United States Department of the Interior

NATIONAL PARK SERVICE
Western Region
600 Harrison Street, Suite 600
San Francisco, California 94107-1372

IN REPLY REFER TO:

Y-14

Memorandum

To: Program Participants and Interested Parties

From: Program Manager, Western Region Fire Monitoring Program

Subject: Fire Monitoring Year-End Report

Please find the enclosed year-end report for the Western Region Fire Monitoring Program. This report is being sent to you for one of the following reasons: your park has an established program; your park has expressed an interest in setting up a fire monitoring program; or lastly, on a regional level, there are parks within your region that meet the above criteria.

This is my first major effort at communicating the status of this five-year-old program. I know there is a large amount of information presented here, but for many of you there are certain sections that can be skimmed. The general idea of this report is to inform the reader about the program's accomplishments, and to give some insight into the future direction of the program. Any feedback can be directed to me via cc:mail, regular mail, or by calling me at (415) 744-3878.

Paul Reeberg

Paul Reeberg

United States Department of the Interior

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Memorandum

To: Program Planning Manager, NIFC

From: Program Manager, Western Region Fire Monitoring Program

Subject: 1993 Fire Monitoring Program Summary

The purpose of this report is to keep you informed concerning the progress of the fire monitoring program. This report will serve as a summation of participating park's year-end summaries, and serve as a year-end summary of the program as a whole.

Interest in the program continues to grow both inside and outside the Department of Interior. This increase in interest can only benefit the program. This interest can lead to: a large and significant database; more input for improvement of the handbook and/or software; better communication and information exchange; insured program continuity; and a clear outline of potential prescribed fire research needs.

This year saw many accomplishments in the fire monitoring program. The most significant of these being that prescribed fire managers burned the largest amount of acreage in a decade. Consequently, managers burned the largest number of monitoring plots ever. The outcome is that we now have made the first major step in creating a postburn database.

The fire monitoring team concept was fully tested this year. Successes and mistakes have helped to make this concept a useful one for managers and technicians alike. Large parks put their larger staffs to excellent use this year. Many crews managed their time so efficiently they had time to leave their home park and provide support for other parks and/or agencies.

This program is still young and changing, but its future is still uncertain. Some managers would like to set up this program, but do not have the financial means. Other managers have a program with their own funding. Some managers wonder whether this program is worth all the money that is spent on it. Other managers are burning large portions of their parks, and looking forward to exploring a significant postburn database. All these points of view are valid, but they require discussion at the national level, and as always the sooner the better.

Program Use by Other NPS Regions and Outside Agencies

The following National Parks outside the Western Region have either requested program information or have set up a fire monitoring program on their own:

- Bandelier NM
- Big Bend NP
- Bryce Canyon NP
- Carlsbad Caverns NM
- Denali National Park
- Grand Teton NP
- North Cascades NP
- Obed Wild and Scenic River
- Ozark National Scenic Riverway
- Voyagers NP
- Yellowstone NP
- Zion NP

This list is correct as far as we know, though other users may exist without our knowledge. There has been some thought from the national FIREPRO Steering Committee that this program (or one that is similar) may go national in the next few years. As one can see from the above list, this is already becoming a national program, which is in need of national leadership. Experience has shown that a regional program provides higher data quality and a better interpretation of the Fire Monitoring Handbook. Therefore, the sooner this program (or one that is similar) becomes a national one, the better off the above parks will be.

The US Fish and Wildlife Service, who sponsored RX80 (Preburn Inventory Techniques) in 1993, is reviewing the fire monitoring program as an option for refuges that use prescribed fire. This course laid the groundwork for managers in the following areas to begin programs in their own units:

- Minnesota Department of Natural Resources;
- US Fish and Wildlife refuges in Iowa, Minnesota, New Jersey, Texas, and Wisconsin;
- US Forest Service areas in Illinois, Michigan, Minnesota, Vermont, and Washington.

Other managers attended, but felt that there needed to be national leadership before they could set up a program at their unit.

US Fish and Wildlife have given the Western Region Fire Monitoring Handbook to the Tall Timbers Research Group for appraisal at Okefenokee NWR. In addition, US Fish and Wildlife has contracted the University of Idaho to create a "Monitoring Navigator." This computer program will be an interactive system that will help managers in the USFWS decide what monitoring methodology best suits their needs. The project is still in its infancy, and is currently not ready for testing.

Also this year, the Washington Institute presented RX91 (Monitoring Prescribed and Prescribed Natural Fire); and the regional office mailed program information to: Forestry

Canada, Environment Canada Parks Service, 18 Bureau of Land Management managers in California, several US Forest Service managers in California, Florida State Parks, and several interested private individuals. California State Parks continue to run the program on a park by park basis. The Bureau of Indian Affairs supports a growing program, and provides training support for all fire monitoring related training courses.

Program Achievements to Date

Plot Installation

This year monitoring crews established 16 grassland plots, 11 brush plots, and 54 forest plots for a total of 81 plots (Table 1). Significant plot installation efforts occurred at Yosemite NP (29) and Grand Canyon NP (26). This year installation efforts raised the current number of plots to: 84 grassland types plots (11% of total), 291 brush plots (38% of total), and 381 forest plots (50% of total) for a total of 756 plots in 74 monitoring types within the Western Region Fire Monitoring Program (Table 1). This averages out to 10 plots per monitoring type region wide, with a regional high of 23 at Pinnacles NM, and a regional low of 3 per monitoring type in Chiricahua NM.

Several parks installed their final plots this year, completing the minimum plot requirements for all their monitoring types (Figure 1). Parks that are complete or are near complete include:

- Golden Gate NRA (100%)
- Lake Mead NRA (100%)
- Lava Beds NM (98%)
- Pinnacles NM (100%)
- Point Reyes NS (100%)
- Redwood NP (94%)
- Santa Monica Mountains NRA (99%)
- Sequoia and Kings Canyon NPs (100%)
- Whiskeytown NRA (90%)
- Yosemite (100%)

TABLE 1. Plot installation by plot type.

Number of Plots Installed Previous Years				*Number of Plots Installed 1993*				*Total Number Plots Installed*			
G	B	F	Total	G	B	F	Total	G	B	F	Total
68	280	327	675	16	11	54	81	84	291	381	756

Half the participating parks have established "control"/non-treatment plots (68 plots), or have plots that burned in a wildfire or during a prescribed natural fire (51 plots). Adding these numbers to the plot network produces a total of 875 plots within the Western Region Fire

Figure 1. Proportion of Plots Installed

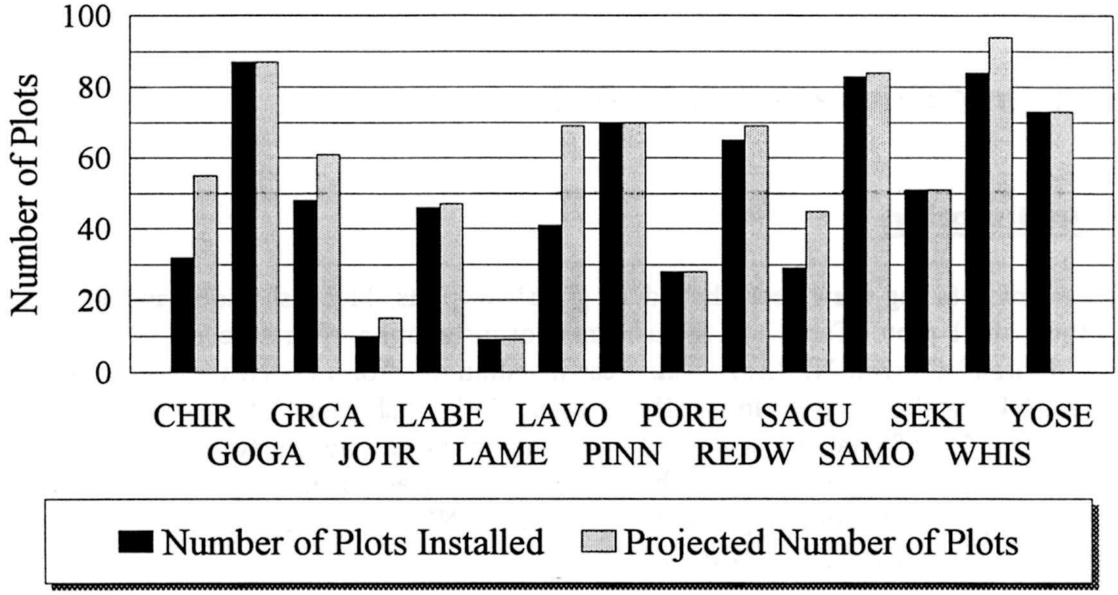
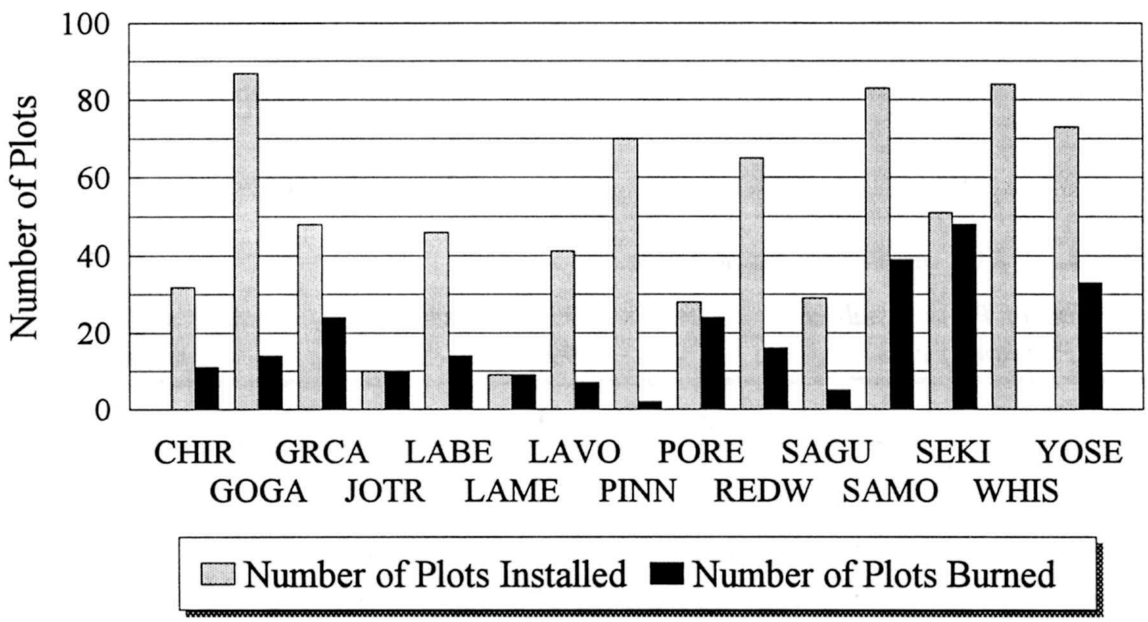


Figure 2. Proportion of Plots Burned



Monitoring Program.

The majority of the grass plots are in Redwood NP (36) and Santa Monica Mountains NRA (26), and Yosemite NP (20); most of the brush plots are found in Golden Gate NRA (78), Pinnacles NM (54), and Santa Monica Mountains NRA (45); and most of the forest plots are in Whiskeytown NRA (64), Yosemite NP (53), Sequoia & Kings Canyon NPs (51), and Grand Canyon NP (48).

Plot Rereads

The number of plots that need to be reread are the numbers to watch if we are to understand what the future work load of the program will be. Although the number of new plots proposed to be installed in 1994 is lower than 1993 figures, the total work load will be similar to 1993. This is because the projected number of revisits for 1994 is significantly higher than for 1993 (Table 2 & 3).

This year monitors reread 267 plots to bring them up to regional standards, to read postburn information, or to update plot information. Teams or parks that performed a large amount of the rereading work load include: the Central-Southern California Monitoring Team (114), the Northern California Monitoring Team (51), Sequoia & Kings Canyon NPs (28), and Grand Canyon NP (21).

TABLE 2. Plot rereads by plot type for 1993 and the anticipated need for 1994.

Total Plots Reread 1993				*Total Plots to Reread 1994*			
G	B	F	Total	G	B	F	Total
35	88	144	267	35	104	148	287

Projected Plot Installation

The approximate number of plots that need to be installed are: 5 grassland plots, 11 brush plots, and 85 forest plots (Table 3). The following parks are where most of the installation work will occur: Chiricahua NM, Grand Canyon NP, Lassen Volcanic NP, Saguaro NM, and Whiskeytown NRA. In all cases, these parks have not installed plots (largely forest plots) because there are monitoring types in these parks that mangers have not burned yet. Managers at the parks plan to burn all their remaining monitoring types in the next three years. Biological Technicians will install these plots the same year managers ignite the burn units containing unburned monitoring types. The projected preburn database will consist of approximately 857 plots, which means the database is now 88% complete (756 plots).

TABLE 3. Projected plot installation by plot type.

Plots to be Installed 1994				*Number of Plots needed to Complete FMH Database*				*Projected Total*			
G	B	F	Total	G	B	F	Total	G	B	F	Total
5	6	30	41	5	11	85	101	89	302	466	857

Plot Burning

Many fire programs have not been able to closely follow their five-year burn plans. This factor will probably force the fire monitoring program into becoming a longer program than initially anticipated (five-years). While we know that many factors are at work here, this note is primarily information for other regions / parks / managed natural areas who are thinking about or are currently conducting a fire monitoring program in their area.

Of the current number plots installed, we have burned 262 (35% of current total) to date; of the anticipated total of 857, 30% have burned (Table 4). This increase in the number of plots burned is due to the 6,783 acres burned in the Western Region in 1993. The number of plots burned this year is more than have burned in all the years of the fire monitoring program combined.

Parks with many of their current number of plots burned include Joshua Tree NM (100%), Lake Mead NRA (100%), Sequoia and Kings NPs (94%), and Point Reyes NS (85%) (Figure 2).

TABLE 4. Number of plots that have burned by plot type.

Total Plots Burned 1993				*Total Plots Burned to Date*			
G	B	F	Total	G	B	F	Total
30	58	60	148	43	74	145	262

Postburn Database

The size of the postburn database has grown significantly due to the acreage burned this year. Bringing the immediate postburn database up to 260 plots (Table 5), which will translate into 260 one-year postburn plots one year from now. This means that database managers probably can perform some initial outputs next winter.

TABLE 5. Postburn status of plots by plot type.

