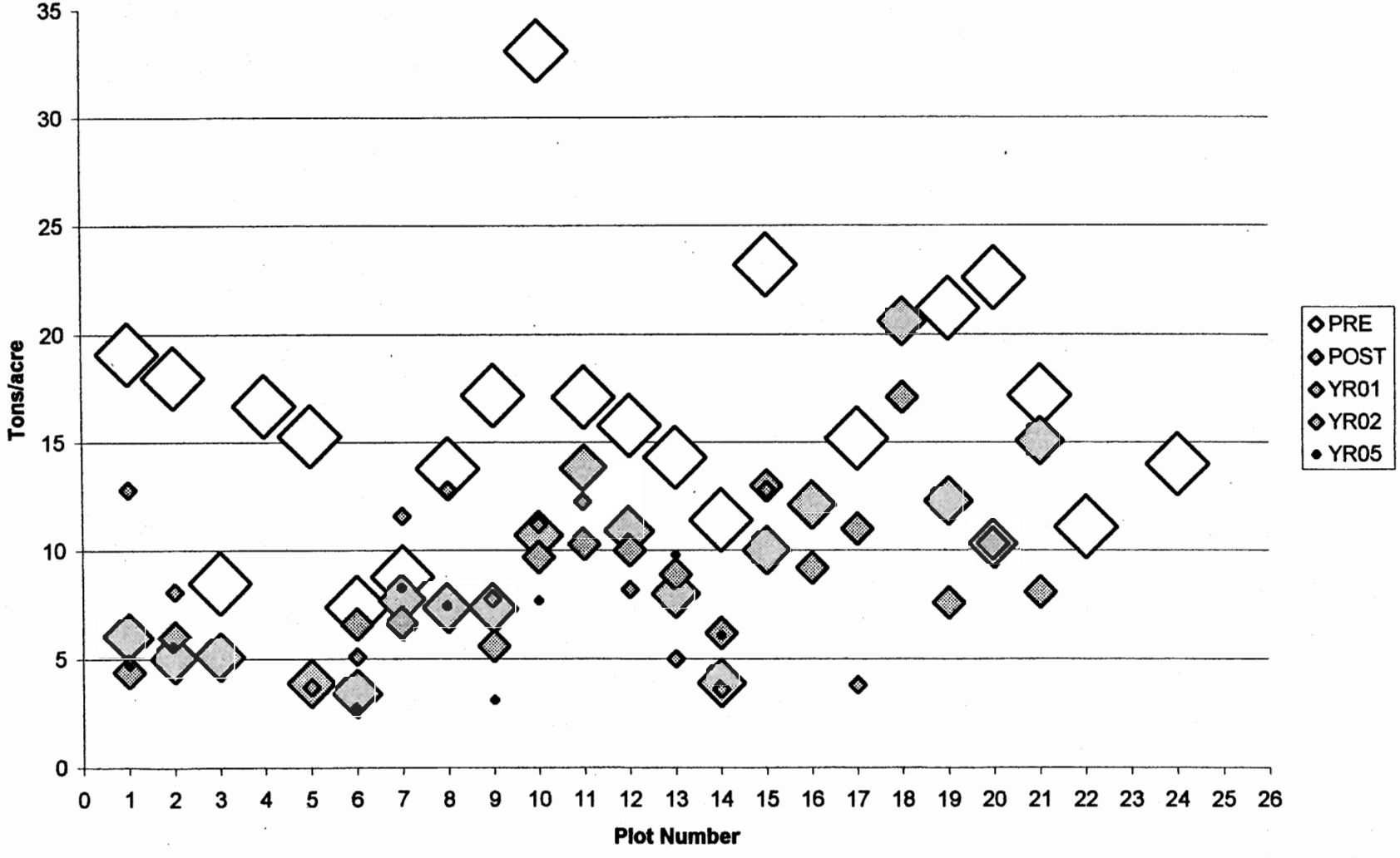


Figure 10. *Pinus ponderosa* pole density, in PIPO PRE and YR02 plots (same plots only)

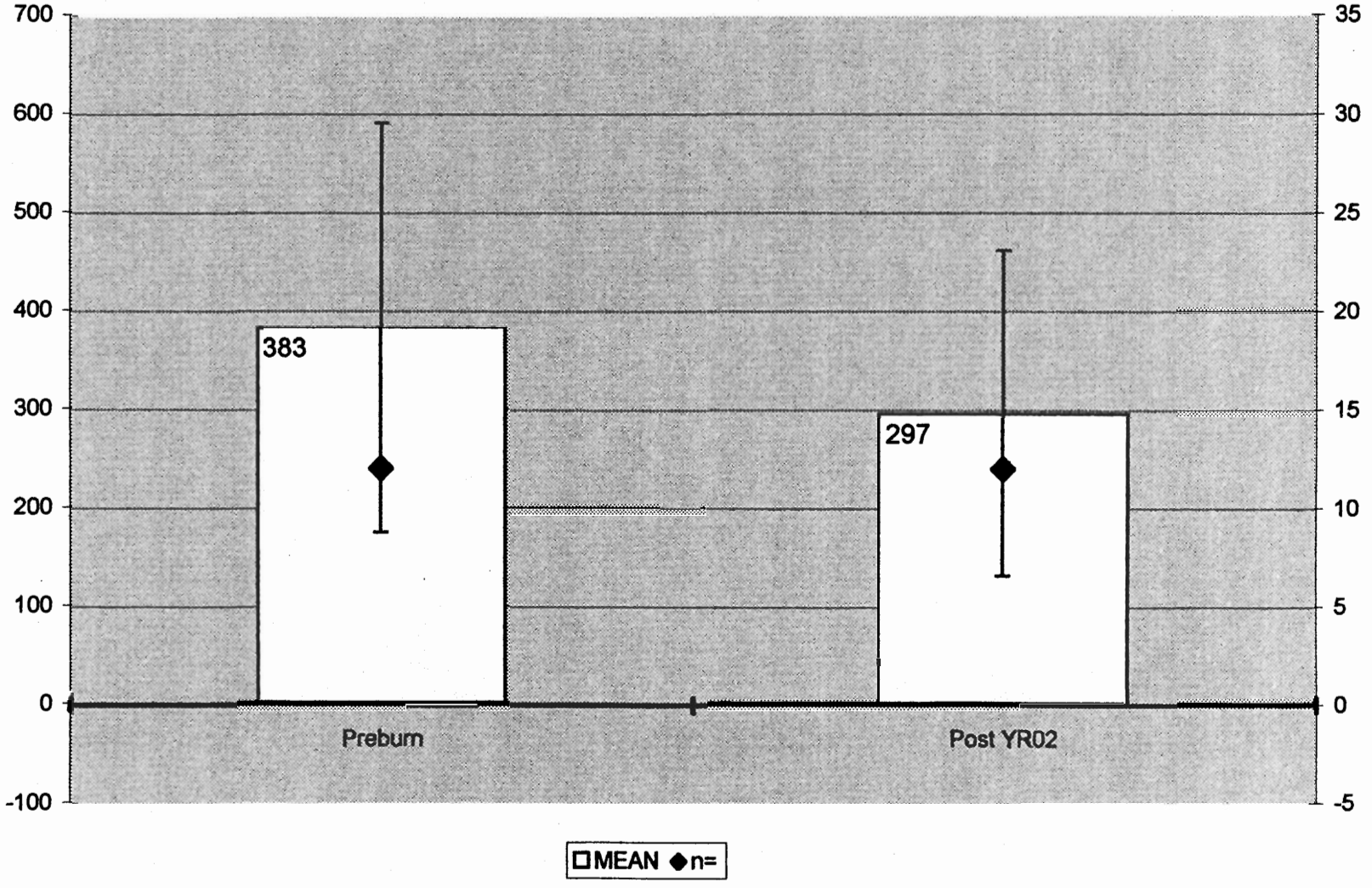
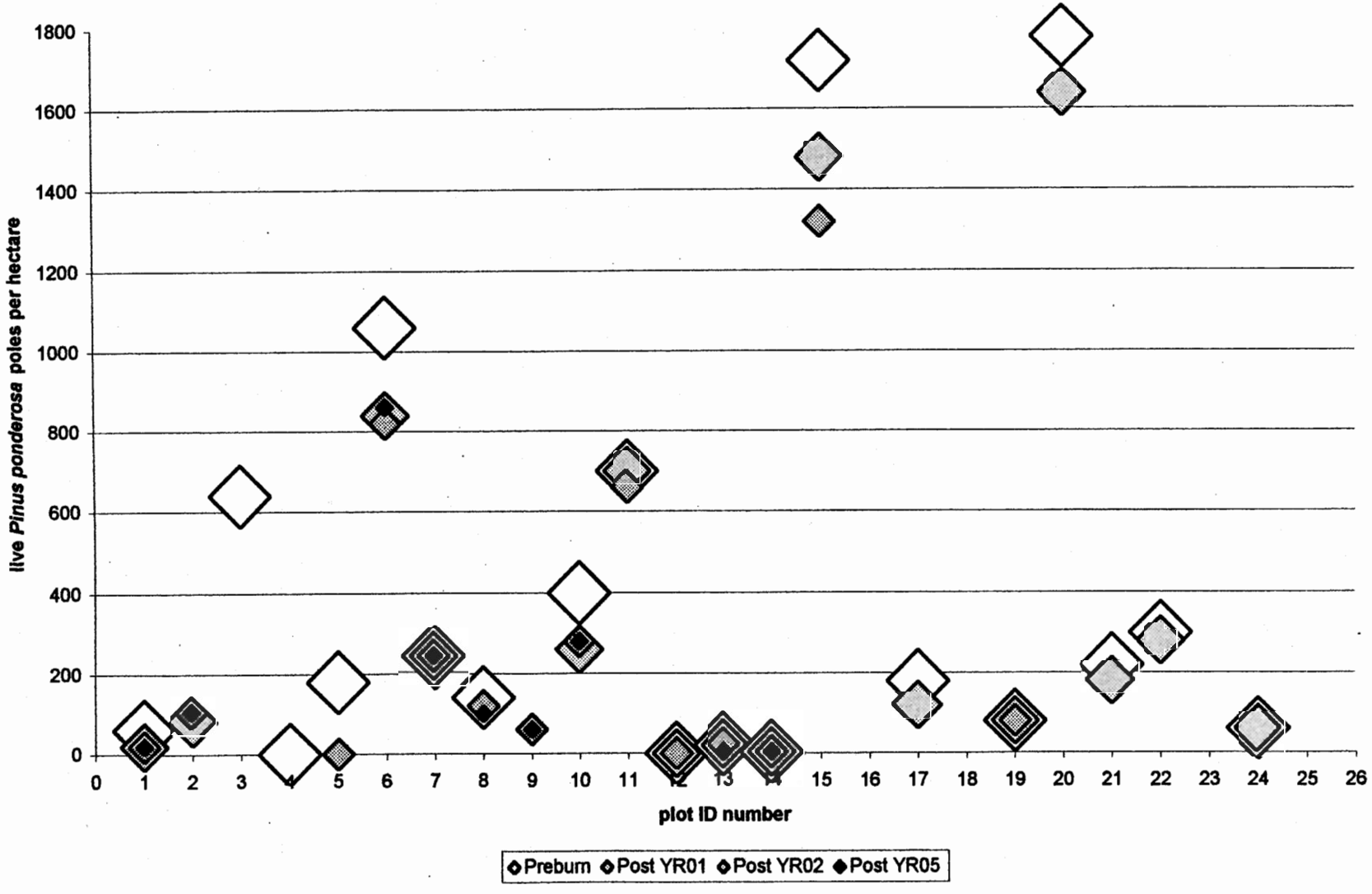


Figure 11. Change in *Pinus ponderosa* pole density in PIPO plots, by plot



PIPN Results and Discussion

Overstory

Objective 1: The revised FMH-4 for PIPN has an objective to limit five-year mortality of overstory ponderosa pine ≥16" dbh to 20% of preburn levels. However, 1998 analyses were completed using the old FMH protocols which counted all overstory trees (>6"). Analysis for ≥16" trees will be done at a later date.

Results: Although Figure 12 visually suggests that overstory density has decreased, the large size of the C.I.'s indicates that we do not have enough data to draw even informal conclusions about what may be happening over the entire monitoring type. From PRE to YR05 on the 2 plots measured, there was a 20.6% decrease in overstory ponderosa pine. However, there are still an average of 365 overstory ponderosa per hectare (148 trees/ac).

Figure 13 shows the actual values for each plot measurement. It shows a decrease in overstory density in 2 out of 2 plots with data beyond the preburn read. These two plots are located on the NW I prescribed burn unit. The other PIPN plots on the graph have only been preburn read.

Was objective met? Unknown.

Objective 2: Limit scorch of overstory ponderosa pine ≥ 16" dbh to 30% of crown immediately postburn.

Results: This objective was not evaluated for 1998 since this is a new objective in the 1999 FMH-4s. It will be evaluated for the 1999 report.

Was Objective met? Unknown.

Fuels

Objective: Reduce total woody fuel load by the levels indicated below, immediately postburn.

Woody Size Class	Goal	Actual
1-hour fuels	40-100% reduction	50% reduction
10-hour fuels	40-100% reduction	50% reduction
100-hour fuels	40-100% reduction	14% reduction
1000-hour fuels	40-80% reduction	74% reduction

Results: Figure 14 has wide error bars because there are only two plots represented on this graph with quite a difference in the two fuel loads. When the fuel loads are closer together (as in YR02), the error bars are smaller. It is not possible to infer from these graphs whether or not a real change in fuel load has occurred, especially with such wide and overlapping confidence intervals. Only 6 plots are installed to date (2 of which have been visited postburn), with a plan to have at least 10 installed by the end of 1999.

Figure 15 shows that the plots represented in Figure 14 (plots 1 and 2) are also the plots with the highest fuel loads in the monitoring type so far. In other words, an "average" preburn total fuel load of 40 tons/acre is probably a high estimate for this monitoring type.

Was objective met?
1-hour fuels, yes on the two plots measured.

10-hour fuels, yes on the two plots measured.
100-hour fuels, no on the two plots measured.
1000-hour fuels, yes on the two plots measured.

Poles

Objective: Reduce ponderosa poles of 1-6" dbh to average 0-494 trees/ha (0-200 trees/ac) by 2 years postburn.

Results:
Figure 16 shows pole densities from PRE to YR02 in the two plots that have postburn data. Although the C.I.'s are reasonably small, the sample size is small enough to make the results an unreliable indicator for the entire monitoring type. In the two plots measured, there was a 32% decrease in ponderosa pole density, from 250 poles/ha (100 poles/ac) to 170 poles/ha (70 poles/ac).

Figure 17 shows plot-by-plot changes in ponderosa pole densities for PIPN. Of 2 plots with data after the preburn read, 1 showed a decrease and the other showed no clear trend.

Was objective met? Yes, for the two plots measured.

Figure 12. *Pinus ponderosa* overstory density, in PIPN PRE and YR05 plots (same plots only)

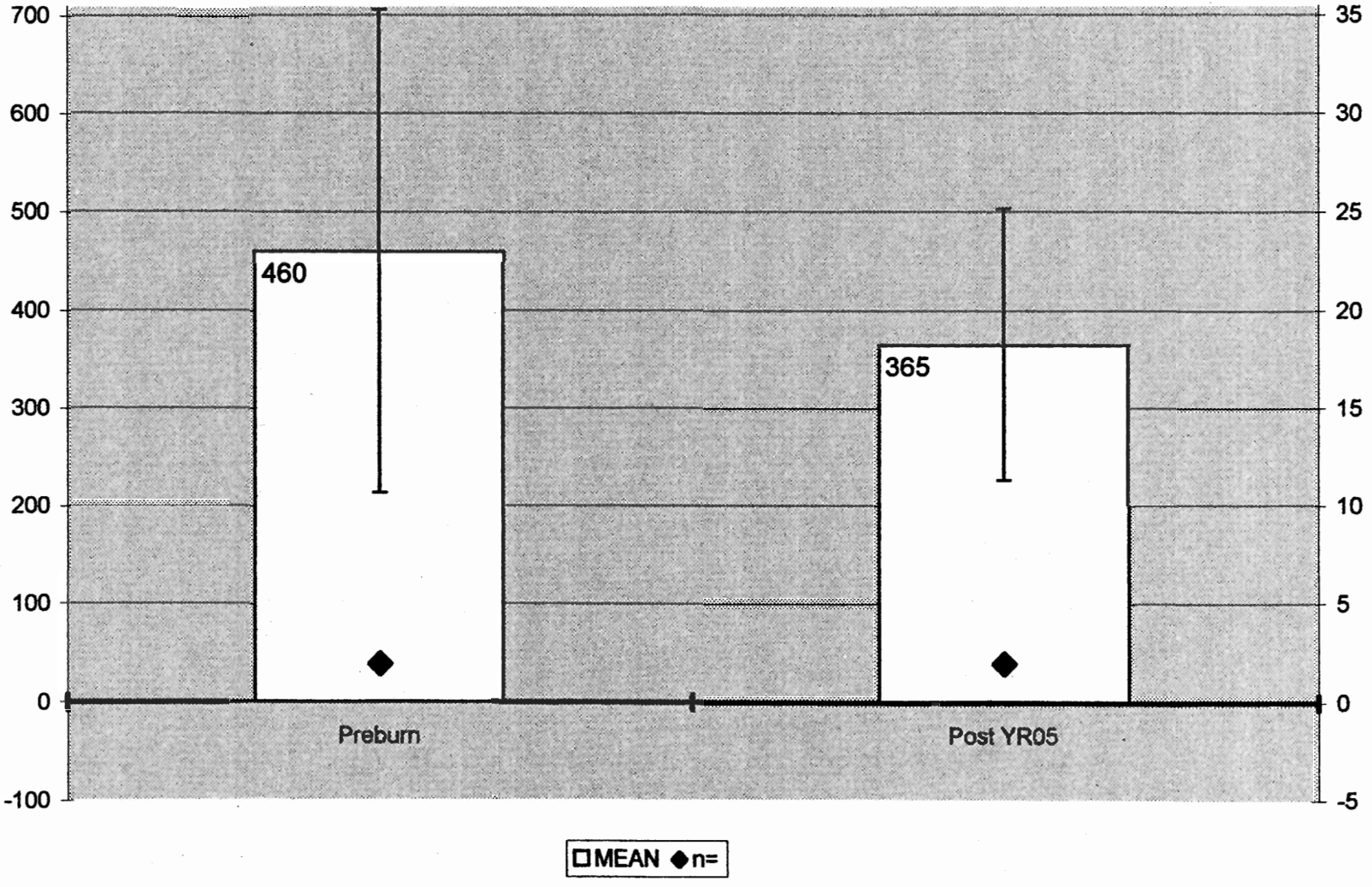


Figure 13. Change in *Pinus ponderosa* overstory density in PIPN plots, by plot

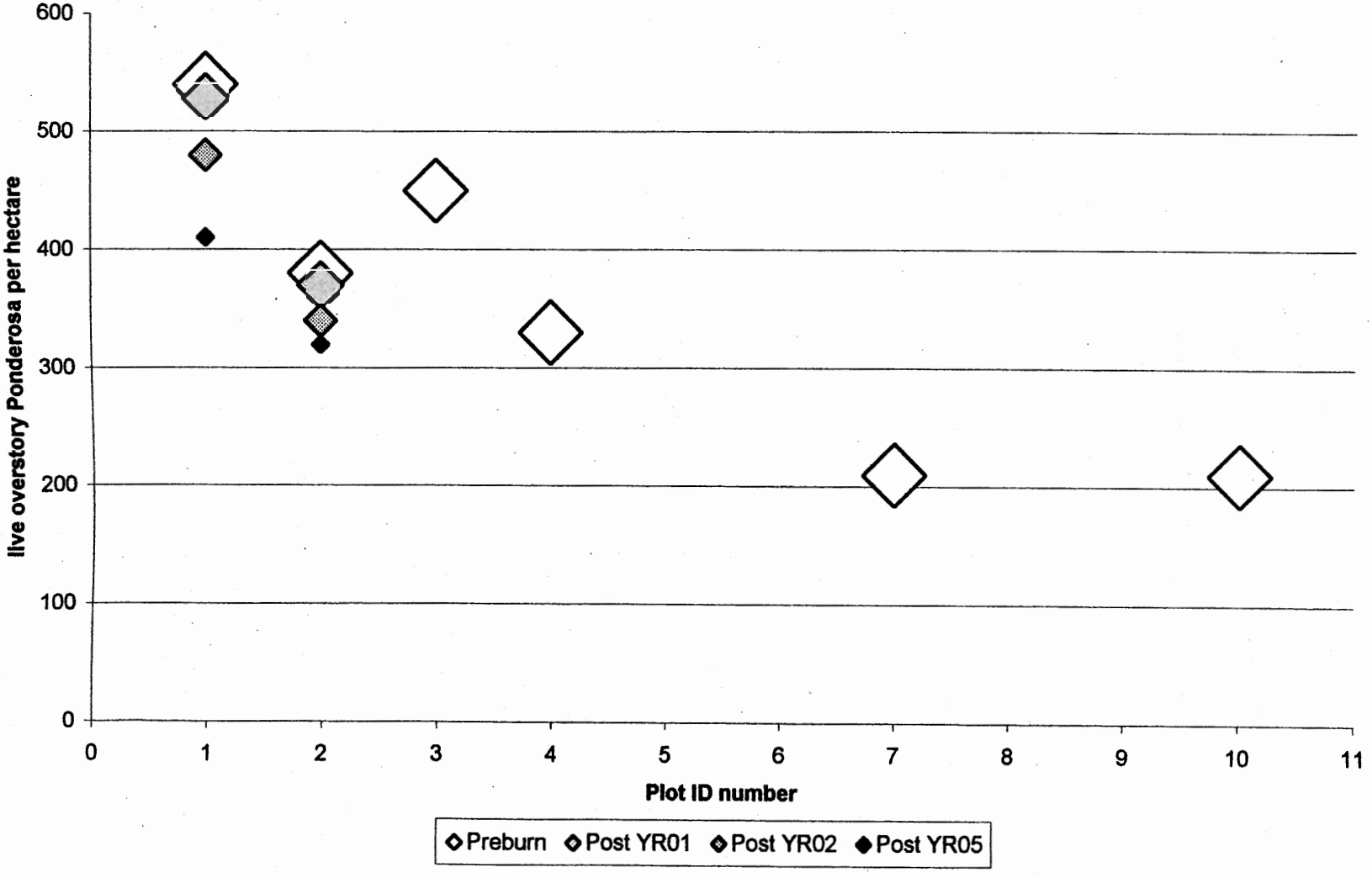


Figure 14. Total Fuel Reduction for North Rim Ponderosa Pine (PIPN)