	Postburn Plot Summary			
	G	B	F	Total
Immediate Postburn	43	73	144	260
1 Year Postburn	13	24	82	119
2 Year Postburn	9	15	55	79
5 Year Postburn	0	0	22	22
10 Year Postburn	0	0	7	7

Program Trends

Now let's examine at some trends that have occurred over the history of this program. Plot installation has dropped from 373 plots installed in 1990, to 249 in 1991, to 128 in 1992, to 81 in 1993 (Figure 3). These numbers are directly correlated to the number of Biological Technicians hired (which has declined) and the shrinking work load (due to the small number of plots burned) up until this year. The number of plots that have been reread (to bring plots up to protocol, for postburn monitoring, or to update plots) has increased as the total number of plots installed has decreased (Figure 3). Future work loads will depend directly upon the

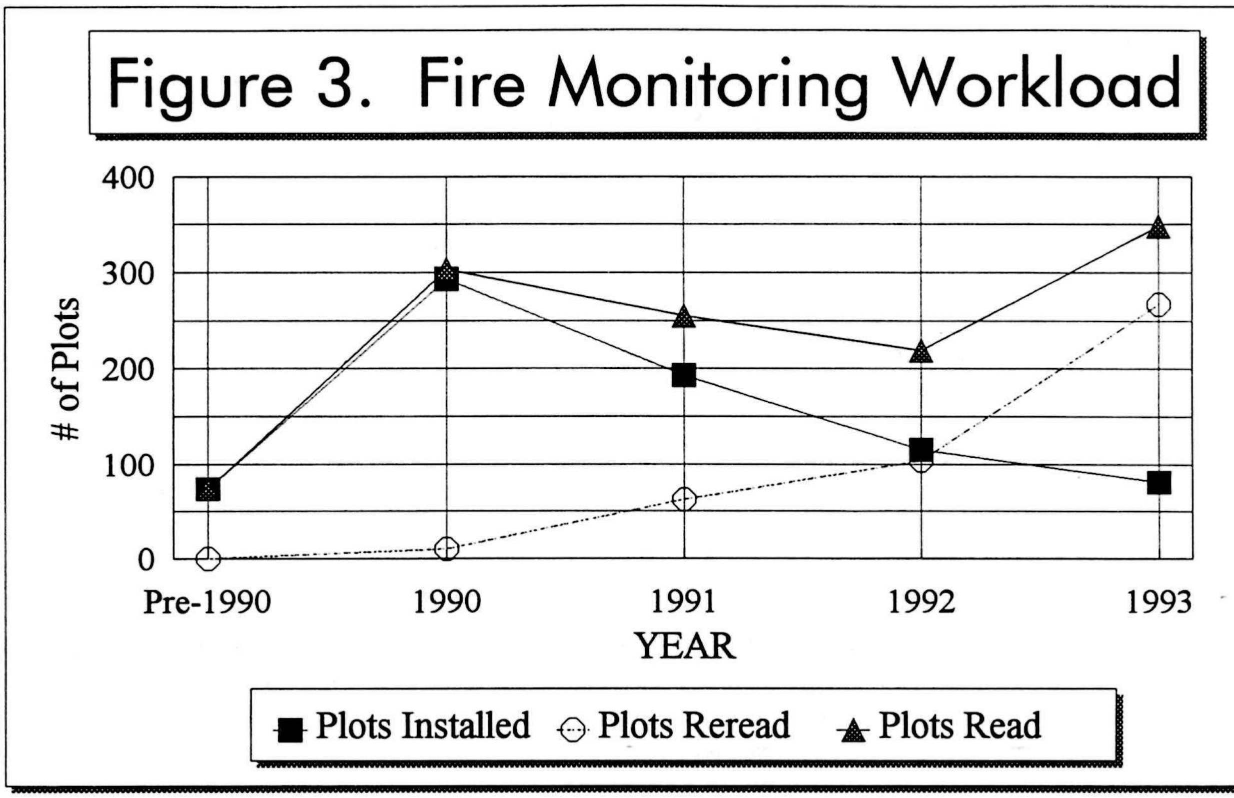


Figure 3. Fire Monitoring Workload
400
300
200
100
0
# of Plots
Pre-1990
1990
1991
1992
1993
YEAR
Plots Installed
Plots Reread
Plots Read

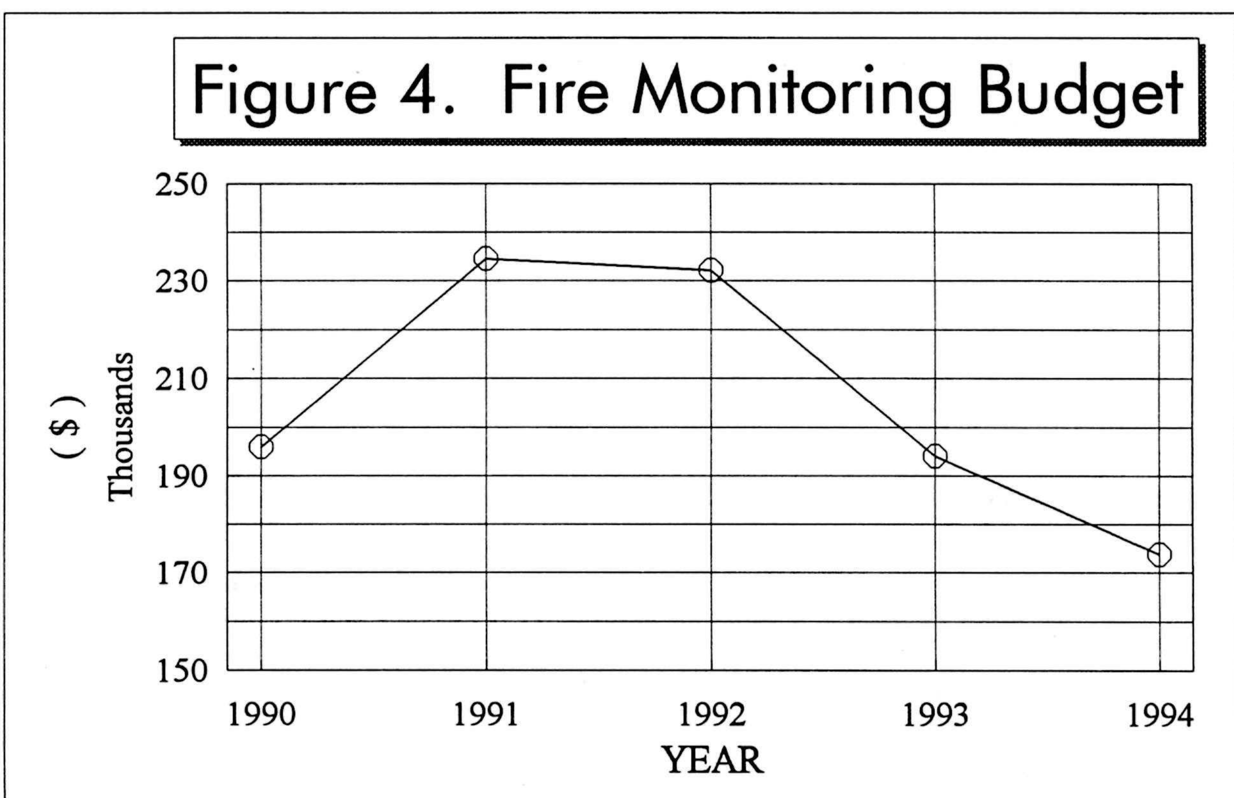


Figure 4. Fire Monitoring Budget
250
230
210
190
170
150
($)
Thousands
1990
1991
1992
1993
1994
YEAR

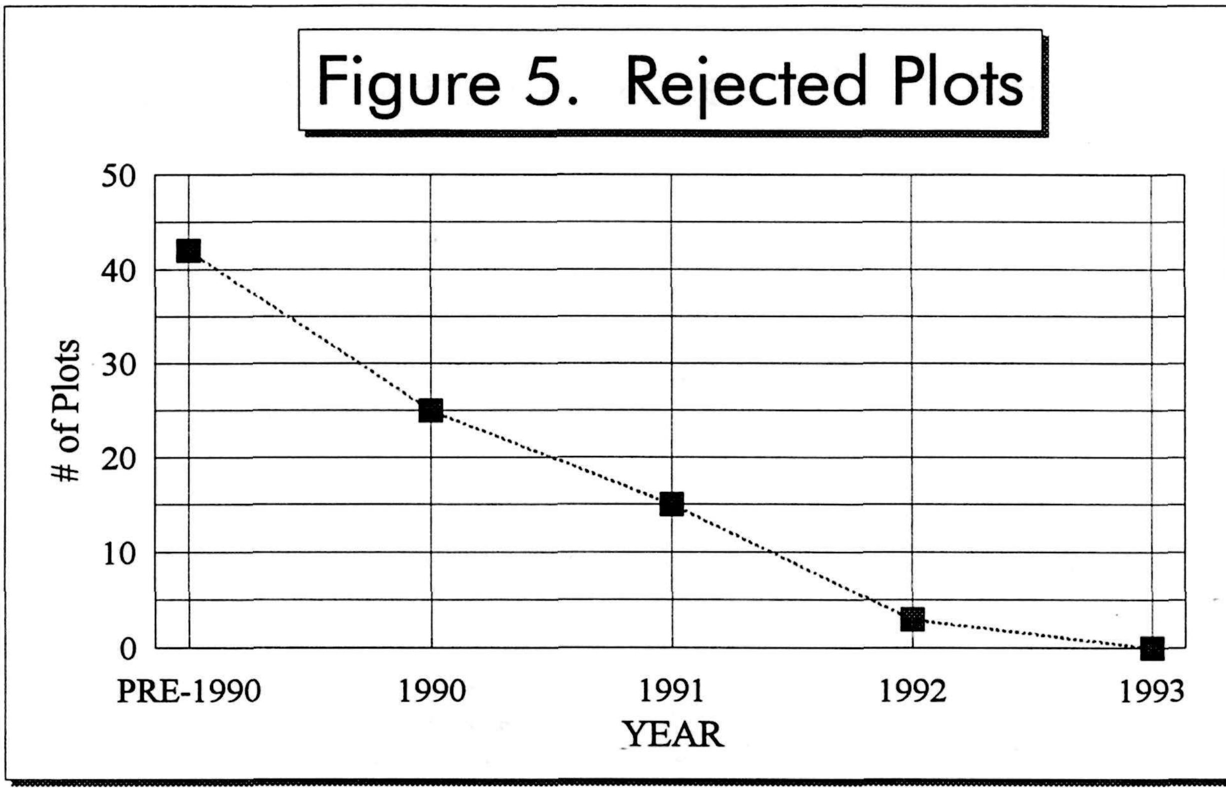


Figure 5. Rejected Plots
50
40
30
20
10
0
# of Plots
PRE-1990
1990
1991
1992
1993
YEAR

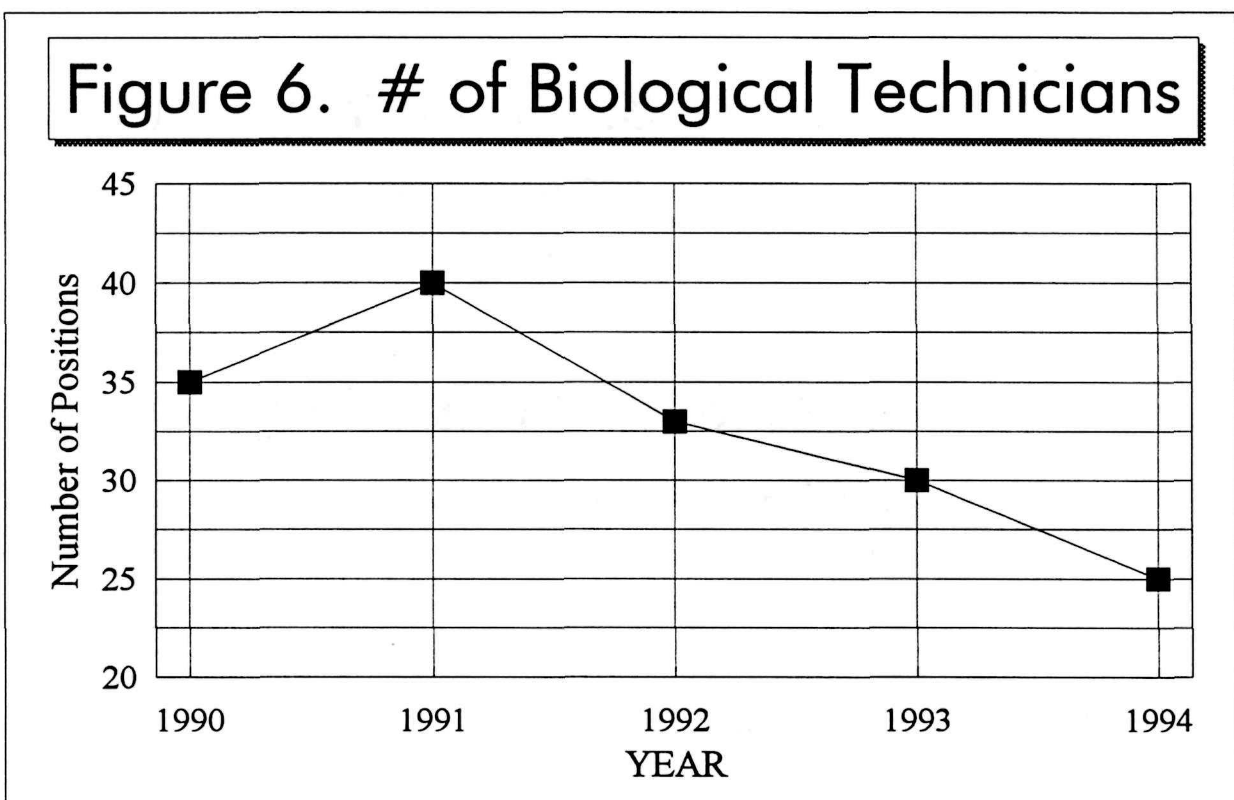


Figure 6. # of Biological Technicians
45
40
35
30
25
20
Number of Positions
1990
1991
1992
1993
1994
YEAR

Figure 7. Projected Workload for SEKI

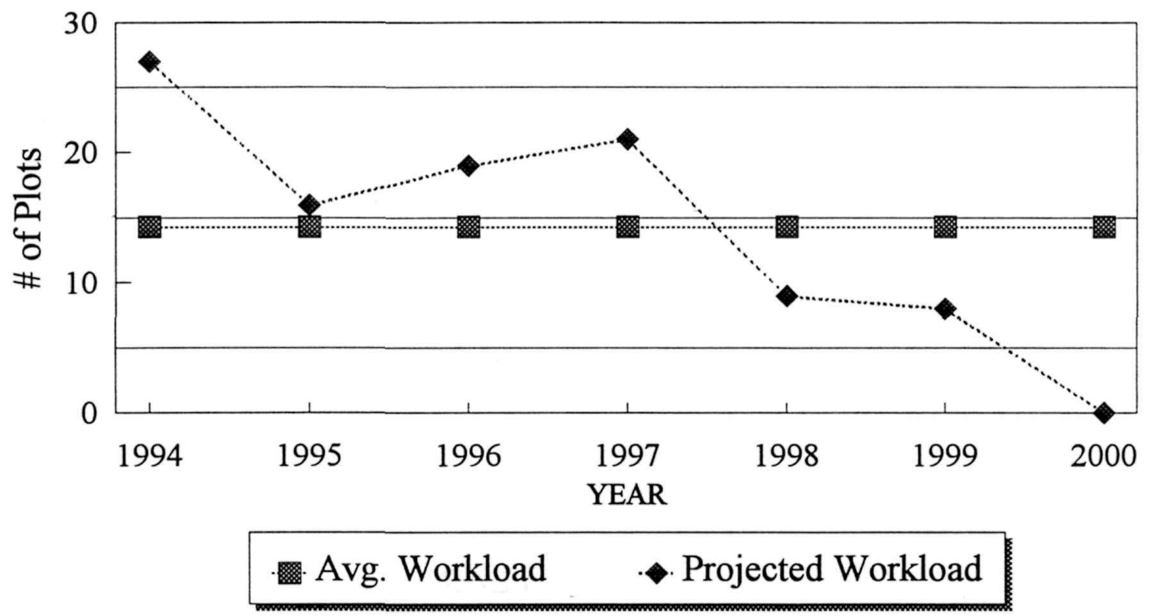
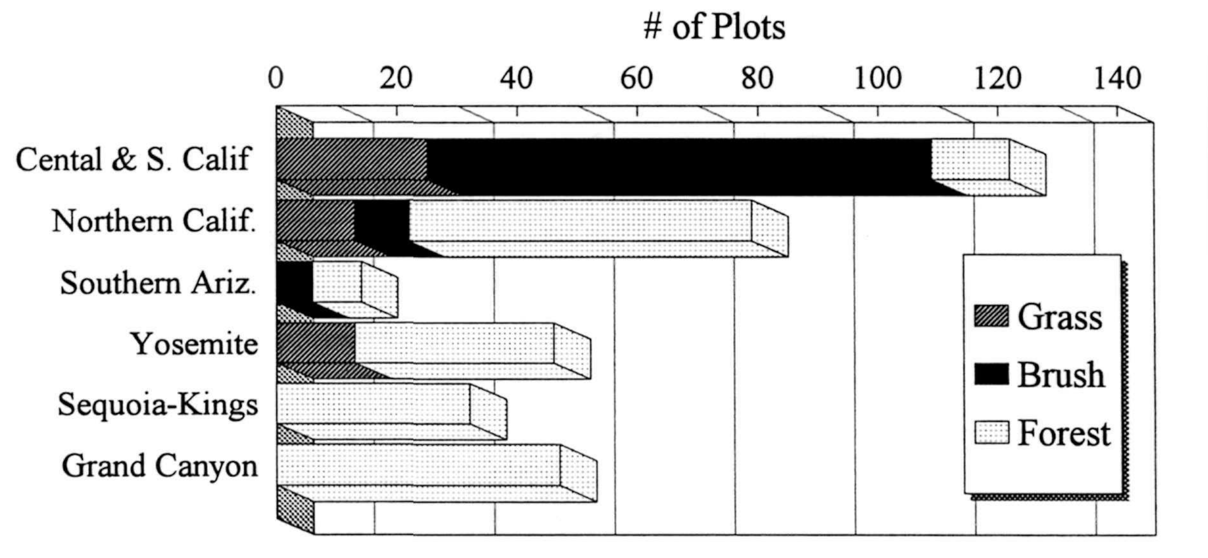


Figure 8. Team Workload
Plots Reread / Plots Installed



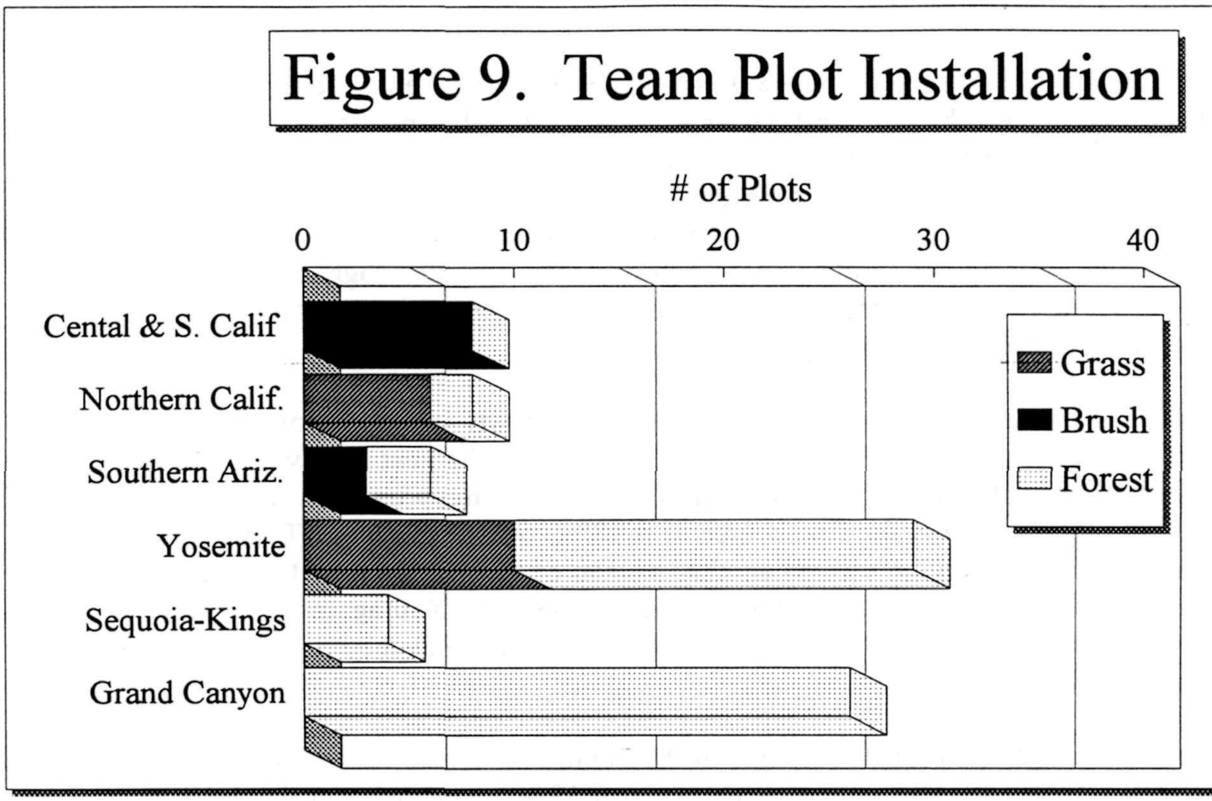


Figure 9. Team Plot Installation
# of Plots
0
10
20
30
40
Cental & S. Calif
Northern Calif.
Southern Ariz.
Yosemite
Sequoia-Kings
Grand Canyon
Grass
Brush
Forest

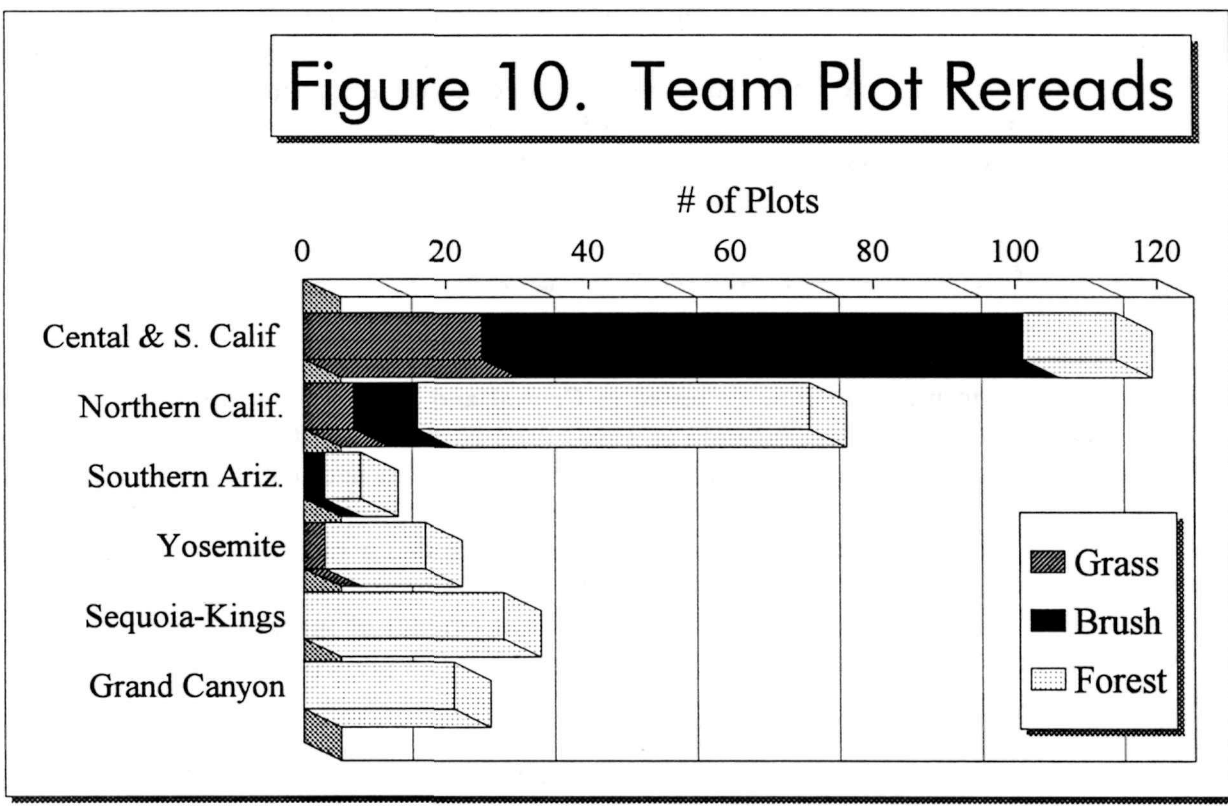


Figure 10. Team Plot Rereads
# of Plots
0
20
40
60
80
100
120
Cental & S. Calif
Northern Calif.
Southern Ariz.
Yosemite
Sequoia-Kings
Grand Canyon
Grass
Brush
Forest

amount of acreage burned.

The fire monitoring program budget has been declining in the last several years (Figure 4), which may suggest that we can transfer some funds to other regions. Comparing Figures 3 and 4, one can see that this program is currently doing more for less. Regarding future trends, if the workload remains constant, the current level of funding and staffing is appropriate, with a slight decline in the next five years. If burning programs lose their current momentum, staffing and funding needs will decrease, and the program will become less useful. However, if the burning program increases beyond the current level, staffing and funding will need to grow beyond current levels.

Looking at Figure 5 one can see that the quality of newly installed plots is increasing. The chart plots how many plots that were rejected based on the year they were installed. The highest number of rejected plots were installed the year the program was in its test phase. In 1990, the region offered the first course of RX80 (Preburn Inventory Techniques). The following year, the region offered another session of RX80. Then in 1992, the region established the program manager position, and presented RX80 again. A total of 85 installed plots have been rejected to date. This number may change as monitoring type descriptions are further modified.

In addition, Figure 6 plots the decline in the number of biological technicians assigned to fire monitoring. This number will decrease again in 1994, as monitors in the three large parks perform other duties, because their plot networks are complete or near complete.

Sequoia and Kings Canyon's year-end report provides a look into the future of the fire monitoring work load. These calculations show what their projected work load will be in the next six years (Figure 7). Although these numbers decline to zero in the year 2000, the numbers will rise when it is time to reread the 5, 10 and 20 year postburn plot information. This information is in keeping with the original funding philosophy for this program.

Regional Team Achievements to Date

The regional monitoring team concept tested in Central and Southern California in 1992 was tried in Arizona and Northern California in 1993. The Northern California team handled their first season in a highly professionally manner. The cooperation and team spirit embraced by the fire management officers and resource management specialists in all four respective parks, and the can do attitude of the team members, helped make this a successful first season. The team managed the second largest work load in the region (Figure 8). This is in due to the high number of plot rereads (Figure 10). A significant amount of management ignited fire activity took place in this area especially in Redwood NP (15 plots burned) and Lava Beds NM (14 plots burned).

The Arizona group did not fare well for many reasons. Managers at Grand Canyon NP and Chiricahua NM were highly skeptical of the Arizona arrangement (with the lead Biological

Sciences Technician stationed at Saguaro NM, and remaining seasonals stationed at Grand Canyon NP). Communication was poor, and managers at Grand Canyon NP and Chiricahua NM were clearly disappointed with the situation. The first step to solve this problem was to remove Grand Canyon NP from the jurisdiction of the Arizona team. However, the removal of the Grand Canyon NP removed the potential work force for the lead technician. Still, the lead technician was able to gain support from employees at Saguaro NM and Chiricahua NM. The agreed upon arrangement established in late 1993 will continue into 1994. The lead Biological Sciences Technician's workload is to be divided between the home park, Saguaro NM, and Chiricahua NM.

The Central and Southern California Team exceeded the standards of quality they set last year. Through the contacts and the lessons that they learned last year they were able to meet the needs of all six of their parks, provide assistance to the Northern California team, work on the course construction of RX-92, and even find time for vacation. The crew had the largest work load in the region this season (Figure 8), which is due to the large number of rereads (Figure 10). A significant amount of management ignited fire activity took place in this area especially in Santa Monica Mountains NRA (29 plots burned, the highest number of plots burned in the region), Point Reyes NS (16 plots burned), and Joshua Tree NM (10 plots burned). In addition, the Green Meadow fire at Santa Monica Mountains NRA burned 10 FMH plots.

Large Park Achievements to Date

The large parks, Grand Canyon NP, Sequoia and Kings Canyon NPs, and Yosemite NP each had excellent seasons for different reasons. Grand Canyon NP had an extremely productive season, they burned 1,232 acres, which burned 12 plots. Monitors provided assistance in management ignited prescribed fire unit preparations, prescribed natural fire monitoring (496 acres) and wildfire suppression (1,997 acres). In addition, they lead the region in installation of forest plots (Figure 9). Members of the crew spent a great deal of time traveling to the North Rim, where much of the above activity took place. To solve this problem, some crew members will be stationed on the North Rim in 1994.

Sequoia and Kings Canyon NPs had a busy and productive season. Monitors spent time monitoring several prescribed natural fires (2,600 acres). The management ignited fire program was small this year due to archeological clearance procedures, weather, state preparedness levels, and budget problems. The crew spent an extensive amount of time "cleaning up" the fire monitoring database, and reevaluating burn objectives. Plots that were established prior to the Western Region program have been formally incorporated within the regional database, with minor modifications. Monitors also spent a significant amount of time performing plot rereads (Figure 10).

Yosemite NP put a significant amount of effort into the completion of their plot network. The Yosemite crew installed the most plots in the region this year (29). This effort was a complete success, as all their plots are now installed. This was probably due to, in their words, the "ever present spiritual guidance of Elvis." In addition, Yosemite NP burned the second highest number of plots in the region (17), see Figure 9.

Program Management Achievements to Date

Year-end reports sent to the region in the past, have ranged from very brief to a wealth of information. This year we experimented with the use of a year-end report form, as a test prototype it seemed to work well. Program supervisors were e-mailed a basic layout, complete with formatted tables to fill in. Supervisors had free license to be creative with formatting and presentation of data. With some minor modifications based on field suggestions, we will definitely use this tool again.

During the 1993 field season the following parks were visited to assist local managers and monitors with problems, inconsistences, or provide support with the fire monitoring program: Chiricahua NM, Golden Gate NRA, Lake Mead NRA, Lassen NP, Pinnacles NM, Point Reyes NS, Saguaro NM, Santa Monica Mountains NRA, Sequoia & Kings Canyon NPs, and Whiskeytown NRA. In addition, assistance was given to California State Parks at Annadel and Lake Tahoe, and Sherburne NWR in Minnesota.