December 1998

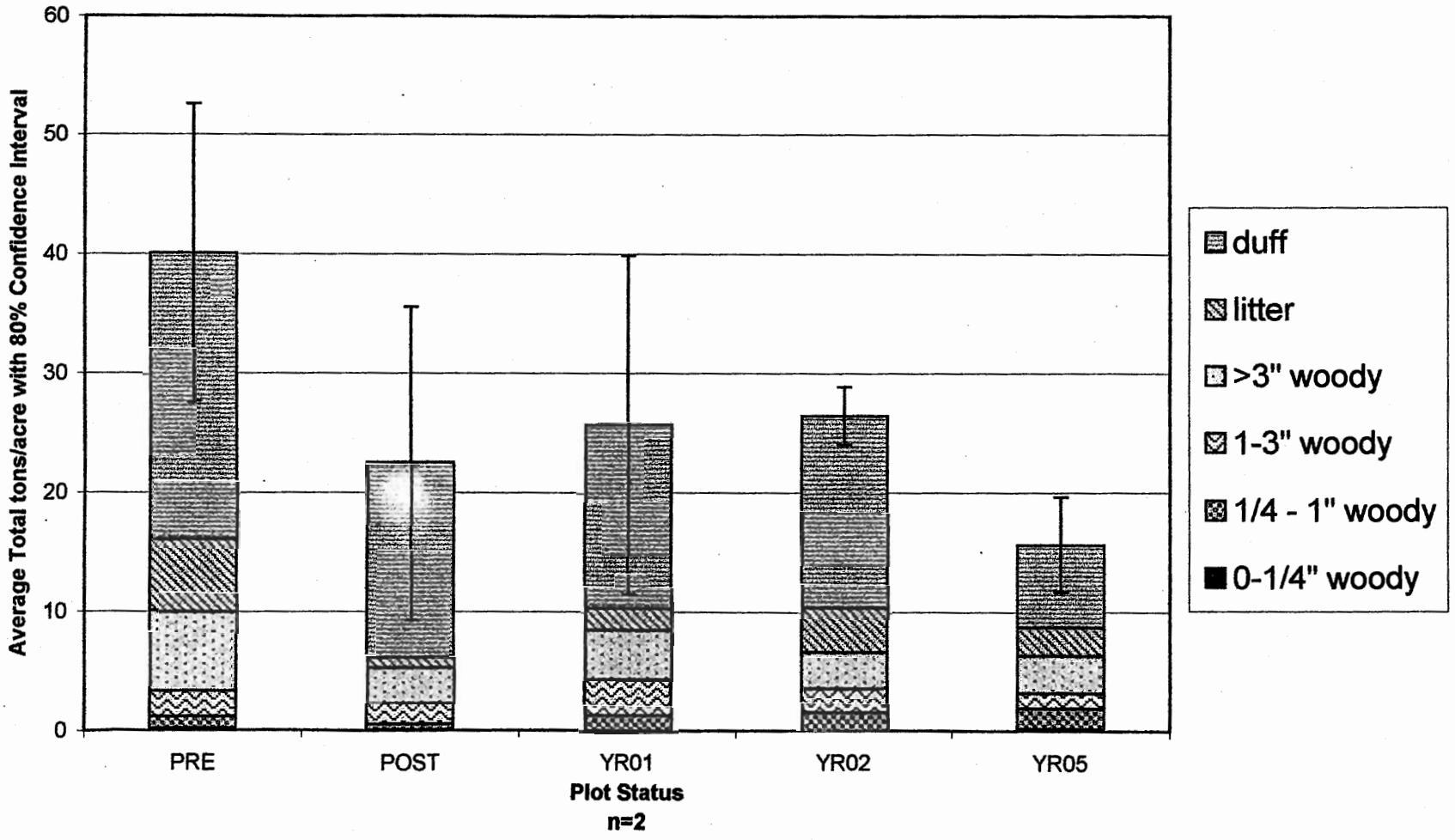


Figure 15. Change in Total PIPN Fuel Load by Plot

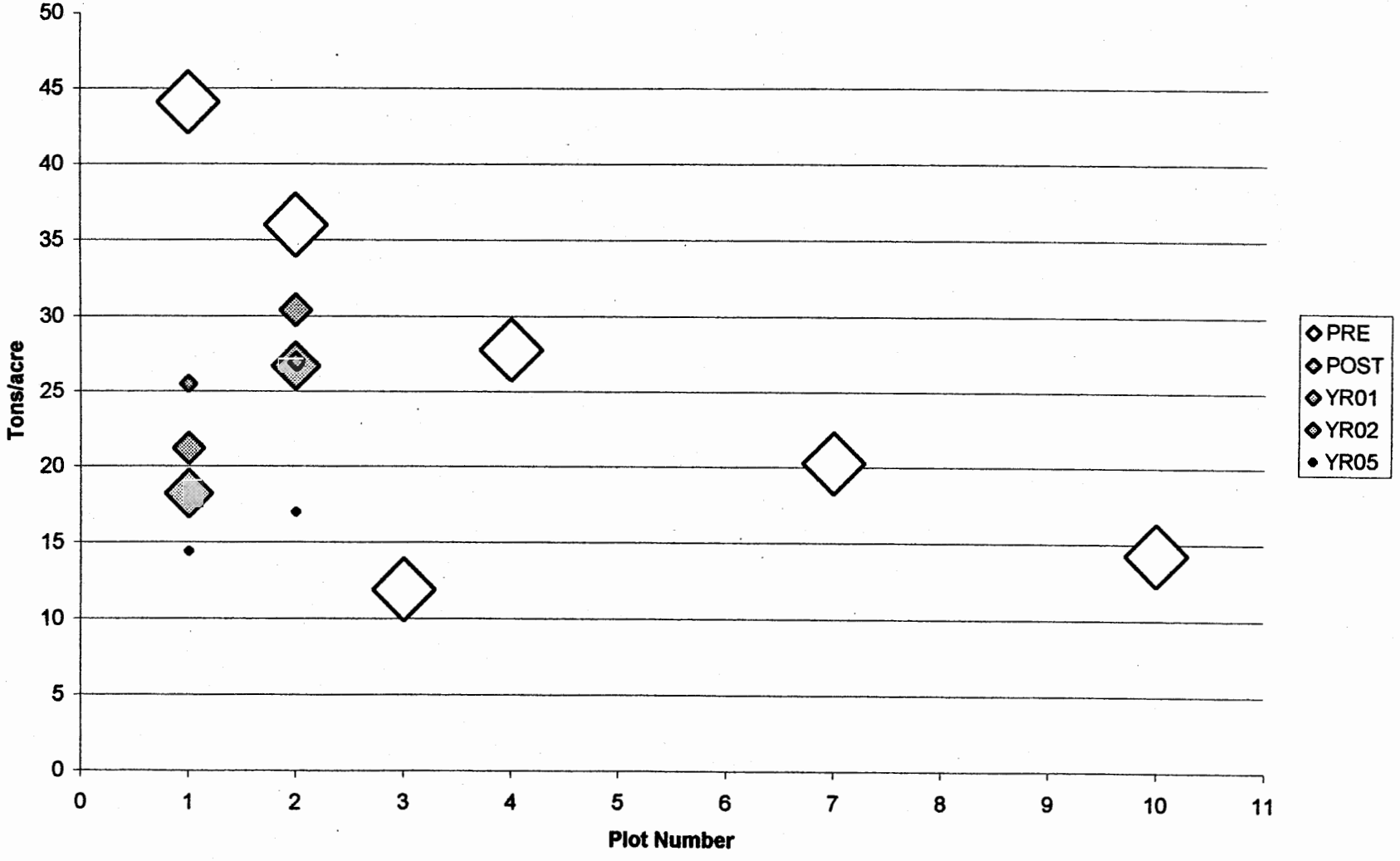


Figure 16. *Pinus ponderosa* pole density, in PIPN PRE and YR02 plots (same plots only)

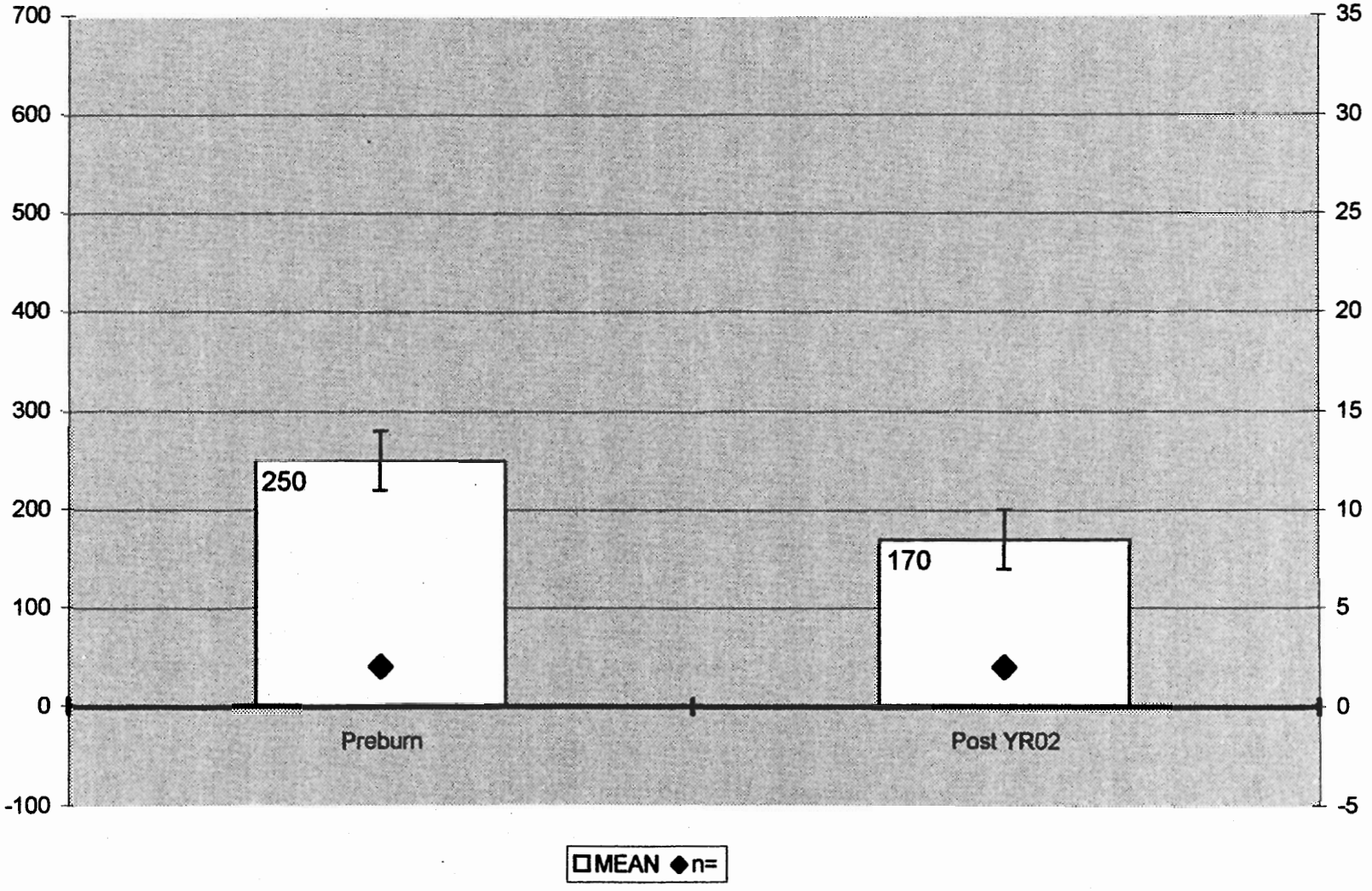
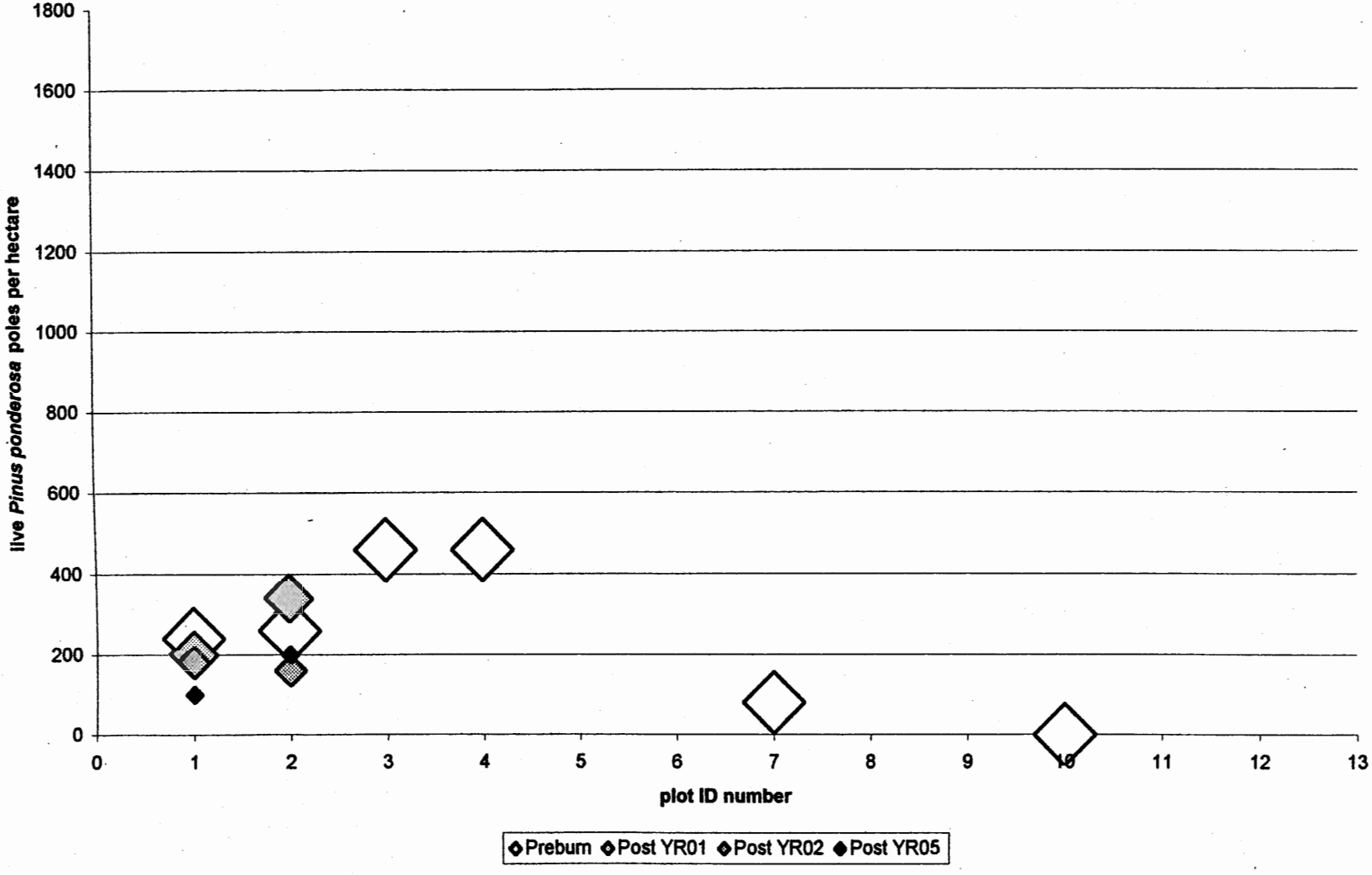


Figure 17. Changes in *Pinus ponderosa* pole density in PIPN plots, by plot



PIAB Results and Discussion

Overstory

Objective 1: Limit overstory mortality of ponderosa pine trees ≥16" dbh to 20% from PRE to 5 years postburn. For 1998, all overstory (>6" dbh) ponderosa were used for the analysis, rather than just those ≥ 16" dbh. In future analyses, the size classes will be divided appropriately, with separate calculations performed for trees greater than 16" dbh.

Results: Figure 18 suggests that no change has occurred, but only 2 plots have reached year 5. This, and the large C.I. for the year 5 data, indicate that no reliable conclusions can be drawn for the entire monitoring type. Within these 2 plots only, overstory density decreased 13%.

Figure 19 shows the actual values for each plot measurement. It shows that we have 4 plots with data beyond the preburn read, and no particular direction of change is obvious.

Was objective met? Yes, on the two plots measured.

Objective 2: Limit crown scorch of ponderosa ≥ 16" dbh to ≤ 30% immediately postburn. The crown scorch objective has been recently revised, and at this point, we have not compiled the data to evaluate this objective.

Results: None.

Was objective met? Unknown.

Fuels

The objective for fuels in this monitoring type is to reduce the woody fuel load by the amounts listed below, immediately postburn.

Woody Size Class	Goal	Actual
1-hour fuels	40-100% reduction	33% reduction
10-hour fuels	40-100% reduction	17% reduction
100-hour fuels	40-100% reduction	22% reduction
1000-hour fuels	40-80% reduction	40% reduction

Figure 20 shows total fuel reduction (woody, litter, and duff combined) for the PIAB monitoring type. Six plots are included here, but seven plots are needed for the precision desired. Again, the confidence interval is large is the PRE column due to high variations in measured fuel loads.

The scatter plot in Figure 21 shows how fuel loads are changing across the whole plot network. It is easy to see that many of the plots have not been burned yet. Diamond shapes that resemble more of a bull's eye suggest that the plot fuel load did not change much at all (Plots 12 and 22), while others show more change (Plots 7 and 25). Plots 7 and 25 were burned on the Northwest III prescribed burn in 1993 which was converted to a wildfire. Plots 12 and 22 were burned with aerial ignition (PSD) in July 1997 in the Tiyo/Outlet prescribed burn.

Was objective met?
1-hour fuels: No on the six plots measured.
10-hour fuels: No on the six plots measured.
100-hour fuels: No on the six plots measured.

1000-hour fuels: Yes on the six plots measured.

PIAB poles

Objective: Reduce white fir poles by 20-70% between PRE and YR02 to average 247 trees/ha (0-100 trees/ac).

Results: Although Figure 22 suggests a decrease in pole density at YR01, the small sample size and large C.I.'s indicate that no conclusions can be drawn. Plots cannot be evaluated at YR02 yet because there is only one plot that has reached YR02 status so far.