The program manager, and prescribed fire personnel from GRCA, JOTR, PINN, and SEKI attended the RX91-Monitoring Prescribed and Prescribed Natural Fire instructor handoff in Boise (April 1993). Following this class, the new Western Region cadre presented one session of RX91 at the Albright Training Center, Grand Canyon in May 1993, and another at Sequoia NP in June 1993.

Course construction for RX92 (Fire Monitoring Program Design and Implementation) by a multi-agency, multi-regional cadre began in early 1993. This course will contain six units: course administration, strategy and planning, design, implementation, data processing and evaluation, and evaluation and testing. The data processing and evaluation unit is the largest (two days), and is the unit that helps managers extract useful information from their park's fire monitoring program. The projected audience for this course will be fire management officers and natural resource specialists. The 1994 class will only address Western Region concerns. Considering the potential for a national or interagency program, we intend to construct the course so that we can easily modify it for use at the national level, using the Western Region as only an example. Six members of the cadre needed to attend Facilitative Instructor. These future instructors attended this course at Tucson in October 1993.

The program director provided assistance to Chiricahua NM in: data entry, data management and data analysis. This help was necessary to bring this data set up to regional standards. Though the data analysis was initial at best, these analyses brought up some sample questions that managers may be asking themselves, once their data sets are analyzed. These analyses are valuable mostly for the questions they ask, since the data is not statistically valid at this time. To provoke conversation and to provide managers a small glimpse of where the program will go in the next few years this analysis has been included here as Appendix C. In a related task, the Sequoia NP ecologist created a poster highlighting the effects of their fire monitoring program. This poster was presented at the Fire in Wilderness Conference in Montana (March 1993).

The program manager presented a poster explaining the fire monitoring program at the Fire in Wilderness Conference in Montana (March 1993), and the Natural Areas Conference in Maine (June 1993). These presentations provided more exposure for the program.

The New York Botanical Garden publishes a Permanent Plot Directory, which is a directory of all the permanent plot databases in the world. The last entry for this fire monitoring program was sometime in the late 1980's, when the program was located solely within Sequoia & Kings Canyon NPs. The program manager provided information regarding the status of the fire monitoring program.

Neil Willits, a statistician at the University of California, Davis, met with the program manager, the regional prescribed fire specialist, the ecologist and environmental specialist, SEKI and the CPSU unit leader. This meeting was to discuss the statistical value of the fire monitoring program. Dr. Willits' comments and suggestions are enclosed as Appendix B.

The program manager attended the Monitoring Natural Resources course at Fort Collins, CO (August 1993). There he met the new Inventory and Monitoring Coordinator for the Western Region, Sarah Allen. Both of us realized the need for resources and fire to work together and all levels, even the regional level. The first action of this cooperation was a joint trip to Santa Monica Mountains NRA following the Green Meadow wildfire. The purpose of our trip was to set up postburn monitoring protocols that involved effects on fauna and flora.

The program manager discussed the status of the fire monitoring program with resource management specialists at the Death Valley Resource Managers Meeting (April 1993). The topics addressed included: resource responsibilities, resource participation, status of the database, and quality control.

The program manager served as an instructor for the RX80 (Preburn Inventory Techniques) presented by the Fish and Wildlife Service in Minnesota (July 1993). This course served as a handoff to US Fish and Wildlife, US Forest Service, and state land managers throughout the country.

Program-wide Recommendations

Last year I recommended that there should be a permanent employee in each park that has the responsibility for carrying out or managing this program. This position could be on the level of a Prescribed Fire or Biological Science Technician supervised by Prescribed Fire or Resource Management. I hope the temporary GS-7 Biological Technician positions we are attempting to create can serve as models for possible positions in other areas. At some point these positions should become ONPS funded positions and managed by resource or fire management as a part of doing business.

I will continue to address the need for basic fire history and/or fire effects data for the dominant plant communities in each park. This lack of data might lead some to suggest that in some parks the implementation of a prescribed fire program may be premature. In these situations a fire monitoring program can be useful in pointing toward research needs. However it is paramount that we meet these research needs. A cooperative funding program could be coordinated with resource programs that would also benefit from this information. Another idea would be to bring the need to the attention of NBS scientists.

For every monitoring team to have a trained botanist, may be the easiest solution to many botanical problems. This practice should continue to be considered a prerequisite of at least one (preferably two) team member(s). Team or park recommendations for changes in protocol, and problems encountered in the field are presented in Appendix A.

Program Goals FY 1994

One primary goal of 1994 will be to provide RX92 (Fire Monitoring Program Design and Implementation) to all fire management officers and natural resource specialists in the Western Region, this coming spring or fall. Course construction for most of the units are in the editorial phase. The most critical unit, Data Processing and Evaluation, is still being written. This is very understandable, as this is the unit that requires the most work.

In 1994 we will establish at least 56% of the remaining uninstalled plots (Table 3). We will install the remaining plots during the same year a burn unit containing an unburned monitoring type is to burn. However, the grass and brush plot database will very close to complete by the end of 1994 (Table 3).

Although we plan to install a lower number (when compared to 1993 figures) of new plots in 1994, the total work load will be similar to 1993. This is because the projected number of revisits for 1994 is significantly higher than for 1993 (Table 2 & 3). In other words biological technicians will be working as hard or harder than they did this year. I say harder because the projected number of plots to reread is typically a conservative figure.

Another goal is to increase the safety and effectiveness of fire monitors throughout the region, which will provide burn bosses the flexibility they need to run an active burn program. Safe and effective management of these people requires the continued cooperation and patience from prescribed fire managers.

Finally, next fall we hope to visit with park managers about some questions that may be arising from the results of their one-year postburn data. Questions that are similar to those presented in Appendix C. These questions will be directed at the effectiveness of the prescribed burn program. Are we meeting our resource management or hazard fuel reduction goals with the current burning regime? This in effect will bring the program full circle, and may help some managers understand what all those biological technicians have been doing for the last five years. If there are any questions regarding this report, do not hesitate to call me at (415) 744-3878.

Paul Reeberg

Paul Reeberg

cc: Steve Botti
Tom Nichols
Tom Zimmerman
Fire Management Officer, Regional Chief Scientist, WRO
CPSU Unit Leader, UCD

Appendix A

Park recommendations for program problems:

Central & Southern California Team

- The policy of remonitoring the plots if they haven't been monitored in the last two years needs to be reevaluated. There needs to be some way to evaluate the necessity for remonitoring based on nature of the vegetation. Having done extensive preburn remonitoring this year, it is easy to see that grasslands can change radically from year to year. The value of remonitoring in these areas is obvious. Coastal scrub and redwood forests, however, do not show the same rate of change and fluctuations in composition. Possibly there should be an extension of monitoring interval for vegetation types not prone to annual composition fluctuations. This should be something that is discussed with resource management staff and fire management staff. Field visits to evaluate on-site vegetation composition should be an integral part of this evaluation process.

Grand Canyon NP

- It should be mandatory that we measure char height while measuring scorch height. The actual percent of overstory or pole-size crown scorch can solely or in part be a result of bark charring.

- To further understand overstory tree crown scorch, pole-size trees should require char and scorch sampling. Areas with high densities of pole and seedling sized trees, provide ladder fuels that can greatly contribute to overstory crown scorch.

- When conducting immediate post-burn monitoring, rereading the 50-meter transects should be mandatory, providing managers a comprehensive view of fire intensities and overall extent of fire spread in and around the plot.

- In burn units without a sufficient safety margin to allow fire monitors to be near plots, identify similar vegetative conditions in locations that provide safe monitoring of fire behavior.

Northern California Team

- The ability to allow for flexible plot installation needs to be discussed, possibly in the handbook. In some cases the vegetation may not allow for any of the standard grassland, brush, or forest plots to be installed. Recommended modifications or suggestions may be incorporated to deal with sampling problems that involve difficult rejection and/or selection criteria.

- The policy of remonitoring the plots if they haven't been monitored in the last two years needs to be reevaluated. There needs to be some way to evaluate the necessity for remonitoring based on nature of the vegetation. Having done extensive preburn remonitoring this year, it is easy to see that grasslands can change radically from year to year. The value of remonitoring in these areas is obvious. Mixed conifer forests, however, do not show the same rate of change and fluctuations in composition. Possibly there should be an extension of monitoring interval for vegetation types not prone to annual composition fluctuations. This should be something that is discussed with resource management staff and fire management staff. Field visits to evaluate on-site vegetation composition should be an integral part of this evaluation process.

Sequoia & Kings Canyon NPs

- We have continued to carry out quality assurance procedures at various steps of data collection and data storage at the park level. Written recognition and guidelines for these procedures with a "checklist" of steps would affirm the importance of, and assist programs in establishing, such data quality checking procedures.

- There is a need for flexibility in monitoring protocol when efficiency and effectiveness are issues. The FMH techniques should offer guidelines for monitoring not rigid constraints.

Southern Arizona Team

- In areas with ever changing burn units, in size and/or location, it is suggested that plots be established not more than a year in advance, or the year of the scheduled burn.

- Propose that resource specialists, biological technicians, prescribed fire managers, park prescribed fire staff, program manager and any other program participants, get together for a preseason meeting to discuss problems, expectations, and the direction of the program.

- There seems to be a increasing need to compare fuel moisture, weather and fire behavior to the fire effects results. This is important in the creation and refining of prescriptions. The software is not prepared to correlate Level 2 variables with Level 3 or even Level 4 monitoring results. My only suggestion is to continue taking through fire behavior, weather, and fuel moisture data and continue making complete burn reports on every burn.

Yosemite NP

- Hazard pay for all personnel involved in the monitoring of prescribed natural and management ignited fires.

- Request the next version of the FMH software, as the present version lacks certain features, which this staff finds petty, but annoying.

- Issue all participants using the FMH program a hand-held data collector to use in the field.

- Establish a permanent fire effects coordinator in all three large parks. This will insure continuity in the program, which is often lacking.

Appendix B

Statistical Consulting / Programming Report

Abstract of the Problem

They had a number of questions about some ongoing work they're doing involving the effectiveness and after-effects of controlled burns that are done in western National Parks. There are some problems in this work, both in terms of the way the data are collected, as well as the type of questions they're trying to address with it.

In recent years the study sites are all being selected randomly, or at least randomly subject to certain entry criteria. As long as the entry criteria are deterministic (i.e., not based on any random characteristics that they've measured at the sites), then this will result in a random sample that's uniformly distributed over the population of all sites that satisfy the entry criteria, which is what they want.

In the past, they weren't always as gung ho about choosing sites at random and people would often go into the field and *haphazardly* select what they thought were representative sites. The reason that this isn't a very good idea in practice is that while you can try to make your representative sites comparable with respect to all the important characteristics you can think of, that doesn't mean that they won't appear later to be unrepresentative with respect to something you *hadn't* thought of. By choosing random sites, your sites will be representative (or at least manageably non-representative) with respect to *any* characteristic.

Their first question is whether to include the data from haphazardly chosen sites in their analyses. I gave a rather equivocal answer to this and suggested that they might want to analyze the data both ways. If the inclusion of the extra sites makes some qualitative differences in their findings, or if they can see ways in which the haphazardly chosen sites are different from the randomly chosen ones, then they probably don't want to use the old sites. If however this doesn't happen, then by including the old data along with the new, they will be able to improve the precision of their statistical estimates of effect sizes.

Their second question will be more difficult to handle. Part of their ongoing monitoring is to look at the progress of these sites following the planned burn to determine what side effects the burn may have had. At times they look at the sites after the fact and see things they weren't looking for that *may* represent side effects. They would like to test to see if these effects are real. Two things make this difficult. First, in order to determine whether an effect is significant, they need a control sample against which to compare it. I would think that control sites would consist of sites that weren't subjected to a *planned* burn, but may have experienced a naturally caused fire. The fact that any such control sites should have been comparable to the experimental sites prior to the burn may restrict the choice of control sites to such an extent that any statistical results would be subject to pseudoreplication. This would happen for example if all of the control sites were geographically isolated from all of the burned sites. That doesn't really affect the validity of the statistical conclusions as much as it affects their applicability. You still know that the burned and control sites responded differently, but since you know that the control sites in one location behaved differently from the burned sites in another location, you can't tease apart geographical effects from the effects of the burn. Since the burns are being used as a management strategy, you can't really talk about doing a formal experiment here, and this problem is something they'll have to live with.

The second problem with these sorts of comparisons is that they decided to carry them out only after noticing something suspicious in the data. As such, they can't really consider these to be preplanned comparisons. In the context of an ANOVA, Scheffé's method can be used to adjust for the fact that a comparison isn't preplanned, but here that isn't really the case. That's because the set of possible comparisons they might have looked at is no longer finite dimensional. In view of this, I think that the best that can come out of this type of analysis is a set of questions or hypotheses to study further, rather than any sort of definitive answer. If a comparison of this type is significant, then that points the way to an interesting item for further study. Even if the comparison *isn't* significant, then that doesn't imply that the effect is absent, but rather that the data they've collected aren't sufficient to document its presence. Because of these ambiguities in these tests, I think it would be instructive not only to test whether such an effect is significant, but also to estimate its *magnitude,* in view of the fact that a significant effect can be so small as to be uninteresting or unimportant, while it's possible for an *insignificant* effect to be of sufficient magnitude to be important, despite the fact it's insignificant.

I'm a little worried in their studies about the consequences of both Type I and Type 11 errors. The reason I say this is that they typically do separate analyses within each of their parks and don't make an effort to look for common features among the parks and differences between them. Part of this is necessary, since each burn is carried out to achieve a specific objective and using a specific (tailored) burn technique, and neither the objective nor the technique are likely to be identical in any two parks. To try to combine such disparate studies into a single analysis would involve meta analysis, which is a black art at best, and yet *not* to do this puts them at risk for a large number of both false positive and false negative results. It will be wise to give some critical overview of the results, so that they wouldn't overreact to an isolated significant finding of a given type amidst a number of similar insignificant findings. For example, if they found that pine trees suffer increased mortality in a given habitat type at Sequoia Park, whereas this type of result is unknown elsewhere, then I would be interested both in trying to replicate this finding, as well as trying to see if it applies under other circumstances. There are three possibilities here:

- the significant finding may have been a Type I error,
- the insignificant findings may have been Type II errors, or
- both results are genuine, and the "contradiction" is caused by a distinction between the two sites.

From a management perspective, it will be important to know which of these three possibilities is the real one, and the only way to distinguish them would be through further experimentation, ideally under controlled (comparable) conditions.

Since they may have additional questions in the future, they're planning on sending me both a copy of their data, along with some explanatory material they have written up.

Neil H. Willits

Appendix C

Chiricahua Fire Monitoring Program

The following is a look at some postburn data collected by the Chiricahua NM Fire Monitoring Program. This program was part of the pilot park program in 1987-8, when all of the plots analyzed in this appendix were installed. The plots analyzed here burned in 1990.

Analysis was performed using all the main monitoring type variables within the park, in monitoring types that were burned, where data were collected postburn. Holes in the data are due to the lack of data collection and storage protocols during the 1987-1991 field seasons. Analyses are not statically valid due to the small sample size. Still, one can see some trends from these analyses. These trends may be validated or refuted by additional monitoring and/or research.