Figure 23 shows the status of poles in the PIAB plot network. Of 3 plots with data, 1 has shown a definite decrease, 1 a slight decrease, and 1 a slight increase.

Was objective met? Unknown.

Figure 18. *Pinus ponderosa* overstory density, in PIAB PRE and YR05 plots (same plots only)

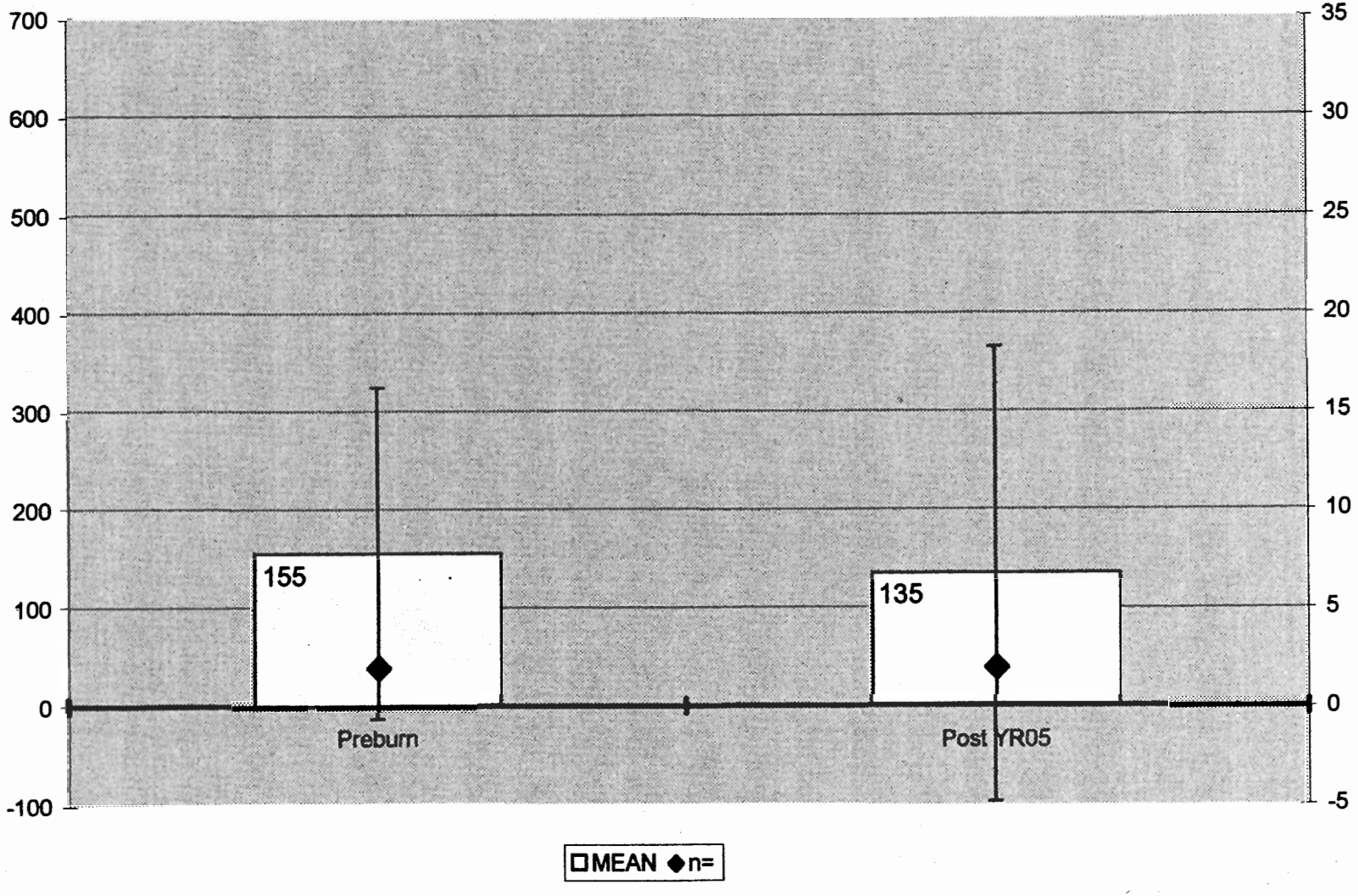


Figure 19. Change in *Pinus ponderosa* overstory density in PIAB plots, by plot

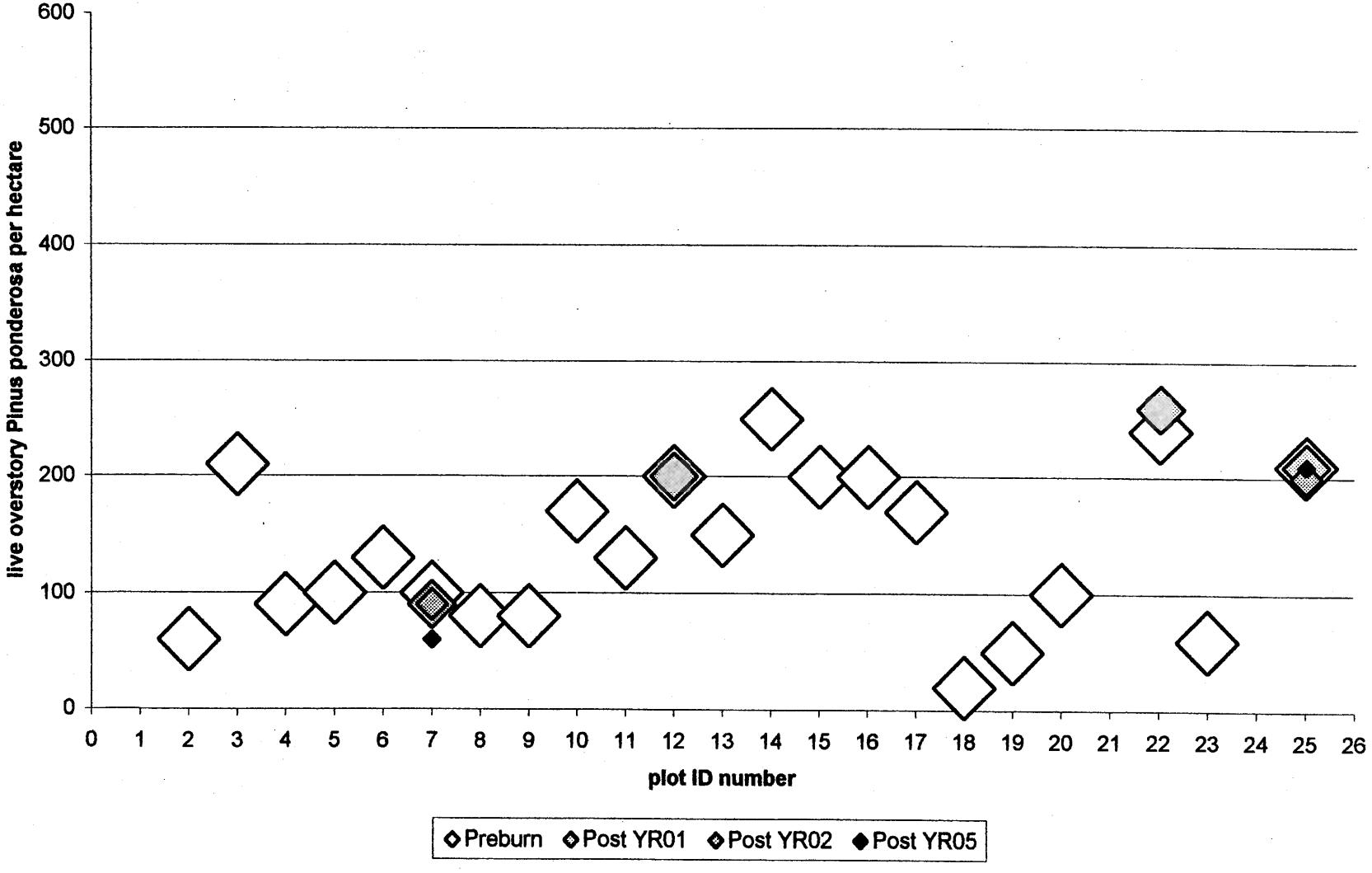


Figure 20. Total Fuel Reduction for Ponderosa with White Fir (PIAB)
December 1998

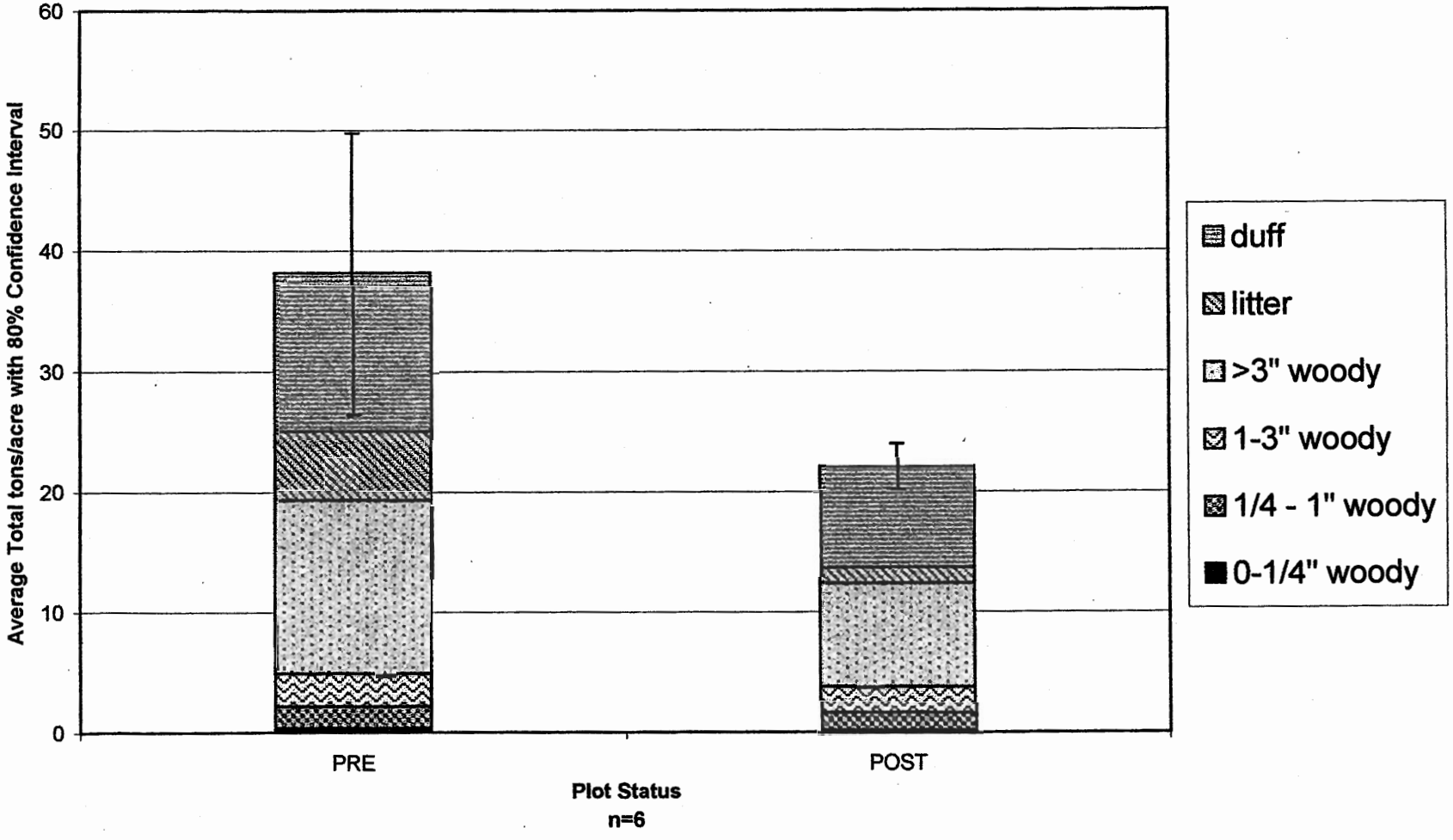


Figure 21. Change in Total PIAB Fuel Load by Plot

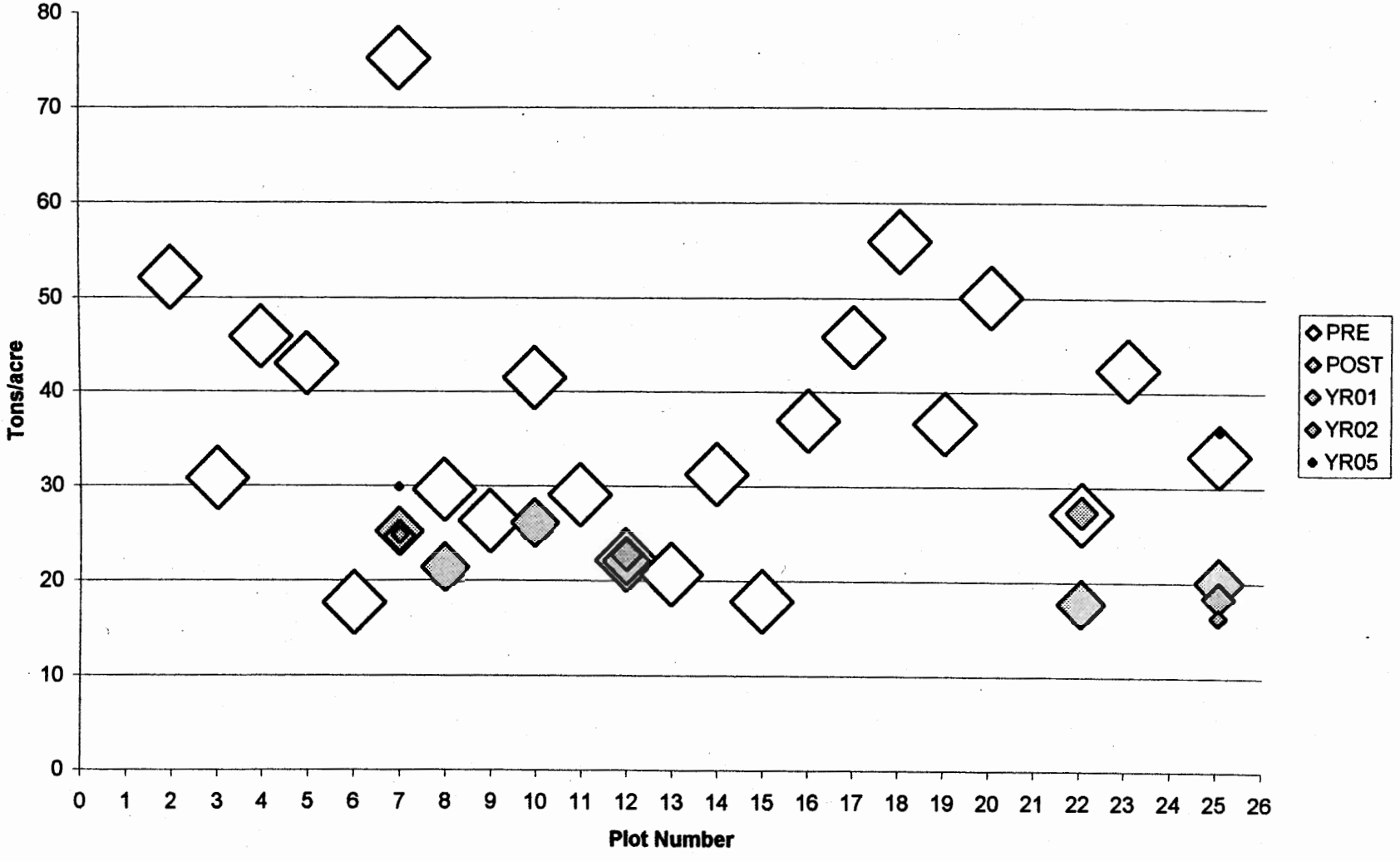


Figure 22. *Abies concolor* pole density, in PIAB PRE and YR01 plots (same plots only)

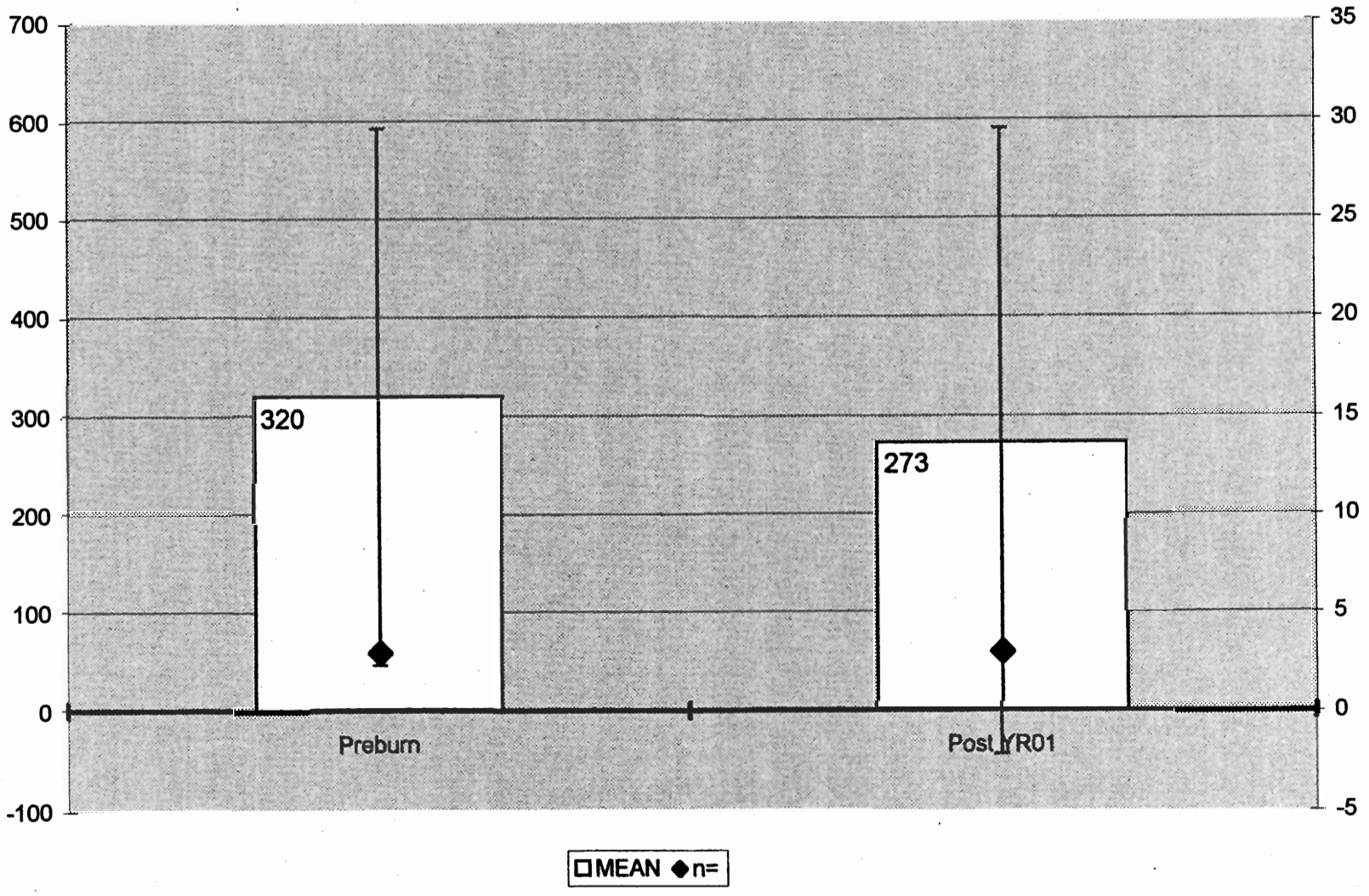
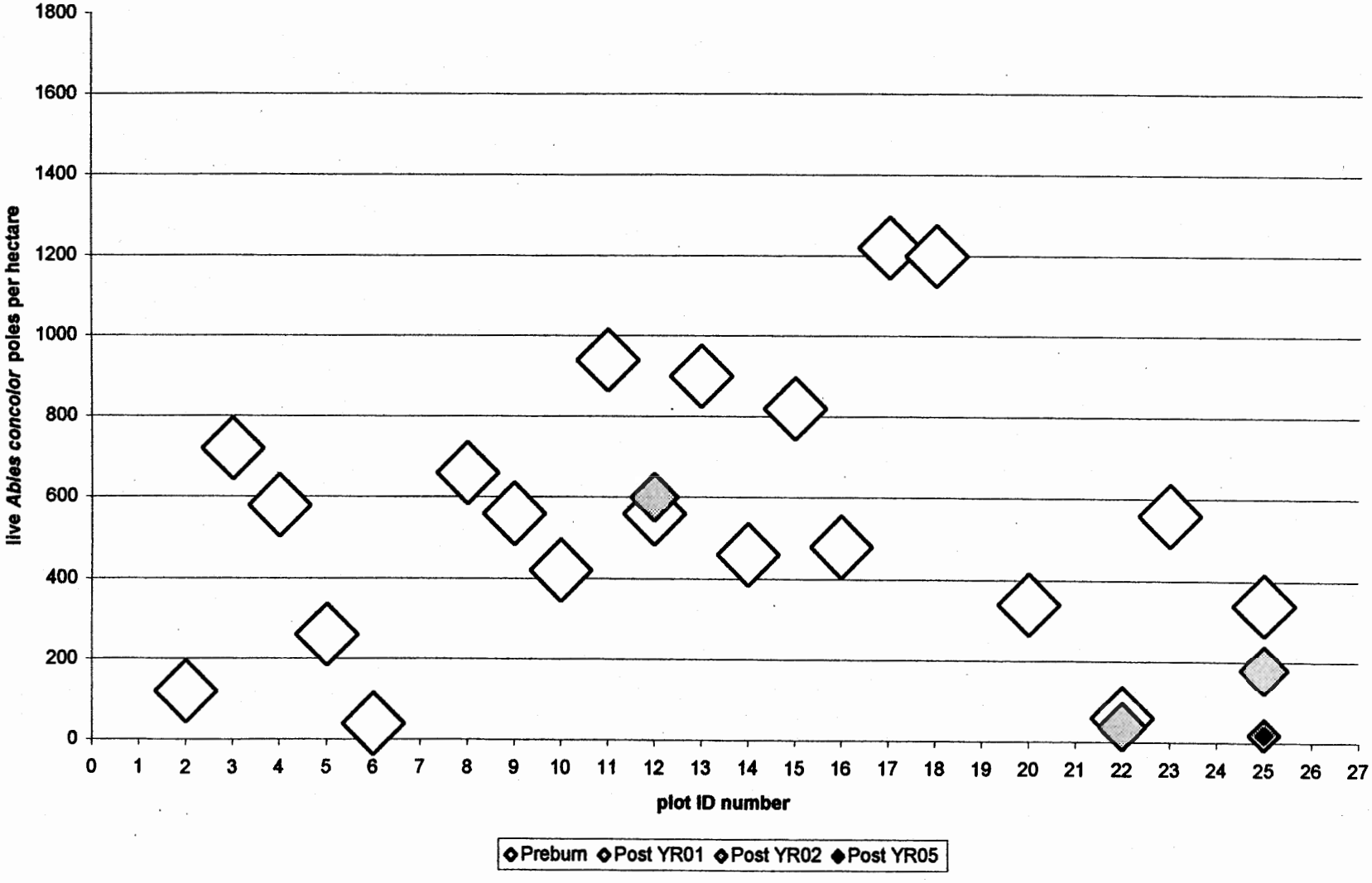


Figure 23. Change in *Abies concolor* pole density in PIAB plots, by plot



Conclusions

There are mixed results in the accomplishment of specific prescribed fire objectives as related to vegetation. Table 10 summarizes successes and failures in meeting the stated objectives.

Table 10. Was the objective met?

	PIED	PIPO	PIPN	PIAB
1-hour fuels	Yes	Yes	Yes	No
10-hour fuels	Yes	No	Yes	No
100-hour fuels	Yes	Yes	No	No
1000-hour fuels	Yes	Yes	Yes	Yes
Overstory Mortality	Yes	Yes	Unknown	Yes
Overstory Scorch	Unknown	Unknown	Unknown	Unknown
Poles	N/A	No, but need 73 plots	Yes, for 2 plots	Unknown (PIAB poles only)

More plots need to be installed and more analysis completed. We made a lot of progress this year in improving the plot network by organizing the files, understanding where information was missing, correcting problems, refining protocols, and writing objectives. Now that some of the basic analysis is completed, we are in a position to explore the data more thoroughly.

FMH-4 MONITORING TYPE DESCRIPTION SHEET
Grand Canyon National Park

Monitoring Type Code: FPIED1D02

Monitoring Type Name: Great Basin Conifer Woodland

Prepared by: Tonja Opperman and Ken Kerr

Date: February 17, 1999

PHYSICAL DESCRIPTION

Located at 6400 to 7000 feet elevation on the South Rim with 0-20% slope, all aspects. Soils are shallow and loamy with gravelly consistency derived from Kaibab limestone. Bare, rocky areas are common.

BIOLOGICAL DESCRIPTION

Ninety percent of overstory stems are pinyon pine and/or Utah juniper with ponderosa pine as an occasional overstory tree; absolute canopy cover is 20-60%. The understory is sparse with pole trees of same species as overstory except for an occasional Gambel oak. Shrubs include mormon tea, banana yucca, snakeweed, serviceberry, cliffrose, apache plume, and rabbitbrush. Herbaceous plants include bluegrass, paintbrush, blue grama, locoweed, lupine, and squirreltail. Combined cover for brush and herbs is <50%.

REJECTION CRITERIA

Large rock outcroppings or barren areas >20% of the plot; areas with anomalous vegetation, boundary fences; areas within 30 meters of roads, utility corridors, human-created trails, human-created clearings, or slash piles; areas within 10 meters of significant historic or prehistoric sites or transitional ecotones; areas burned within the past 10 years; areas with more than 3 overstory ponderosa pine trees or >10% ponderosa pine cover; areas with >75% cover of either pinyon pine or Utah juniper.

DESIRED FUTURE CONDITION

This monitoring type is mainly located around the South Rim Village area and is being treated to reduce hazardous fuel conditions that could present an urban interface problem. One goal for this monitoring type is to maintain the fuel load at a level that does not exceed 20 tons/acre. A second goal is to limit the overstory tree mortality to 20%, but at this time there has not been a comprehensive literature search to determine what a realistic overstory density goal should be. A study in northern Arizona suggests an average of 360 trees/ha (145 trees/acre) (Klopatek 1986) on 3 plots. This monitoring type is not burned with a true underburn in many instances, but is instead pile burned due to concerns around developed areas.

BURN PRESCRIPTION

Units will be burned during the monsoon season or from September until May or until green-up using head, flanking, and backing fires as needed to meet burn objectives.