The preburn data set, not thoroughly analyzed here, can be useful as a quantitative glimpse at resource conditions. The charts included (Figures 1-18) represent a minimum amount of the information that can be retrieved from this program. This report's intent is to provoke questions and present possible trends that may be statistically verified or refuted in the future. If further analyses can answer these questions, specific requests should be directed, at this time, to Paul Reeberg, WRO. However, it is probably too early to extract a large amount of data from this program, as the plot network is very incomplete. This is due in part to the following statistics:

- ≈54% the number of plots needed are installed
- ≈48% of the current plot network has burned
- ≈26% of the potential database has burned
- ≈50% of the postburn measurements are either missing, not entered in the computer, or were not collected during the 1990-1 field seasons

The information gathered here is to give Chiricahua managers a glimpse inside "the box of stuff" that has been sitting in the resource management office. Questions that arise after examining this information, should be directed to Paul Reeberg, WRO.

Postburn Summary

Arizona Cypress

The average burn severity for Arizona cypress was 4.8 on a 5-point scale, one signifying a heavily burned vegetation/substrate layer, and five signifying an unburned vegetation/substrate layer. A 4.8 suggests that most of the monitoring type did not burn at all, and the remaining small patches burned poorly. Therefore it is not surprising that char height, scorch height and scorch percentage values are all very low (Table 1).

Chihuahua Pine

Average burn severity for Chihuahua pine was 3.4 on the five-point scale mentioned above. A 3.4 indicates that the monitoring type was lightly burned on average. Char height, scorch height and scorch percentage values are higher than those found in Arizona cypress, but they are still low (Table 1).

Emory Oak

The average burn severity for emory oak was 4.2 on the five-point scale mentioned above. A 4.2 indicates that the monitoring type was scorched, but not burned on average. The char height, scorch height and scorch percentage values are all very low (Table 1).

Blue Grama

Average burn severity for blue grama was 3.2 on the five-point scale mentioned above. A 3.2 suggests that the monitoring type was lightly burned on average, with patches that burned more severely.

TABLE 1. Postburn data summary

	Burn Severity	*Average Char Height (m)*	*Average Scorch Height (m)*	*Average Percent Scorch (%)*
Arizona Cypress	4.8	0.19	0.39	0.37
Chihuahua Pine	3.4	0.06	1.04	7.68
Emory Oak	4.2	0.07	0.167	0.008
Blue Grama	3.2	N.A.	N.A.	N.A.

Overstory Density

Arizona Cypress

In the Arizona cypress plot the populations of alligator juniper (*Juniperus deppeana*) and Arizona cypress (*Cupressus arizonica*) remained fairly stable. The two remaining overstory tree species exhibited increases and decreases in average DBH and/or density (Figures 1 & 2).

The following increasing trends are noted:

- density of Arizona white oak (*Quercus arizonica*)
- average DBH of Arizona white oak

The following decreasing trend is noted:

- density of emory oak (*Quercus arizonica*)

Chihuahua Pine

In the Chihuahua pine (*Pinus leiophylla* var. *chihuahuana*) plot all the overstory tree species exhibited slight increases and decreases in average DBH and/or density (Figures 3 & 4).

The following increasing trends are noted:

- density of Arizona white oak, after an initial decrease
- average DBH of Arizona white oak
- average DBH of alligator juniper

The following decreasing trends are noted:

- average DBH of emory oak
- density of emory oak
- growth rate of Arizona white oak
- density of alligator juniper
- average DBH of Chihuahua pine

In addition, some Chihuahua pines died, but were replaced in the overstory by pole-sized trees, thus leaving the density the same postburn.

Emory Oak

In the three emory oak plots the populations of alligator juniper, Chihuahua pine and Arizona madrone (*Arbutus arizonica*) stayed fairly stable postburn. The three remaining overstory tree species exhibited increases and decreases in either average DBH or density (Figures 5 & 6).

The following increasing trend is noted:

- density of Arizona white oak

The following decreasing trends are noted:

- density of emory oak

- density and average DBH of Southwestern choke cherry (*Prunus serotina*), which led to complete loss in the second year, postburn.

TABLE 2. Pre- and Post-burn Fuel Loading

				Percent Reduction	
	Preburn (tons / acre)	*Year 1 (tons / acre)*	*Year 2 (tons / acre)*	*Year 1 (%)*	*Year 2 (%)*
Arizona Cypress	12.1	11.3	10.5	3.9	13.7
Chihuahua Pine	11.6	0.7	5.3	94.2	54.2
Emory Oak	10.2	5.0	7.9	51.3	22.9

Fuel Loading

Arizona Cypress

In the Arizona cypress plot the total fuel load increased initially postburn and then declined in subsequent years (Table 2, Figure 7). The data supporting these changes are also shown in Figure 8.

The following increasing trends are noted:

- The postburn increase is due to an increase in duff, 1-Hour and sound 1,000-Hour fuels, with the 1,000-Hour fuels leveling off at higher levels postburn than preburn;

- 100-Hour fuel in year 1, with a decline in year 2 (an overall net increase).

The following decreasing trends are noted:

- The rotten 1,000-Hour fuel was reduced;
- Duff was reduced by year 1 (postburn duff readings possibly included ash in the duff layer);
- 1- and 10-Hour Fuels.

Chihuahua Pine

In the Chihuahua pine plot the total fuel load declined postburn, and continued to decline in year 1, then rising in year 2 (Table 2, Figure 7). The data supporting these changes are shown in Figure 9.

The following increasing trends are noted:

- 1-Hour Fuels;
- Duff was reduced until year 1, with a dramatic increase in year 2 (an overall net increase).

The following decreasing trends are noted:

- The sound 1,000-Hour fuel was effectively reduced;
- 10- and 100-Hour Fuels.

Emory Oak

In the emory oak plots the total fuel load declined postburn, and continued to decline in year 1, then rising in year 2 (Table 2, Figure 7). The majority of this change took place in the duff layer, the fire not affecting the 1-1,000-Hour fuels (Figure 10).

The following decreasing trend is noted:

- Duff was reduced until year 1, with a dramatic increase in year 2.

Herbaceous Understory

Arizona Cypress

The fire did not affect the non-plant proportion of the understory and had a marginal affect on the living herbaceous layer, with a notable exception of pinyon ricegrass (*Piptochaetium fimbriatum*). Pinyon ricegrass disappeared in the postburn environment, and then increased in cover and frequency postburn (Figures 11 & 12).

Schott's yucca (*Yucca schottii*), a plant of concern to mangers due to its flammability, exhibited neither a strong nor weak reaction to the fire.

Chihuahua Pine

The fire did not affect the non-plant proportion of the understory, but decreased the relative cover and frequency of pointleaf manzanita (*Arctostaphylos pungens*). Bullgrass (*Muhlenbergia emersleyi*), pinyon ricegrass, and poverty threeawn (*Aristida divaricata*) all seemed to benefit from the fire, while mesquite grass (*Hilaria belangeri*) fared poorly (Figures 13 & 14).

Emory Oak

The fire had little effect on the non-plant proportion of the understory, but decreased the relative cover of pointleaf manzanita and beggartick threeawn (*Aristida orcuttiana*). The relative cover of butterfly pea (*Clitoria mariana*) and pinyon ricegrass both seemed to benefit from the fire, while the relative cover of beargrass (*Nolina microcarpa*) remained fairly stable (Figures 15 & 16).

Grassland Herbaceous Data

Blue Grama

The most significant change that occurred postburn, which is not graphed, was the dramatic increase in the number of species encountered, from 5 to 17. This also coincided with a drop in the percentage of native species from 100% to 96.2%. Figures 17 & 18 show that fire may not significantly affect the populations of the three dominant native grama grasses (*Bouteloua gracilis*, *B. curtipendula*, and *B. hirsuta*). In addition, it is quite possible that there is a significant decrease in frequency values for the native turpentine bush (*Ericameria larcifolia*) and litter/duff/bare ground postburn.

Conclusions

The analysis gathered here is introductory, and is provided solely to instigate questions. Some questions may include:

- If the overstory emory oaks are declining due to fire, what is happening to the population as a whole? Looking at the pole-size and seedling tree data, can provide additional clues.

- Is the amount of fuel reduction an adequate reduction of the fuel hazard? Although the rotten logs are removed, can the canopy still carry a crown fire?

- Are the increases in species diversity, and relative cover of herbaceous plants desirable? If so, is this partial support for expanding the burning program?

- What does this information show in regard to the current goals of the burning program? Have program goals, and burn objectives been met using these prescriptions and firing techniques?

- Does the burn program have measurable goals, which can be evaluated? It may be in the managers best interest to have quantitative goals, so that a burn or burn program's success can be determined by postburn data.

- Are any of the trends shown indicative of data collection errors? Closer examination of the data, and consulting former biological technicians, may provide some answers. How can these data collection errors be avoided in the future?

- Did the overstory trees that died, die due to the fire or due to other causes?

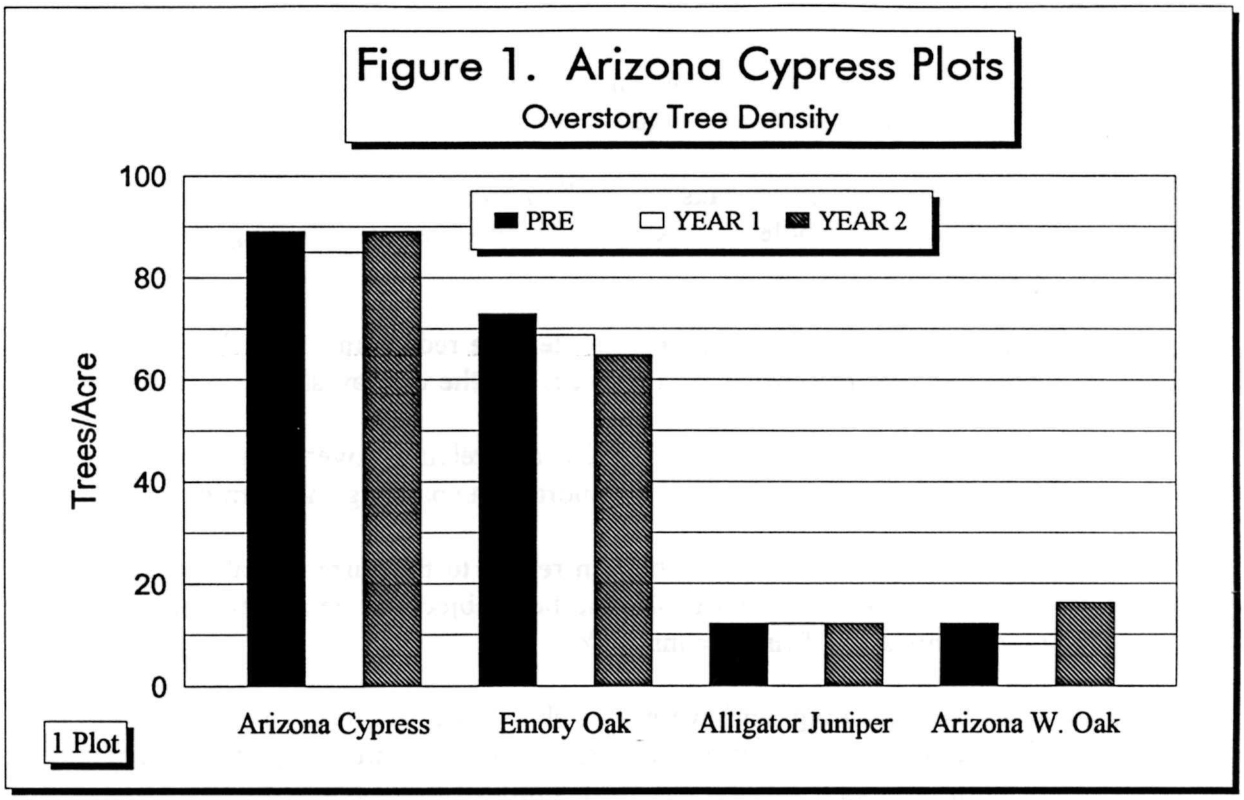


Figure 1. Arizona Cypress Plots
Overstory Tree Density
PRE
YEAR 1
YEAR 2
Trees/Acre
100
80
60
40
20
0
Arizona Cypress
Emory Oak
Alligator Juniper
Arizona W. Oak
1 Plot

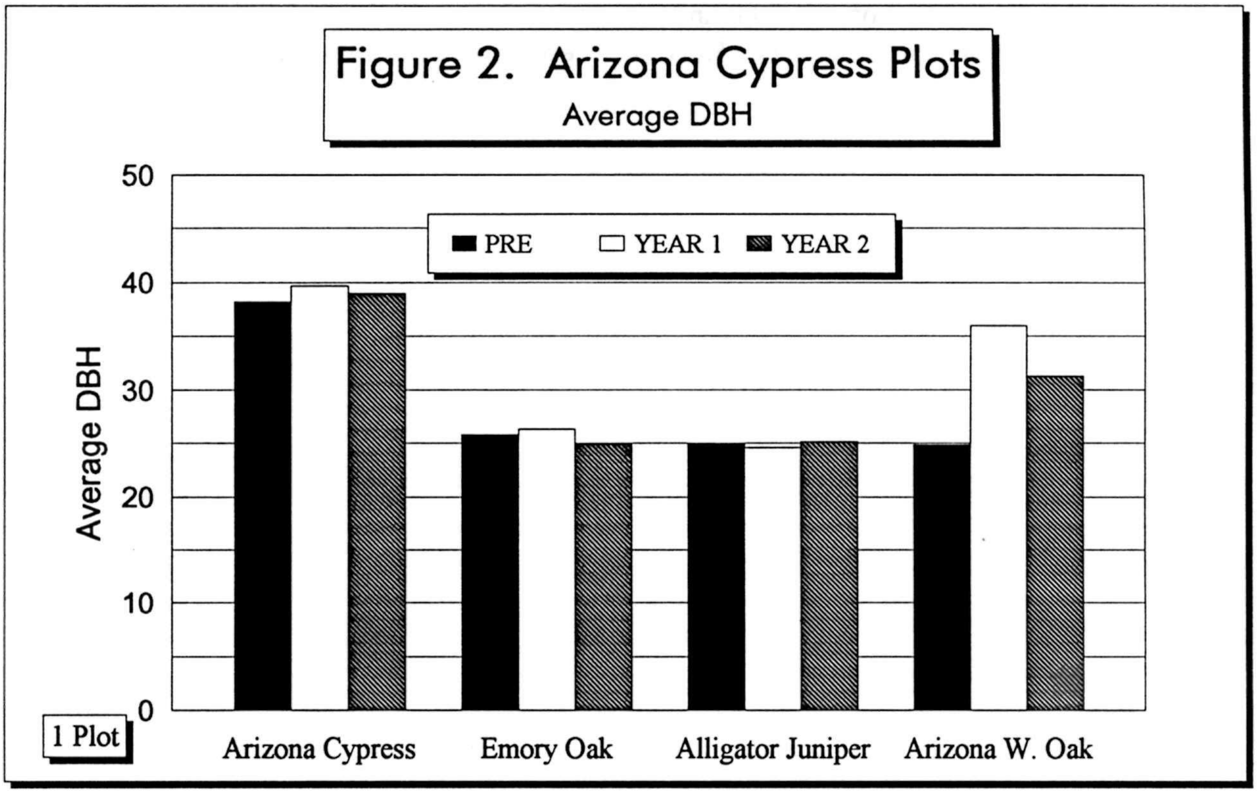


Figure 2. Arizona Cypress Plots
Average DBH
PRE
YEAR 1
YEAR 2
Average DBH
50
40
30
20
10
0
Arizona Cypress
Emory Oak
Alligator Juniper
Arizona W. Oak
1 Plot