Fire Prescription Elements	
RH = 20-50%	Live Fuel Moisture = 60-120%
Dry Bulb = 50-90 F	Average Flame Length = 1-6 feet
Average Mid-flame Winds=0-7mph G15mph	Average Rate of Spread = 1-28 chs/hour
10-hour TLFM = 6-12%	1000-hour TLFM = 9-20%

PRESCRIBED FIRE PROJECT OBJECTIVES—First Entry Burn

1. Reduce total average fuel load (including all woody material, litter, and duff) so as not to exceed 20 tons/acre (49 tons/ha). *Preburn fuel loads range from 6 to 26 tons per acre (15-64 tons/ha) on 5 plots.*
2. Limit overstory mortality of all species to an average of 20% within 5 years post-burn.

FIRE MONITORING OBJECTIVES

1. Install enough plots to sample total fuel load with 80% confidence that totals are within 20% of the true population mean.
2. Install enough plots to sample overstory tree density with 80% confidence that values are within 20% of the true population mean.

DATA ANALYSIS

1. Track total fuel load for all reads from PRE to YR05, broken down by size class, litter, and duff.
2. Track overstory density from PRE to YR05 for all species combined.
3. Compute a percent mortality for overstory trees at YR05, all species combined.

Literature Cited

Klopatek, J.M. 1986. Nutrient patterns and succession in pinyon-juniper ecosystems of northern Arizona. In: Proceedings—pinyon-juniper conference. USDA Forest Service GTR-INT-215 pp 391-396.

Plot Protocols for PIED

GENERAL PROTOCOLS		YES (√)	NO (√)		YES (√)	NO (√)
Preburn	Control Plots/Opt		√	Herb Height/Rec	√	
	Herbaceous Density/Opt		√	Abbreviated Tags	√	
	OP/Origin Buried		√	Crown Intercept/Opt		√
	Voucher Specimens/Rec	√		Herb. Fuel Load/Opt		√
	Stereo Photography/Opt		√	Brush Individuals/Rec	√	
	Belt Transect Width	2 x 50 meters		Stakes Installed: All		
	Number of Belts recorded	2				
	Herbaceous Data and Brush Data Collected at: Q4-Q1 and Q3-Q2					
Burn and Postburn	Duff Moisture/Rec		√	Flame Zone Depth/Rec	√	
	Herbaceous Data/ Opt		√	Herb. Fuel Load/Opt		√
	100 Pt. Burn Severity/Opt	√				

FOREST PLOT PROTOCOLS		YES (√)	NO (√)		YES (√)	NO (√)
Overstory	Area sampled	50 x 20 m		Quarters Sampled	Q1,Q2,Q3,Q4	
	Tree Damage/Rec	√		Crown Position/Rec	√	
	Dead Tree Damage/Opt		√	Dead Crown Position/Opt	√	
Pole-size	Area Sampled	25 X 20 m		Quarters Sampled	Q1 & Q2	
	Height/Rec	√		Poles Tagged/Rec	√	
Seedling	Area Sampled	25 X 10 m		Quarters Sampled	Q1	
	Height/Rec	√		Seedlings Mapped/Opt		√
Fuel Load	Sampling Plane Length	100 feet		Fuel Continuity/Opt		√
	Aerial Fuel Load/Opt		√			
Postburn	Char Height/Rec	√		Mortality/Rec	√	

Rec = Recommended Opt = Optional

FMH-4 MONITORING TYPE DESCRIPTION SHEET
Grand Canyon National Park

Monitoring Type Code: FPIPO1D09

Monitoring Type Name: South Rim Ponderosa Pine

Prepared by: Tonja Opperman and Ken Kerr

Date: March 17, 1999

PHYSICAL DESCRIPTION

Located at 6000 to 7500 feet elevation on the South Rim on level to rolling terrain, including all aspects. Soils are moderately shallow with a silty loam texture. All are derived from Kaibab limestone parent material. Occasional barren rock outcrops.

BIOLOGICAL DESCRIPTION

Total overstory[1] stems are 50-100% *Pinus ponderosa*. *Pinus edulis, Juniperus osteosperma*, and *Quercus gambelli* may be present. Absolute canopy cover is 20-60%. The understory is likely a mix of the same overstory species. Common shrubs include *Artemisia tridentata, Gutierrezia sarothrae*, and *Cowania mexicana*. Common herbaceous plants include *Bouteloua gracilis, Poa fendlariana, and Lupinus* spp.

REJECTION CRITERIA

Large rock outcroppings or areas >20% of the plot with <10% ground cover; areas with anomalous vegetation, boundary fences; areas within 30 meters of roads, utility corridors, human-created trails, human-created clearings, or slash piles; areas burned within past 10 years; areas within 10 meters of significant historic or prehistoric sites or transitional ecotones. Areas with greatest amount of basal area contained in a species other than ponderosa pine.

DESIRED FUTURE CONDITION

At this time a literature search has been initiated to determine the desired future condition of ponderosa forests at Grand Canyon National Park, but it is not complete. Preliminary research suggests that there were anywhere from 19-25 overstory trees per acre (47-62 trees/ha) during pre-settlement and ponderosa pine comprised over 90% of the basal area, with the remainder occupied by pinyon, juniper, and Gambel oak (Covington 1994, Covington et al. 1998). Usually crown cover was less than 25% with trees clumped in groups of 2-44 individuals (Woolsey 1911, White 1985). All size classes were typically represented, but it was not a continuous pattern—trees were arranged in distinct size groups due to a number of decades between regeneration events (White 1985). Frequent openings occurred, dominated by grasses and other herbaceous plants. Total fuel loads were typically 2 to 8 tons/acre (5-20 tons/ha) with averages estimated from 0.2 to 9.3 tons/acre (0.5-23 tons/ha) (Covington 1992, Covington 1994, Harrington and Sackett 1992).

BURN PRESCRIPTION

Units will be burned during the growing, transition, and dormant seasons with head, flanking, and backing fires as needed to meet burn objectives. Units may be burned at six-year intervals for up to three consecutive treatments or until a Desired Future Condition is met.

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[1] Overstory trees are defined in the Fire Monitoring program as trees with a diameter at breast height of 15 cm (6 in) or greater. This definition does not take individual tree dominance or crown position into account.

Fire Prescription Elements	
RH = 10-80%	Live Fuel Moisture = n/a
Dry Bulb = 40-80 F	Average Flame Length = 1-10 feet
Average Mid-flame Winds=0-15mph G30mph	Average Rate of Spread = 1-40 chs/hour
10-hour TLFM = 3-15%	1000-hour TLFM = 9-25%

PRESCRIBED FIRE PROJECT OBJECTIVES—First Entry Burn

Immediately Post-Burn:

1. Reduce average woody (dead and down) preburn fuel load over landscape, with average percent reductions in the following size classes:
   a) 1-hour fuel size class reduction by 40-100% (currently 0.1 t/ac, 0.2 t/ha)
   b) 10-hour fuel size class reduction by 40-100% (currently 0.7 t/ac, 1.7 t/ha)
   c) 100-hour fuel size class reduction by 40-100% (currently 1.0 t/ac, 2.5 t/ha)
   d) 1000-hour fuel size class reduction by 40-80% (currently 2.3 t/ac, 5.8 t/ha)

2. Limit crown scorch to 30% on *Pinus ponderosa* with dbh greater than or equal to 16" (40 cm).

Two Years Post-Burn:

1. Reduce *Pinus ponderosa* poles with dbh of 1-6 inches (2.5-15 cm) to average 0-200 trees/acre (0-494 trees/ha). *This is a conservative target and more research is needed to define a better pole density target; there are currently 0-730 poles/ac (0-1800 poles/ha) of* Pinus ponderosa *in this size class.*

Five Years Post-Burn

1. Limit mortality of *Pinus ponderosa* with dbh greater than or equal to 16 inches (40 cm) to 20%. *Pre-burn densities for* Pinus ponderosa *in this size class average 20 trees/acre (49 trees/ha).*

PRESCRIBED FIRE PROJECT OBJECTIVES—Second Entry Burn

Objectives will be written for this section, once results from first entry burn are known.

PRESCRIBED FIRE PROJECT OBJECTIVES—Third Entry Burn

Objectives will be written for this section, once results from first and second entry burns are known.

FIRE MONITORING OBJECTIVES

1. Install enough plots to be 80% confident that overstory ponderosa pine density figures are within 20% of the true population mean.
2. Install enough plots to be 80% confident that total fuel load estimates are within 20% of the true population mean.
3. With less than 30 plots, estimate pole densities with the most confidence possible. At this time over 70 plots are needed to monitor poles due to a high variation in the preburn pole densities.

DATA ANALYSIS

1. Compute scorch heights on ponderosa pine overstory trees and report figures with average and range for each prescribed burn and for the entire monitoring type.
2. Track percent change in total fuel load by year and percent change between all size classes, litter, and duff through YR05.
3. Track overstory density by size class for ponderosa pine for each postburn year through YR05.
4. Track ponderosa pine pole tree densities by size class for each postburn year through YR02.
5. Track overstory snag densities (defined as greater than six inches dbh) with the most confidence possible, categorized by size classes.
6. Track changes in herbaceous layer species composition categorized by native/non-native.

Literature Cited

Covington, W.W. and M.M. Moore. 1992. Postsettlement changes in natural fire regimes: implications for restoration of old-growth ponderosa pine forest. *In* Old-growth forests in the Southwest and Rocky Mountain regions: proceedings of a workshop, p. 81-99. USDA For. Serv. Gen. Tech. Rep. RM-213. 201p.

Covington, W.W. and M.M. Moore. 1994. Southwestern ponderosa pine forest structure. J. For. 39-47.

Covington, W.W., M.M. Moore, P.Z. Fule, H.B. Smith. 1998. Grand Canyon Forest Ecosystem Restoration Report on Pre-treatment measurements of experimental blocks. Northern Arizona University unpublished manuscript.

Harrington M.G.and S.S. Sackett. 1992. Past and present fire influences on southwestern ponderosa pine old growth. *In* Old-growth forests in the Southwest and Rocky Mountain regions: proceedings of a workshop, p. 81-99. USDA For. Serv. Gen. Tech. Rep. RM-213. 201p.

White, A.S. 1985. Presettlement regeneration patterns in a southwestern ponderosa pine stand. Ecology 66:589-94.

Woolsey, T.S. Jr. 1911. Western yellow pine in Arizona and New Mexico. USDA For. Serv. Bull. 101. 64pp.

Plot Protocols for PIPO

GENERAL PROTOCOLS		YES (√)	NO (√)		YES (√)	NO (√)
Preburn	Control Plots/Opt		√	Herb Height/Rec	√	
	Herbaceous Density/Opt		√	Abbreviated Tags	√	
	OP/Origin Buried		√	Crown Intercept/Opt		√
	Voucher Specimens/Rec	√		Herb. Fuel Load/Opt		√
	Stereo Photography/Opt		√	Brush Individuals/Rec	√	
	Belt Transect Width	2 x 50 meters		Stakes Installed: All		
	Number of Belts recorded	2				
	Herbaceous Data and Brush Data Collected at: Q4-Q1 and Q3-Q2					
Burn and Postburn	Duff Moisture/Rec		√	Flame Zone Depth/Rec	√	
	Herbaceous Data/ Opt		√	Herb. Fuel Load/Opt		√
	100 Pt. Burn Severity/Opt	√				

FOREST PLOT PROTOCOLS		YES (√)	NO (√)		YES (√)	NO (√)
Overstory	Area sampled	50 x 20 m		Quarters Sampled	Q1,Q2,Q3,Q4	
	Tree Damage/Rec	√		Crown Position/Rec	√	
	Dead Tree Damage/Opt		√	Dead Crown Position/Opt	√	
Pole-size	Area Sampled	25 X 20 m		Quarters Sampled	Q1 & Q2	
	Height/Rec	√		Poles Tagged/Rec	√	
Seedling	Area Sampled	25 X 10 m		Quarters Sampled	Q1	
	Height/Rec	√		Seedlings Mapped/Opt		√
Fuel Load	Sampling Plane Length	100 feet		Fuel Continuity/Opt		√
	Aerial Fuel Load/Opt		√			
Postburn	Char Height/Rec	√		Mortality/Rec	√	

Rec = Recommended Opt = Optional

FMH-4 MONITORING TYPE DESCRIPTION SHEET
Grand Canyon National Park

Monitoring Type Code: FPIPN1D09

Monitoring Type Name: North Rim Ponderosa Pine

Prepared by: Tonja Opperman and Ken Kerr

Date: March 17, 1999

PHYSICAL DESCRIPTION

Located at 6,900 to 8,900 feet elevation on the North Rim with slopes from 0% to 60%, including all aspects and depending on elevation. Soils are moderately shallow on ridgetops with silty loams occurring in drainage bottoms. All soils are derived from Kaibab limestone parent material.

BIOLOGICAL DESCRIPTION

Total canopy cover is at least 25%. *Pinus ponderosa* dominates the overstory[1], comprising at least 80% of overstory species. Other possible overstory species include occasional *Abies concolor, Populus tremuloides, Pseudotsuga menziesii,* and *Picea engelmanni.* The understory is composed of mostly (75% or more) *Pinus ponderosa* poles. Common brush species are *Berberis repens, Rosa fendleri,* and *Ceanothus fendleri.* Common herbaceous plants include *Achillia lanulosa, Carex* spp., *Poa fendleriana, Sitanion hystrix,* and *Viguiera multiflora.*

REJECTION CRITERIA

Large rock outcroppings or barren areas >20% of the plot; areas with anomalous vegetation, boundary fences; areas within 30 meters of roads, utility corridors, human-created trails, human-created clearings, or slash piles; areas within 10 meters of significant historic or prehistoric sites or transitional ecotones; areas burned in the last 10 years; areas with >20% overstory cover of trees other than ponderosa pine; areas with pole densities including >25% species other than ponderosa pine.