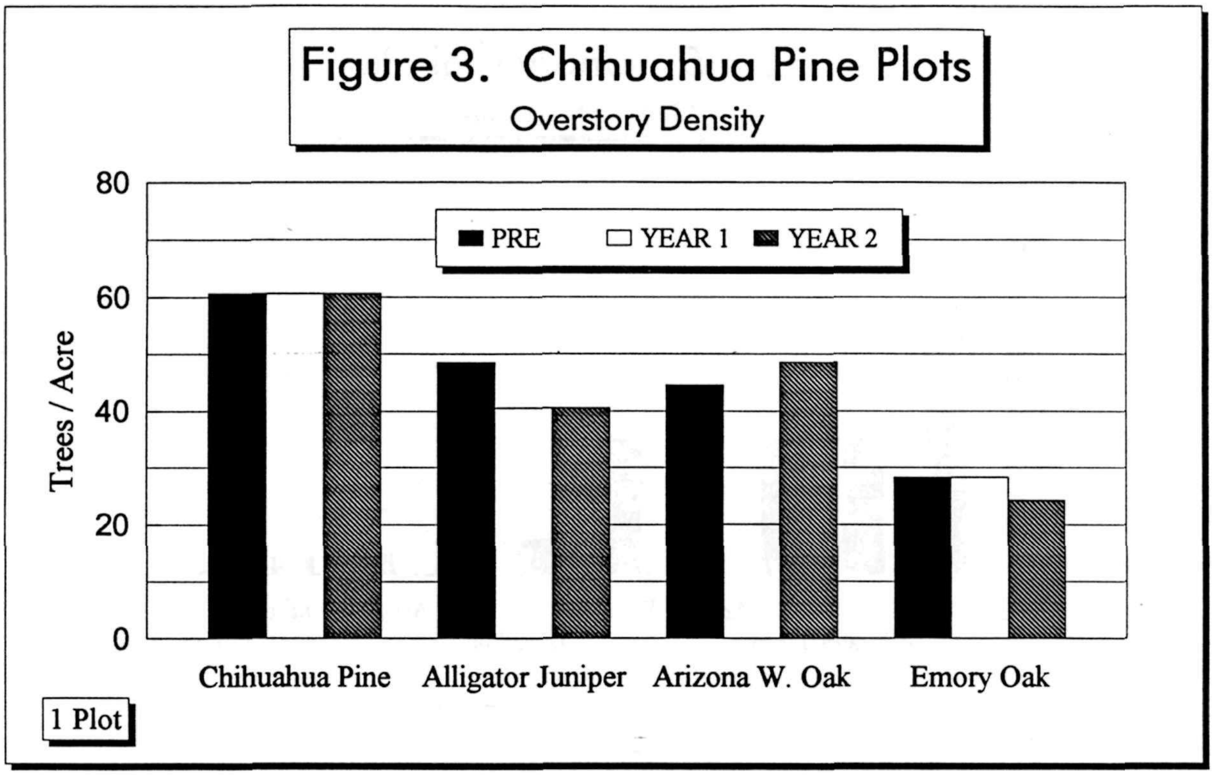


Figure 3. Chihuahua Pine Plots
Overstory Density
PRE
YEAR 1
YEAR 2
Trees / Acre
80
60
40
20
0
Chihuahua Pine
Alligator Juniper
Arizona W. Oak
Emory Oak
1 Plot

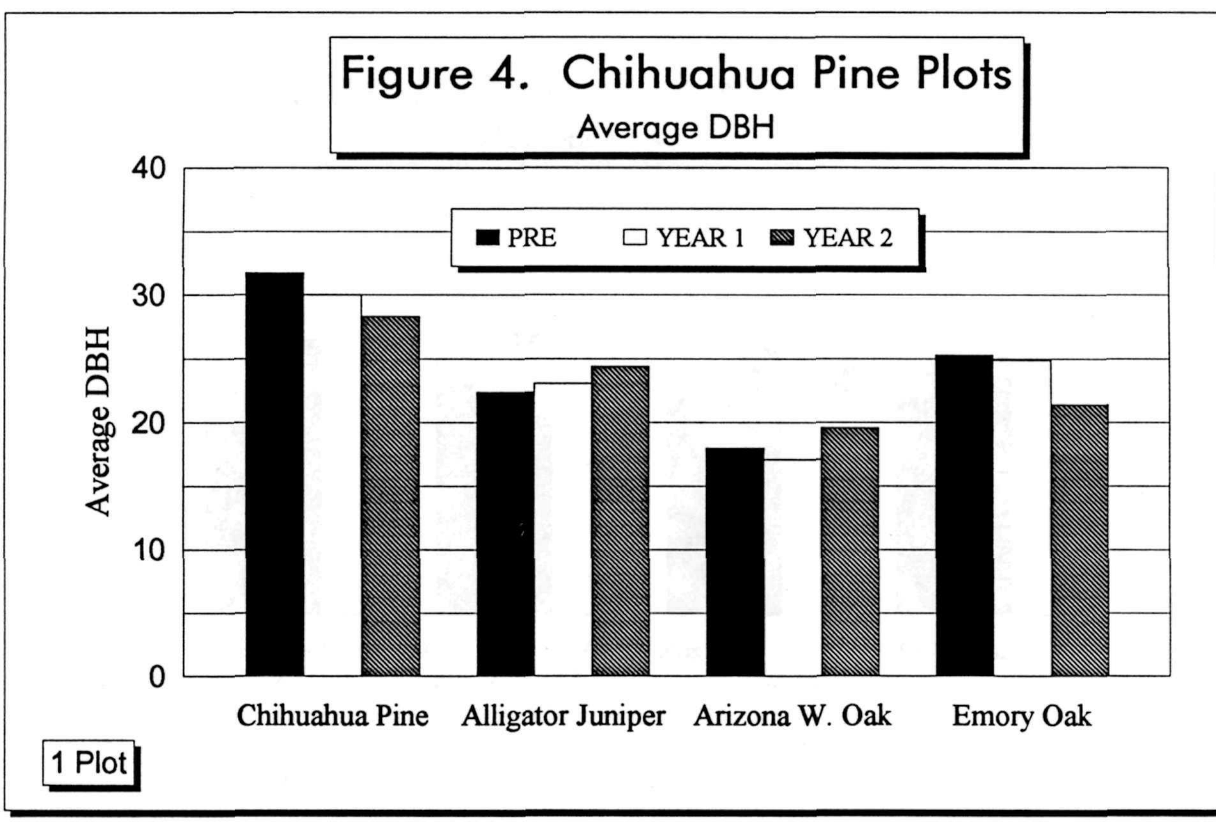


Figure 4. Chihuahua Pine Plots
Average DBH
PRE
YEAR 1
YEAR 2
Average DBH
40
30
20
10
0
Chihuahua Pine
Alligator Juniper
Arizona W. Oak
Emory Oak
1 Plot

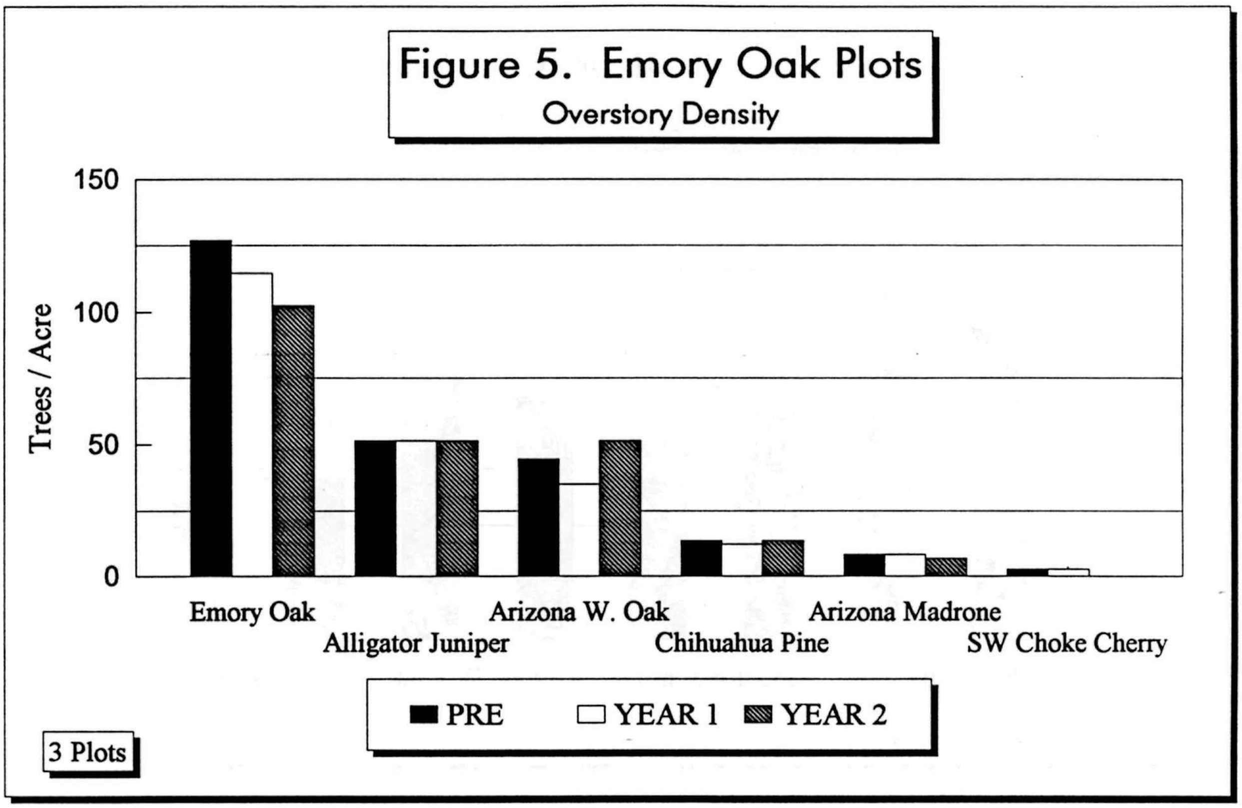


Figure 5. Emory Oak Plots
Overstory Density
150
100
50
0
Trees / Acre
Emory Oak
Alligator Juniper
Arizona W. Oak
Chihuahua Pine
Arizona Madrone
SW Choke Cherry
PRE
YEAR 1
YEAR 2
3 Plots

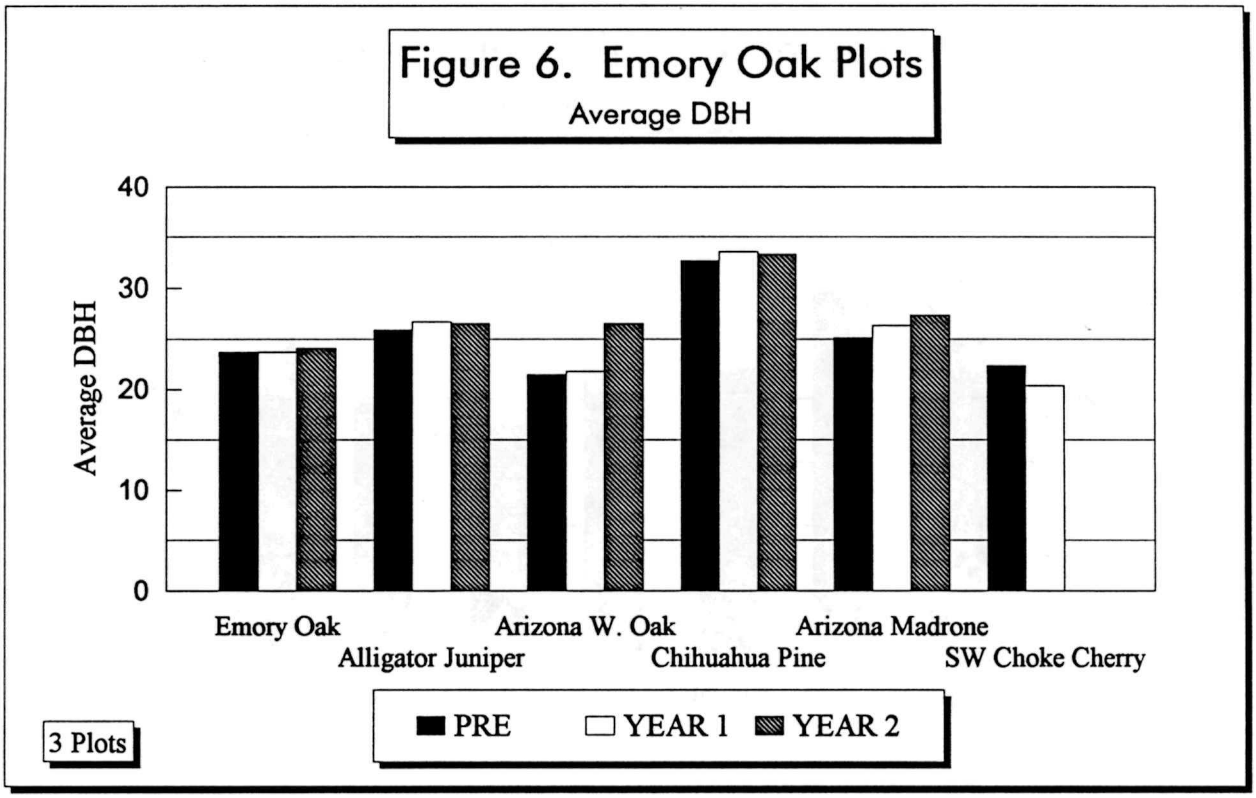


Figure 6. Emory Oak Plots
Average DBH
40
30
20
10
0
Average DBH
Emory Oak
Alligator Juniper
Arizona W. Oak
Chihuahua Pine
Arizona Madrone
SW Choke Cherry
PRE
YEAR 1
YEAR 2
3 Plots