DESIRED FUTURE CONDITION

At this time a literature search has been initiated to determine the desired future condition of North Rim *Pinus ponderosa* at Grand Canyon National Park, but it is not complete. These forests were likely open stands with relatively few, large overstory trees, dominated by an herbaceous understory. Research suggests in one study that there were 56 *Pinus ponderosa* trees per acre (138 trees/ha) in North Rim *Pinus ponderosa* stands (Covington 1992), and in another study that there were 40-55 trees/acre (99-136 trees/ha) on the Kaibab Plateau during presettlement times. Fuel loads ranged from 0.2 to 9.3 tons/acre (0.5-23 tons/ha) (Covington 1992). Pole-sized trees less than six inches in diameter (15 cm) were estimated to be in groups of 200-400 but no density figures are given (Rasmussen 1941). The fire frequency on the North Rim is estimated at 2 to 15 years for these elevations (Wolf and Mast 1998) but this study did not incorporate forests on the very southernmost parts of the plateaus. It is likely that the forests on the edges of the North Rim plateaus were less dense due to drier conditions and more frequent lightning-caused fires.

[1] Overstory trees are defined in the Fire Monitoring program as trees with a diameter at breast height of 15 cm (6 in) or greater. This definition does not take individual tree dominance or crown position into account.

BURN PRESCRIPTION

Units will be burned during the growing , dormant, and transition seasons from summer (June) to fall (November). In drier years the time period may move into April and/or December. The following values present a range of conditions that may be used to accomplish objectives. Optimal values and relationships exist between these ranges that relate to on-the-ground fire effects achieved as well as resistance to control.

Fire Prescription Elements	
RH = 10-80%	Live Fuel Moisture = n/a
Dry Bulb = 40-80 F	Average Flame Length = 1-10 feet
Average Mid-flame Winds=0-15mph G30mph	Average Rate of Spread = 1-40 chs/hour
10-hour TLFM = 3-15%	1000-hour TLFM = 9-25%

PRESCRIBED FIRE PROJECT OBJECTIVES—First Entry Burn

Immediately Post-Burn:

1. Reduce average woody (dead and down) preburn fuel load over landscape, with average percent reductions in the following size classes:
   a) 1-hour fuel size class reduction by 40-100% (currently 0.1 t/ac, 0.2 t/ha)
   b) 10-hour fuel size class reduction by 40-100% (currently 0.8 t/ac, 2.0 t/ha)
   c) 100-hour fuel size class reduction by 40-100% (currently 0.8 t/ac 2.0 t/ha)
   d) 1000-hour fuel size class reduction by 40-80% (currently 3.3 t/ac, 8.2 t/ha)

2. Limit crown scorch to 30% on *Pinus ponderosa* with dbh greater than or equal to 16" (40 cm).

Two Years Post-Burn:

1. Reduce Pinus ponderosa poles with dbh of 1-6 inches (2.5-15 cm) to average 0-200 trees/acre (0-494 trees/ha). *This is a conservative target and more research is needed to define a better pole density target; Preburn pole densities range from 0-500* Pinus ponderosa *trees/acre (1235 trees/ha) and average of 51 trees/acre (126 trees/ha) in this monitoring type on 6 plots.*

Five Years Post-Burn

1. Limit overstory mortality to 20% on *Pinus ponderosa* greater than or equal to 16" dbh (40 cm dbh). *There are currently 41 trees/acre (101 trees/ha) of* Pinus ponderosa *in this size class.*

PRESCRIBED FIRE PROJECT OBJECTIVES—Second Entry Burn

Objectives will be written for this section, once results from first entry burn are known.

PRESCRIBED FIRE PROJECT OBJECTIVES—Third Entry Burn

Objectives will be written for this section, once results from first and second entry burns are known.

FIRE MONITORING OBJECTIVES

1. Install enough plots to be 80% confident that overstory ponderosa pine density figures are within 20% of the true population mean.
2. Install enough plots to be 80% confident that total fuel load estimates are within 20% of the true population mean.
3. Install enough plots to be 80% confident that pole density estimates are within 20% of the true population mean.

DATA ANALYSIS

1. Compute scorch heights on ponderosa pine overstory trees and report figures with average and range for each prescribed burn and for the entire monitoring type.
2. Track percent change in total fuel load by year and percent change between all size classes, litter, and duff through YR05.
3. Track overstory density by size class for ponderosa pine for each postburn year through YR05.
4. Track ponderosa pine pole tree densities by size class for each postburn year through YR02.
5. Track overstory snag densities (defined as greater than six inches dbh) with the most confidence possible, categorized by size classes.
6. Track changes in herbaceous layer species composition categorized by native/non-native.

Literature Cited

Covington, W.W. and M.M. Moore. 1992. Postsettlement changes in natural fire regimes: implications for restoration of old-growth ponderosa pine forest. *In* Old-growth forests in the Southwest and Rocky Mountain regions: proceedings of a workshop, p. 81-99. USDA For. Serv. Gen. Tech. Rep. RM-213. 201p.

Rasmussen, D.I. 1941. Biotic communities of Kaibab Plateau, Arizona. Ecol. Monogr. 11:229-76.

Wolf, J. and J. Mast. 1998. Fire history of mixed-conifer forests on the North Rim, Grand Canyon National Park, Arizona. Physical Geography, 19, 1, pp. 1-14.

Plot Protocols for PIPN

GENERAL PROTOCOLS		YES (√)	NO (√)		YES (√)	NO (√)
Preburn	Control Plots/Opt		√	Herb Height/Rec	√	
	Herbaceous Density/Opt		√	Abbreviated Tags	√	
	OP/Origin Buried		√	Crown Intercept/Opt		√
	Voucher Specimens/Rec	√		Herb. Fuel Load/Opt		√
	Stereo Photography/Opt		√	Brush Individuals/Rec	√	
	Belt Transect Width	2 x 50 meters		Stakes Installed: All		
	Number of Belts recorded	2				
	Herbaceous Data and Brush Data Collected at: Q4-Q1 and Q3-Q2					
Burn and Postburn	Duff Moisture/Rec		√	Flame Zone Depth/Rec	√	
	Herbaceous Data/ Opt		√	Herb. Fuel Load/Opt		√
	100 Pt. Burn Severity/Opt	√				

FOREST PLOT PROTOCOLS		YES (√)	NO (√)		YES (√)	NO (√)
Overstory	Area sampled	50 x 20 m		Quarters Sampled	Q1,Q2,Q3,Q4	
	Tree Damage/Rec	√		Crown Position/Rec	√	
	Dead Tree Damage/Opt		√	Dead Crown Position/Opt	√	
Pole-size	Area Sampled	25 X 20 m		Quarters Sampled	Q1 & Q2	
	Height/Rec	√		Poles Tagged/Rec	√	
Seedling	Area Sampled	25 X 10 m		Quarters Sampled	Q1	
	Height/Rec	√		Seedlings Mapped/Opt		√
Fuel Load	Sampling Plane Length	50 feet		Fuel Continuity/Opt		√
	Aerial Fuel Load/Opt		√			
Postburn	Char Height/Rec	√		Mortality/Rec	√	

Rec = Recommended Opt = Optional

FMH-4 MONITORING TYPE DESCRIPTION SHEET
Grand Canyon National Park

Monitoring Type Code: FPIAB1D09

Monitoring Type Name: Ponderosa Pine with White Fir Encroachment

Prepared by: Tonja Opperman and Ken Kerr

Date: March 17, 1999

PHYSICAL DESCRIPTION

Located at 8000 to 9000 feet elevation on the North Rim with slopes from 0% to 60%, including all aspects. Soils are moderately shallow on ridgetops with silty loams occurring in drainage bottoms. All soils are derived from Kaibab limestone parent material.

BIOLOGICAL DESCRIPTION

Total canopy cover is at least 25% but can near 100%. It is a mixed conifer forest dominated by *Pinus ponderosa, Abies concolor,* and *Populus tremuloides* with the greatest basal area in *Pinus ponderosa* even though there may be more overstory[1] *Abies concolor* stems per acre. Other possible overstory species include *Pseudotsuga menziesii, Picea pungens, Abies lasiocarpa,* and *Picea engelmanni.* The understory is composed of mostly *Abies concolor* (25 to 100%), *Pinus ponderosa, Populus tremuloides,* and *Pseudotsuga menziesii.* Common brush species are *Amelanchier utahensis, Berberis repens,* and *Robinia neomexicana.* Common herbaceous plants include *Bouteloua gracilis, Carex* spp., *Fragaria ovalis, Lotus utahensis, Pedicularis centranthera,* and *Poa fendleriana.*

REJECTION CRITERIA

Large rock outcroppings or barren areas >20% of the plot; areas with anomalous vegetation, boundary fences; areas within 30 meters of roads, utility corridors, human-created trails, human-created clearings, or slash piles; areas within 10 meters of significant historic or prehistoric sites or transitional ecotones; areas burned in the last 10 years; areas where majority of basal area is not in ponderosa pine; areas with pole densities that do not include white fir as a major component.

DESIRED FUTURE CONDITION

At this time a literature search has been initiated to determine the desired future condition of North Rim *Pinus ponderosa* forests at Grand Canyon National Park, but it is not complete. Forests in the PIAB monitoring type are at a slightly higher elevation and experience slightly wetter conditions and cooler temperatures than the North Rim Ponderosa Pine (PIPN) monitoring type. *Pinus ponderosa* likely dominated these stands but occasionally other mixed conifer species were present as well as pockets of *Populus tremuloides.* At the 8200' elevation on the North Rim, research suggests the stands were comprised of 51 overstory *Pinus ponderosa* per acre (126 trees/ha) with a mixture of *Abies concolor* and *Populus tremuloides* equally occupying the remaining 40 overstory trees per acre (99 trees/ha) (Covington et. al. 1998). Fire likely occurred in these stands every 4-15 years (Wolf and Mast 1998). Pre-European settlement fuel load estimates are unknown, as are pole density figures for this forest type.

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[1] Overstory trees are defined in the Fire Monitoring program as trees with a diameter at breast height of 15 cm (6 in) or greater. This definition does not take individual tree dominance or crown position into account.

BURN PRESCRIPTION

Units will be burned during the growing and dormant seasons from summer (June) to fall (November). In drier years the time period may move into April and/or December. The following values present a range of conditions that may be used to accomplish objectives. Optimal values and relationships exist between these ranges that relate to on-the-ground fire effects achieved as well as resistance to control.

Fire Prescription Elements	
RH = 10-80%	Live Woody Fuel Moisture = 60-250%
Dry Bulb = 40-80 F	Average Flame Length = 0.5 – 30 feet
Mid-flame Winds=0-15mph G30mph	Average Rate of Spread = 1-40 chs/hour
10-hour TLFM = 3-15%	1000-hour TLFM = 9-25%

PRESCRIBED FIRE PROJECT OBJECTIVES—First Entry Burn

Immediately Post-Burn:

1. Reduce average woody (dead and down) preburn fuel load over landscape, with average percent reductions in the following size classes:
   a) 1-hour fuel size class reduction by 40-100% (currently 0.3 t/ac, 0.8 t/ha)
   b) 10-hour fuel size class reduction by 40-100% (currently 1.7 t/ac, 4.1 t/ha)
   c) 100-hour fuel size class reduction by 40-100% (currently 2.5 t/ac, 6.1 t/ha)
   d) 1000-hour fuel size class reduction by 40-80% (currently 13.1 t/ac, 32.4 t/ha)

2. Limit crown scorch to 30% on *Pinus ponderosa* with dbh greater than or equal to 16" (40 cm).

Two Years Post-Burn:

1. Reduce *Abies concolor* poles in 1-6" (2.5-15 cm) size class by 20-70% to average 0-100 trees/ac (247 trees/ha). *This is a conservative target until more research indicates a better target. Preburn* Abies concolor *pole densities average 237 trees/ac, and* Pinus ponderosa *poles average 31 trees/ac (77 trees/ha) in this monitoring type on 21 plots.*

Five Years Post-Burn

1. Limit mortality of *Pinus ponderosa* with dbh greater than or equal to 16 inches (40 cm) to 20%. *On 22 plots there is an average of 27* Pinus ponderosa *trees per acre in this size class.*

PRESCRIBED FIRE PROJECT OBJECTIVES—Second Entry Burn

Objectives will be written for this section, once results from first entry burn are known.

PRESCRIBED FIRE PROJECT OBJECTIVES—Third Entry Burn

Objectives will be written for this section, once results from first and second entry burns are known.

FIRE MONITORING OBJECTIVES

1. Install enough plots to be 80% confident that overstory ponderosa pine density figures are within 20% of the true population mean.
2. Install enough plots to be 80% confident that total fuel load estimates are within 20% of the true population mean.
3. Install enough plots to be 80% confident that white fir pole density estimates are within 25% of the true population mean.

DATA ANALYSIS

1. Compute scorch heights on ponderosa pine overstory trees and report figures with average and range for each prescribed burn and for the entire monitoring type.
2. Track percent change in total fuel load by year and percent change between all size classes, litter, and duff through YR05.
3. Track overstory density by size class for ponderosa pine for each postburn year through YR05.
4. Track white fir pole tree densities for each postburn year through YR02.
5. Track overstory snag densities (defined as greater than six inches dbh) with the most confidence possible, categorized by size classes.
6. Track changes in herbaceous layer species composition categorized by native/non-native.

Literature Cited

Covington, W.W., M.M. Moore, P.Z. Fule, H.B. Smith. 1998. Grand Canyon Forest Ecosystem Restoration Report on Pre-treatment measurements of experimental blocks. Northern Arizona University unpublished manuscript.

Wolf, J. and J. Mast. 1998. Fire history of mixed-conifer forests on the North Rim, Grand Canyon National Park, Arizona. Physical Geography, 19, 1, pp. 1-14.