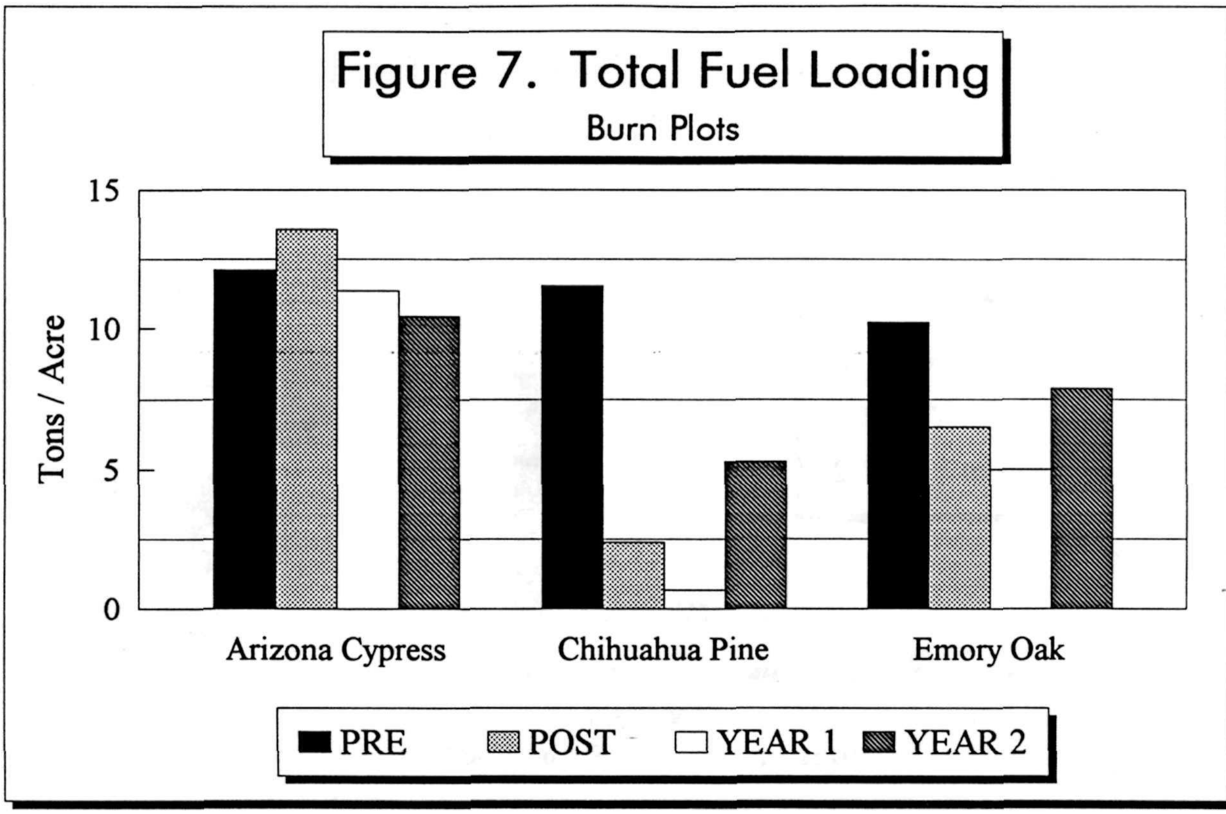


Figure 7. Total Fuel Loading
Burn Plots
15
10
5
0
Tons / Acre
Arizona Cypress
Chihuahua Pine
Emory Oak
PRE
POST
YEAR 1
YEAR 2

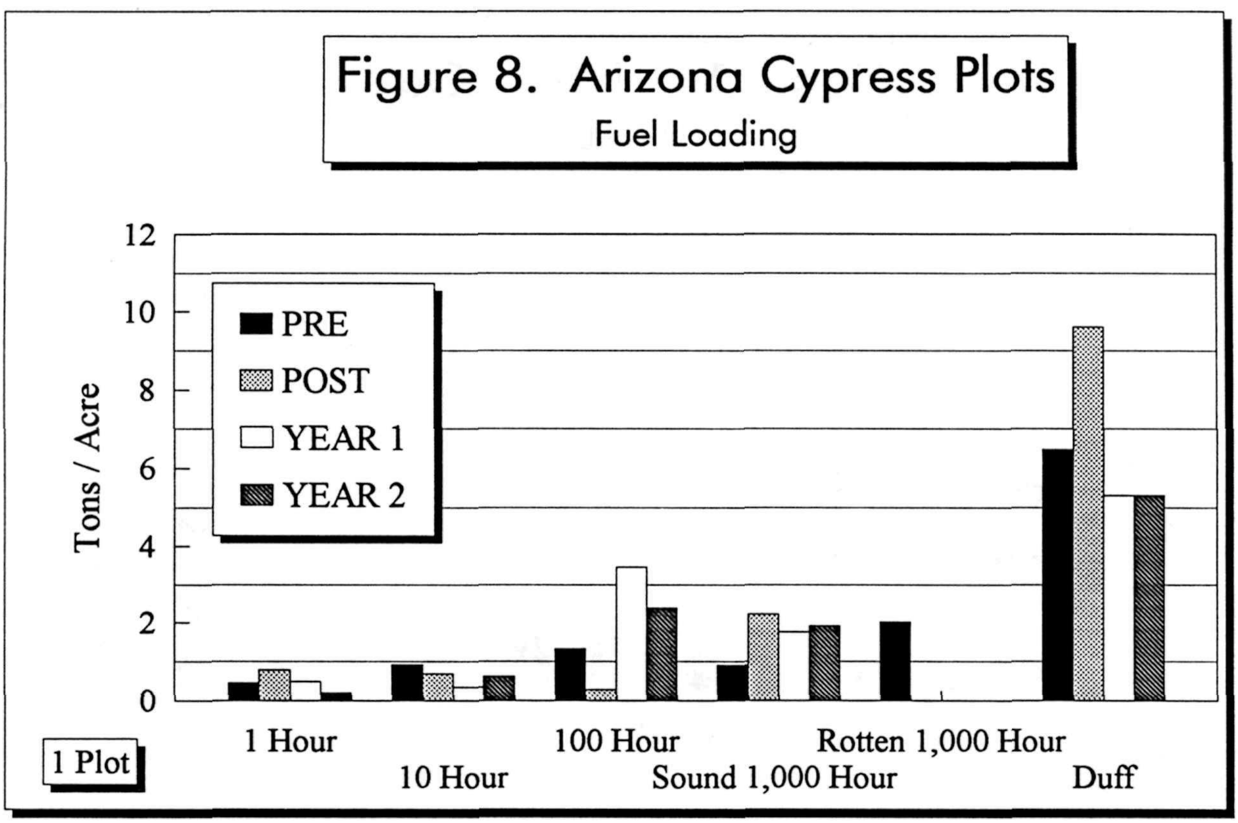


Figure 8. Arizona Cypress Plots
Fuel Loading
12
10
8
6
4
2
0
Tons / Acre
PRE
POST
YEAR 1
YEAR 2
1 Hour
10 Hour
100 Hour
Sound 1,000 Hour
Rotten 1,000 Hour
Duff
1 Plot

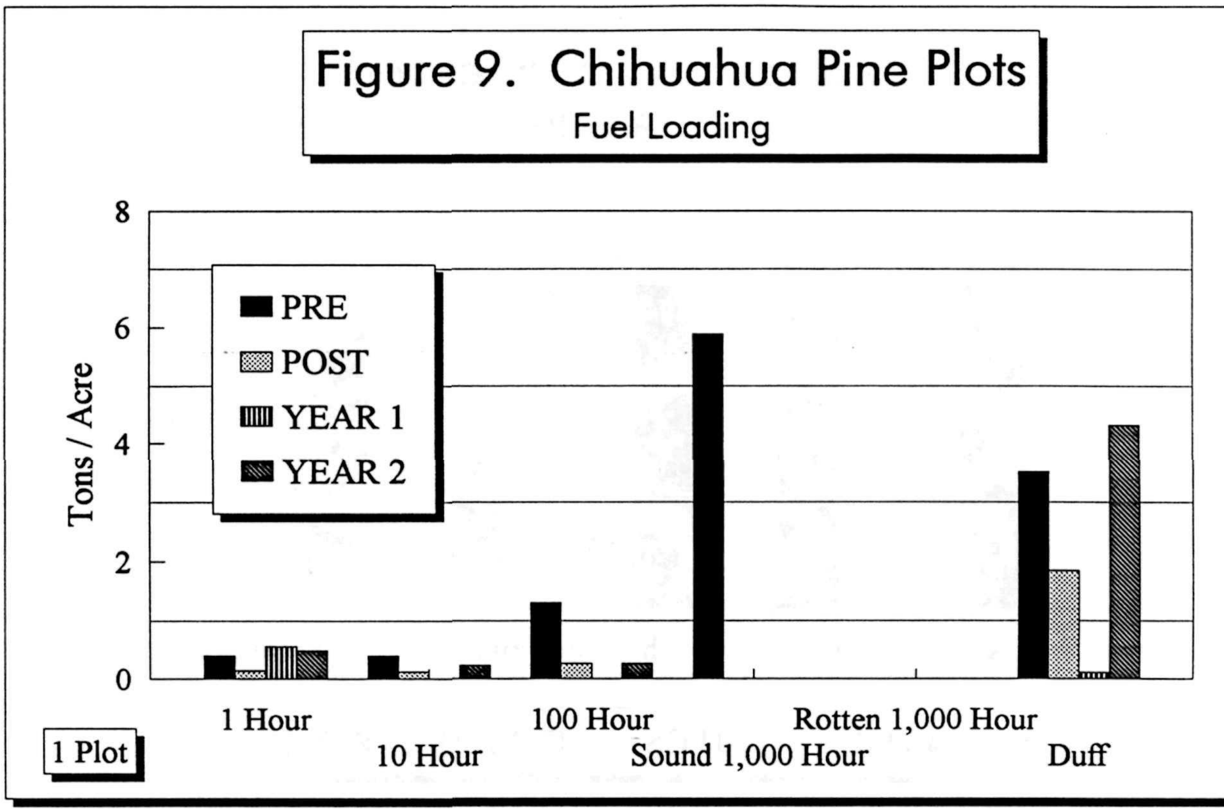


Figure 9. Chihuahua Pine Plots
Fuel Loading
8
6
4
2
0
Tons / Acre
PRE
POST
YEAR 1
YEAR 2
1 Hour
10 Hour
100 Hour
Sound 1,000 Hour
Rotten 1,000 Hour
Duff
1 Plot

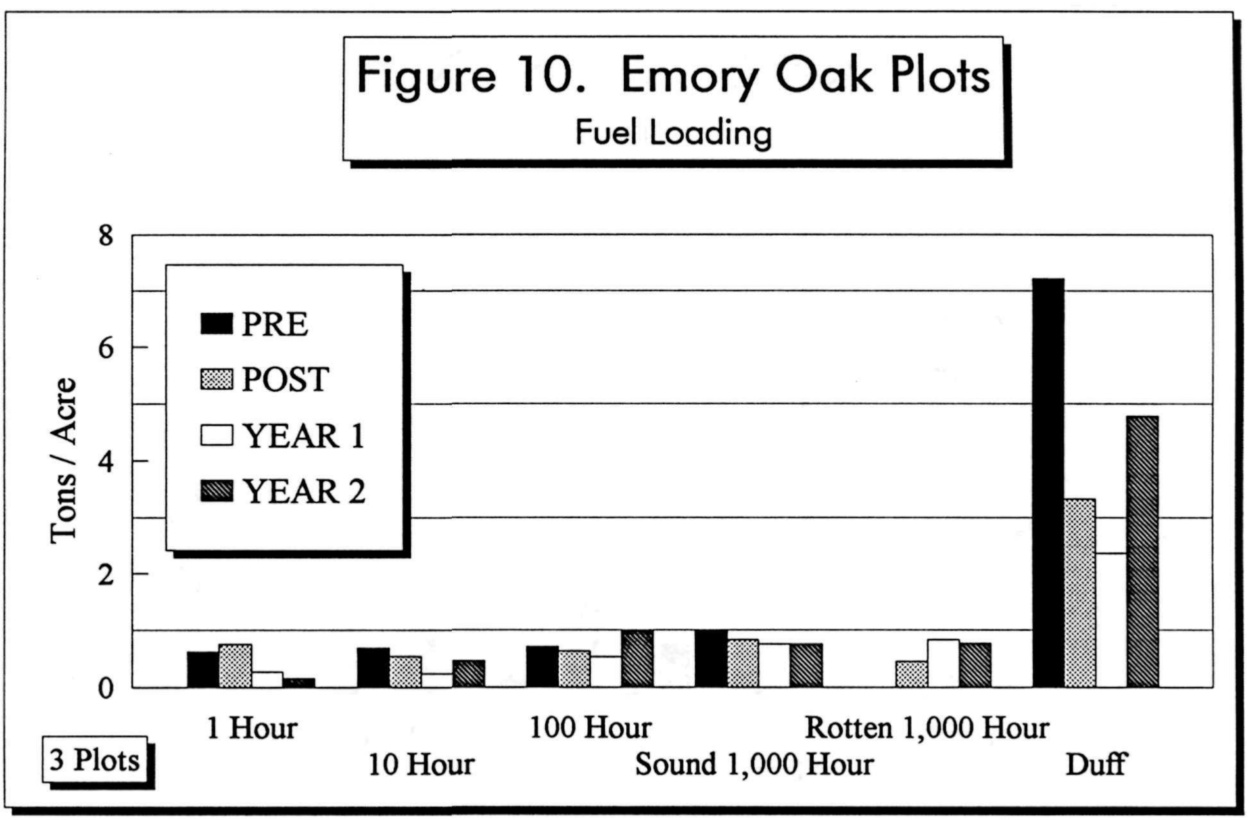


Figure 10. Emory Oak Plots
Fuel Loading
8
6
4
2
0
Tons / Acre
PRE
POST
YEAR 1
YEAR 2
1 Hour
10 Hour
100 Hour
Sound 1,000 Hour
Rotten 1,000 Hour
Duff
3 Plots

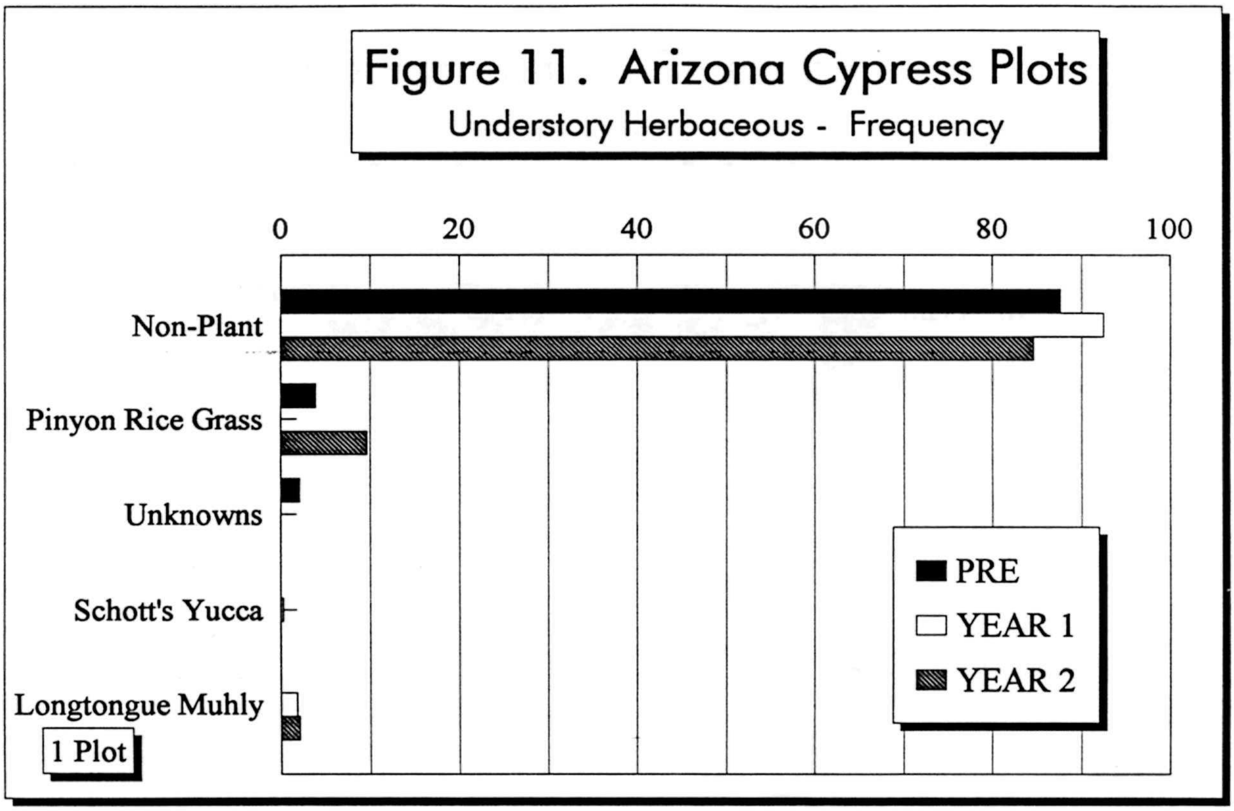


Figure 11. Arizona Cypress Plots
Understory Herbaceous - Frequency
0
20
40
60
80
100
Non-Plant
Pinyon Rice Grass
Unknowns
Schott's Yucca
Longtongue Muhly
1 Plot
PRE
YEAR 1
YEAR 2