Plot Protocols for PIAB

GENERAL PROTOCOLS		YES (√)	NO (√)		YES (√)	NO (√)
Preburn	Control Plots/Opt		√	Herb Height/Rec	√	
	Herbaceous Density/Opt		√	Abbreviated Tags	√	
	OP/Origin Buried		√	Crown Intercept/Opt		√
	Voucher Specimens/Rec	√		Herb. Fuel Load/Opt		√
	Stereo Photography/Opt		√	Brush Individuals/Rec	√	
	Belt Transect Width	2 x 50 meters		Stakes Installed: All		
	Number of Belts recorded	2				
	Herbaceous Data and Brush Data Collected at: Q4-Q1 and Q3-Q2					
Burn and Postburn	Duff Moisture/Rec		√	Flame Zone Depth/Rec	√	
	Herbaceous Data/ Opt		√	Herb. Fuel Load/Opt		√
	100 Pt. Burn Severity/Opt	√				

FOREST PLOT PROTOCOLS		YES (√)	NO (√)		YES (√)	NO (√)
Overstory	Area sampled	50 x 20 m		Quarters Sampled	Q1,Q2,Q3,Q4	
	Tree Damage/Rec	√		Crown Position/Rec	√	
	Dead Tree Damage/Opt		√	Dead Crown Position/Opt	√	
Pole-size	Area Sampled	25 X 20 m		Quarters Sampled	Q1 & Q2	
	Height/Rec	√		Poles Tagged/Rec	√	
Seedling	Area Sampled	5 X 10 m		Quarters Sampled	Q1	
	Height/Rec	√		Seedlings Mapped/Opt		√
Fuel Load	Sampling Plane Length	50 feet		Fuel Continuity/Opt		√
	Aerial Fuel Load/Opt		√			
Postburn	Char Height/Rec	√		Mortality/Rec	√	

Rec = Recommended Opt = Optional

Appendix B: Identified Problems and Solutions in GRCA FMH Database

The Fire Monitoring Handbook (FMH) database at Grand Canyon requires corrections before it can be analyzed with sufficient accuracy. In many cases, the reason the database was not maintained properly stems from a lack of personnel dedicated to the task. Reorganization of the prescribed fire staff at the Canyon has eliminated many past deficiencies to provide continuity and guidance for the monitoring program. Following is a list of problems identified in 1997 with potential solutions and actions taken to date.

FMH Problems	FMH Solutions	1998 Corrections
1. Brown's transect lengths are not the same for all plots in a monitoring type; some are 50' and some are 100'.	1. Begin reading all plots correctly in 1998; fix misread data by deleting or multiplying existing data by a correction factor.	We started reading transects properly and have corrected some monitoring types, but not all. Some data can never be recovered/corrected.
2. Fifteen FMH plots established in conjunction with NAU were numbered differently in the database, the files, and the field; no FMH-4s exist for these plots.	2. Label files to reflect database labels. Change plot tags next year when visiting North Rim; decide whether any of these plots are acceptable for use in current monitoring types, or if additional N.Rim types should be established; decide to disregard plots which do not fit in current or foreseen forest monitoring types.	Plots were incorporated into the current monitoring system or put into a miscellaneous category if they did not fit. Plots in the XXXX category will remain installed but will not be read unless they fit into a future monitoring type description because we cannot afford to collect data for "data's sake".
3. No fire history information is written on FMH-5s for any plots.	3. No solution at present. The fire history database does not make this information easy to obtain; fire locations are entered as points with acreage, but there are no maps of fire occurrences.	No action taken as of this time. Rumor has it a fire atlas *might* be available, however, this will be an involved project even so.
4. Not every plot file has a detailed plot location description.	4. Photocopies of topographic maps will be put in each file with plot location clearly marked; written descriptions will be revised to clearly match maps; all plots will be located on a set of FMH topographic maps to remain in map case for reference.	All plots that were visited in 1998 were fixed, but plots that have not been visited have not had files updated. Crewmembers are trained on how to properly document the plot locations. Wall maps were made of all locations and are currently being incorporated into GPS.

5. Unknown plant species and lack of follow-up in having them identified and entered in database.	5. Make known to all field personnel an established procedure to get plants properly collected and identified; hold persons accountable for follow-up.	A new system is in place to prevent this problem from occurring again. This involves a separate area in the office dedicated to plant identification, a logbook for recording unknown codes, and more interaction with the GRCA botanist on a regular basis.
6. Numbers on overstory and pole tags are the same, resulting in confusion when pole trees grow into the overstory.	6. Future plots will have overstory trees numbered 1-100 and pole trees 101-999; poles growing into overstory can just have the "P" crossed off the tag. More care will be taken with established plots to ensure that new overstory trees are immediately tagged with new numbers that do not conflict with any other overstory or pole tag on the plot; such tag changes will be documented in the hardcopy for each plot.	New installations have overstory labeled 1-100 and poles start with P101. Old plots are fixed on a case-by-case basis in the easiest manner that will avoid future confusion. We will not re-tag entire plots if it is not necessary.
7. Tags are not readily updated or replaced; pole trees grown into the overstory may still have P-tags for many years; trees in non-pole quadrants which have grown into the overstory may be overlooked during re-reads because they did not have original tags.	7. Field crews will carry extra blank tags, nails, and a stamp kit in the field on every plot visit to make tag changes, additions, and replacements; crews will be advised to measure all trees in non-pole quadrants to ensure capture of new overstory trees.	Field crews carry extra tags and understand when to add/replace tags. Training the crew will help to avoid missing the new poles and overstory trees in the future.
8. Tags are not always placed on trees at dbh, resulting in measuring errors.	8. Re-nail all tags at proper height as plots are revisited; take care to nail future trees at correct height; inform crews that dbh measurements must be made at the nail for consistency.	Tags are re-nailed, or if the nail is too high due to duff reduction, the nail is left in place so measurements are the same. Multiple stemmed juniper trees are nailed and measured at the root collar.
9. Postburn information is missing for some plots because FMH crew season had already ended when postburn read was due.	9. Permanent or term positions will help to eliminate this problem in addition to greater communication between field personnel and supervisory staff.	A term position was hired in August 1998.
10. Some data sheets and photos are missing entirely.	10. No solution at present.	This data can never be recovered.

11. Fire behavior information missing for some burned plots.	11. Check all other, non-FMH burn files for such information; disregard plots with no fire behavior information until they are reburned.	This data can never be recovered for a specific plot; we have taken no action to check other burn files for behavior information on that particular prescribed fire.
12. Plots not burned in accordance with established burn prescriptions, resulting in highly variable fire effects data which is difficult to analyze with accuracy. Igniters sometimes intentionally put a lot of fuel on FMH plots to "get them to burn."	12. Decide to either follow established prescriptions for burning in future, or stratify monitoring types to reflect different burning seasons (this would result in many plot installations); inform ignition crews at briefing of how to approach lighting an FMH plot.	Monitoring types are burned in all seasons; we will not stratify because it will impact our burning program negatively. Hand ignition needs to be accomplished in concert with an ignition specialist informed on plot locations. Ignition specialist needs to direct igniters not to dump torch fuel on plots.
13. The 50-meter transects may not be sampling grass species sufficiently.	13. Revise protocols to capture grasses; solicit help from GRCA Botanist.	No action was taken; Botanist does not think we should change protocol. We will consult Botanist when establishing protocols for new Pinyon-Juniper type. May use Daubenmire methods.
14. A few plots are not square, resulting in failure to read last 2 or 3 points on a 50-meter transect.	14. Make plots square as they are revisited in 1998.	Plots were re-squared as visited; crew training will help avoid this in the future.
15. Misidentification of tree species from year to year.	15. Develop a quick-reference guide for N.Rim trees; identify and correct discrepancies; revisit plots in 1998 to confirm correct species identification.	A plant reference guide is being developed for field use at this time. Crew training will help.
16. Brush species tagged and counted as poles.	16. Identify such individuals and make necessary corrections in field, on all datasheets, and in database program.	Training will help alleviate this problem, as well as the plant guide (above).
17. Non-brush species counted as brush.	17. Because there are so few brush species, make a reference list with i.d. characteristics for use in the field; or revise brush data sheet with all possible codes listed at bottom.	Plant reference guide will help, as well as crew training. Botanist advises cactus are counted as brush species on the brush belt.
18. Failure to obtain comparable photo documentation from year to year.	18. Take previous photos into field for easy match; establish protocols for camera position; promptly re-take unacceptable photos.	Protocols established and made known. Use of tripod is standard. Bracketing photos is standard. Crew training is a priority for photography.

19. Plots not read at same phenological stage each year.	19. Begin to read plots on a schedule based on ecosystem dryness; plots which will dry out first will be read first. Reference photos before going into the field to see which plants were flowering during the last visit.	Plot schedule has been corrected to read plots from "dry" ecosystems to "moist" ecosystems to ensure flowering plants are captured.
20. Possible problems with data entry, though they have not yet been identified. When data sheets are difficult to read, people sometimes "guess" or can accidentally insert the wrong name/number.	20. Check all hard copies for possible errors and identify; fix such errors in database as soon as possible. This is a major project that will take many months to sort through.	Quality control is being developed to be in place for the 1999 field season. No documentation exists at this time, however it will involve the plot folder going through a second check against the database before being filed.

Appendix C: Schedule for GRCA FMH "Shortcourse"

SCHEDULE

Day 1

Morning

- Issue field equipment to all new staff (compass, clinometer, hand lens, etc.)
- Overview of Branch of Fire and Aviation—how it all fits together
- Overview of the Prescribed Fire program—goals for 1999 and accomplishments of 1998
- How the Fire Effects program fits into the puzzle—what we do and why it's important
- Explain local Monitoring Types, vegetation, and fuel conditions
  - FMH-4 Monitoring Type Description Form
    - This is where you get biological descriptions
    - This is the burn prescription
    - These are things we're interested in measuring
    - These are protocols for this whole monitoring type
- Location of FMH information, materials, and equipment

Afternoon

- Lessons on Forest Plots in the RX-80 Student Guide

Day 2

Morning

- Visit a plot and lay out tapes to give a visual perspective
- Review compass, pacing, chaining, reading maps
- Organize paperwork, equipment, and information required to read a plot

Afternoon

- Brief introduction to plant families, dichotomous keys, common plants frequently encountered in Grand Canyon, collecting and preserving specimens, T&E species, taught by GRCA botanist

Day 3

Morning and Afternoon

- Install a practice plot from a point on a map
  - Review photographic protocols and standards; emphasize the long-term importance of these photos
  - Write a detailed FMH-5 route description with appropriate UTM, Lat/Long, TRS, slope, aspect, fire history, plot visit history, etc.
  - Assure all headings, diameters, heights, ages, locations, tags are in order both in the paperwork and on the plot
  - Focus on consistency in implementation to assure long-term validity of data collection

Day 4

Morning

- What to do with the data and equipment once back at the office
  - Rewrite the FMH-5 with proper directions
  - Make the map
  - Put the plot folder in proper place for data entry
  - Mark the plot board
  - Update field copy folder for next visit
  - Identify unknowns from the vegetative transects, label collected samples, send samples to Nancy Brian or the Study Collection
  - File completed FMH-26 in appropriate file so that slide sorting will be easy
  - File completed rolls of film in an envelope ready for processing

Afternoon

- Introduction to computer data entry for FMH using practice plot data
- Explore analysis functions in FMH computer program
- Review quality control protocols
- Review computer backup procedures and schedule
- Review hardcopy backup procedures and schedule

Day 5

Morning

- Revisit practice plot and remeasure selected individuals and transects

Afternoon

- Re-enter data into FMH.EXE and note differences
- Stress importance of measuring and recording properly, using examples of "bad" plot reads, photos, graphs, etc.

Appendix D: Current Equipment Vendors

Insight (For computer equipment/supplies/programs)
6820 S. Harl Ave
Tempe AZ 85283
1-800-467-4448 (ask for Marguerite Lara at x5961)

Forestry Suppliers (Field equipment)
P.O. box 8397
Jackson MS 39284-8397
1-800-647-5368

Century Photo Products (3-ring binders and clear photo/slide holders for storage)
P.O. Box 2393
Brea, CA 92822
1-800-767-0777

HomeCo Ace Home Center (rebar—can be cut to specifications (1/2" x 18") and delivered to GRCA)
1763 E. Butler Avenue
Flagstaff AZ 86001
1-800-628-0582

National Weather Service (pilot balloons)
Phone: 301-713-1829

International Association of Wildland Fire (IAWF) (Reference books on fire/ecology)
P.O. Box 328
Fairfield WA 99012-0328

Ben Meadows Co. (Field equipment)
P.O. Box 80549
Atlanta GA 30366
1-800-241-6401

National Band and Tag Co. (Brass tags Style #115 w/hole at 3/16", pre-numbered and blank)
721 York St/P.O. Box 430
Newport KY 41072-0430
(606) 261-TAGS

Trimble Navigation (GPS information)
2203 Timberloch Place
Suite 250
The Woodlands TX 77380

National Wildfire Coordinating Group Catalog (NWCG) (Fire-related materials, equipment and books)
ATTN: Great Basin Cache Supply Office
3833 South Development Ave
Boise ID 83705

Patricia Ledlie Bookseller (Reference books and field guides)
One Bean Road/P.O. Box 90
Buckfield ME 04220
(207) 336-2778
http://www.ledlie.com

Xerox (For rolls of copier paper for large map copies at Engineering)
1851 E. First St, Ste 552
Santa Ana, CA 92705
1-800-822-2200

Seattle Filmworks (photo, slide, and photo-on-disk developing)
1260 16th Ave W.
Seattle WA 98119
1-800-FILMWORKS
Customer #: 29733369

Kodak (ordering film in bulk)
U.S. Customer Support—Government
1187 Ridge Road West
Rochester NY 14650-3009
1-800-828-6203

Grand Canyon National Park Lost and Found (extra cameras for monitor's fire pack