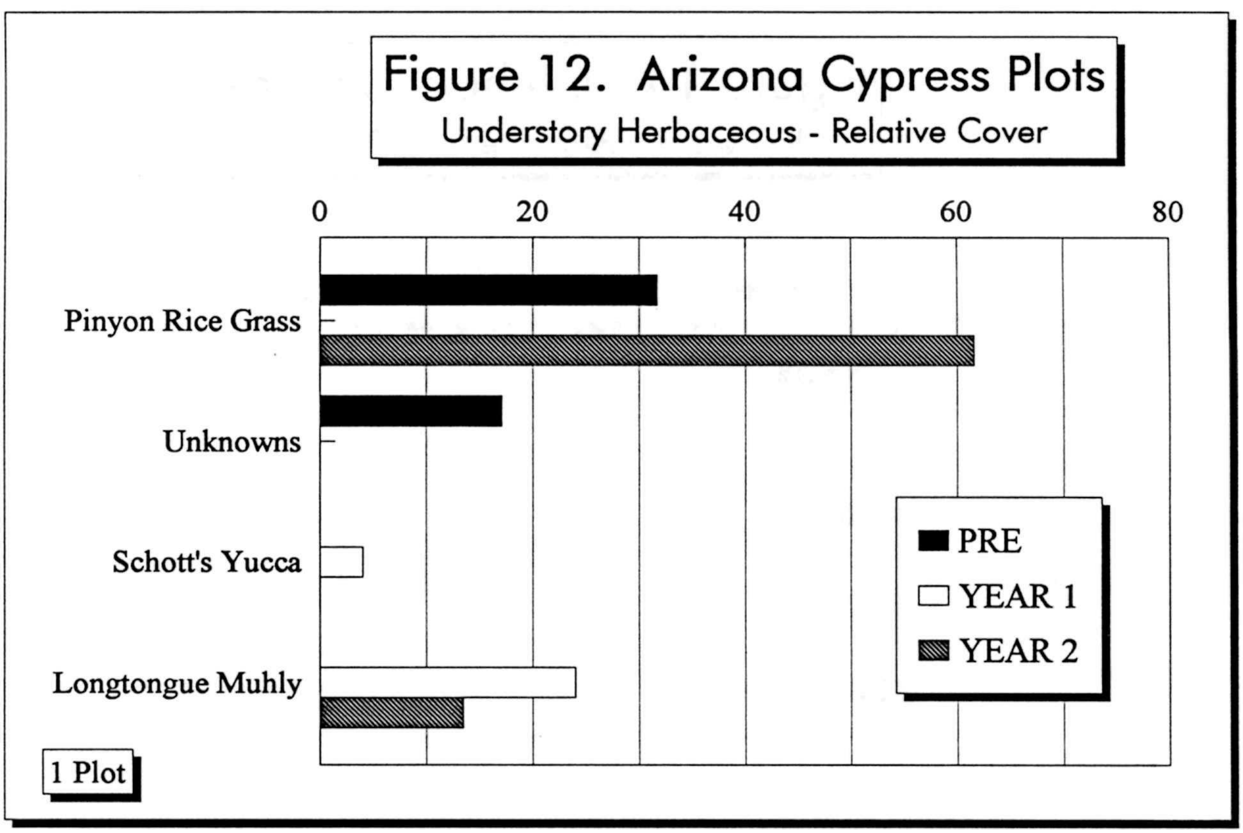


Figure 12. Arizona Cypress Plots
Understory Herbaceous - Relative Cover
0
20
40
60
80
Pinyon Rice Grass
Unknowns
Schott's Yucca
Longtongue Muhly
1 Plot
PRE
YEAR 1
YEAR 2

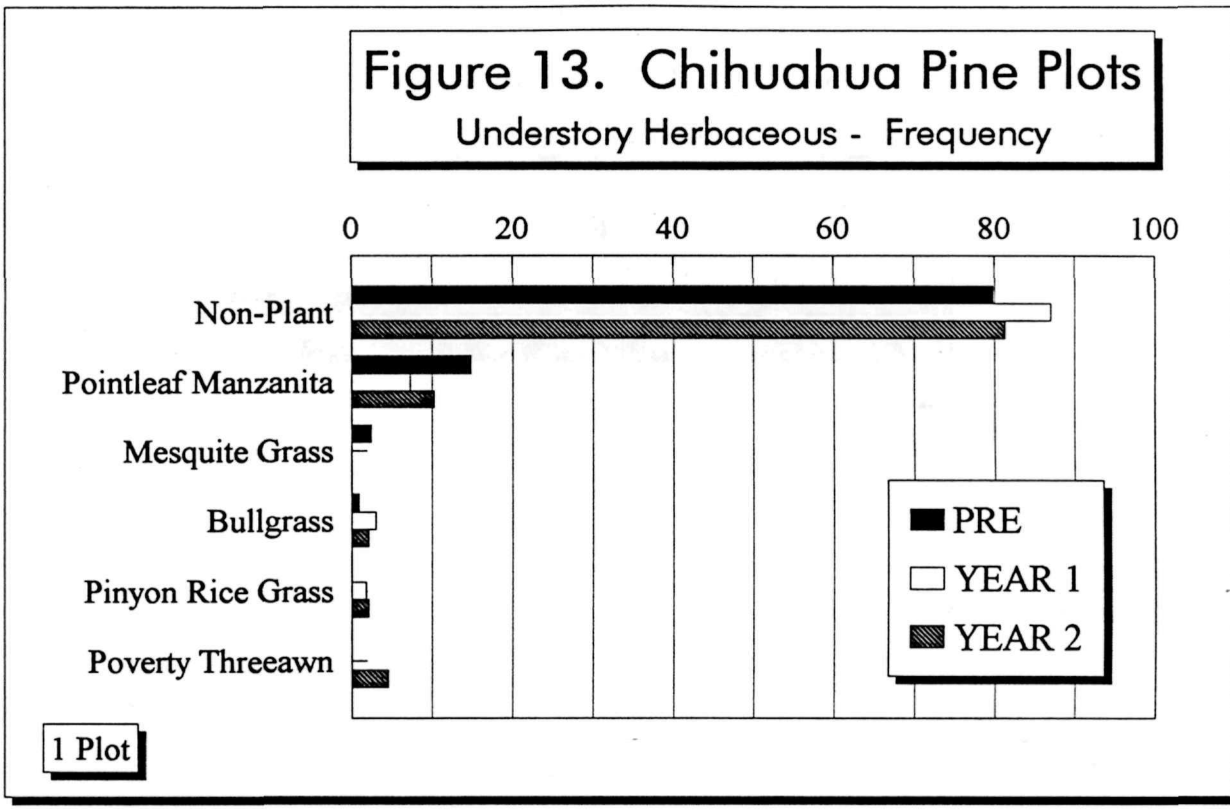


Figure 13. Chihuahua Pine Plots
Understory Herbaceous - Frequency
0
20
40
60
80
100
Non-Plant
Pointleaf Manzanita
Mesquite Grass
Bullgrass
Pinyon Rice Grass
Poverty Threeawn
PRE
YEAR 1
YEAR 2
1 Plot

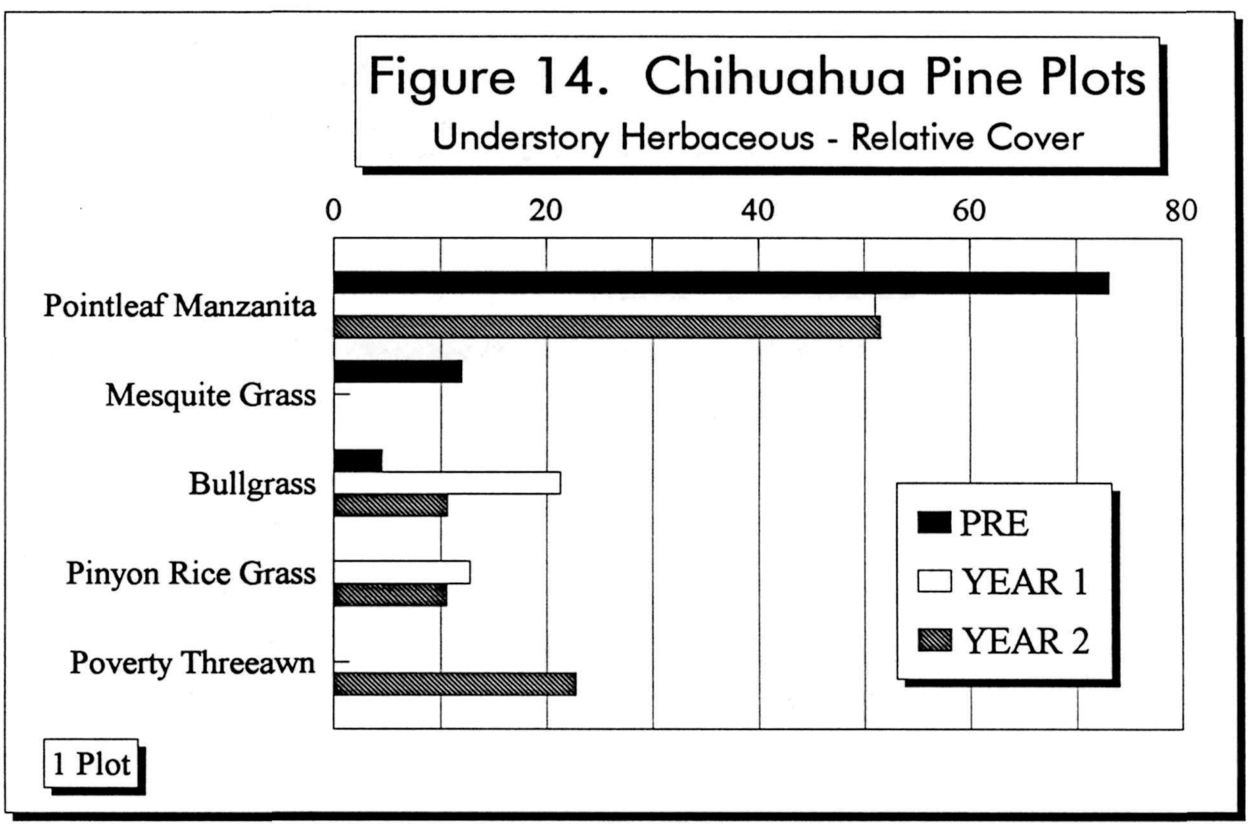


Figure 14. Chihuahua Pine Plots
Understory Herbaceous - Relative Cover
0
20
40
60
80
Pointleaf Manzanita
Mesquite Grass
Bullgrass
Pinyon Rice Grass
Poverty Threeawn
PRE
YEAR 1
YEAR 2
1 Plot

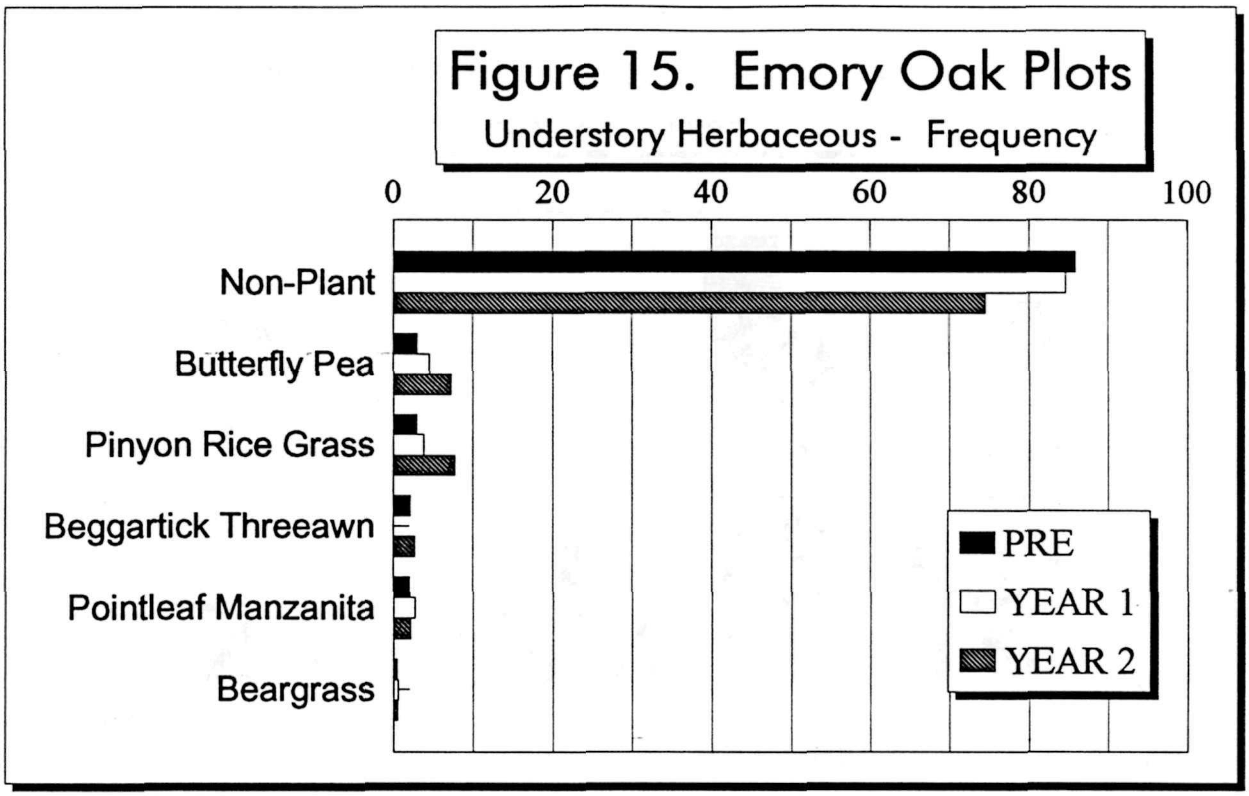


Figure 15. Emory Oak Plots
Understory Herbaceous - Frequency
0
20
40
60
80
100
Non-Plant
Butterfly Pea
Pinyon Rice Grass
Beggartick Threeawn
Pointleaf Manzanita
Beargrass
PRE
YEAR 1
YEAR 2

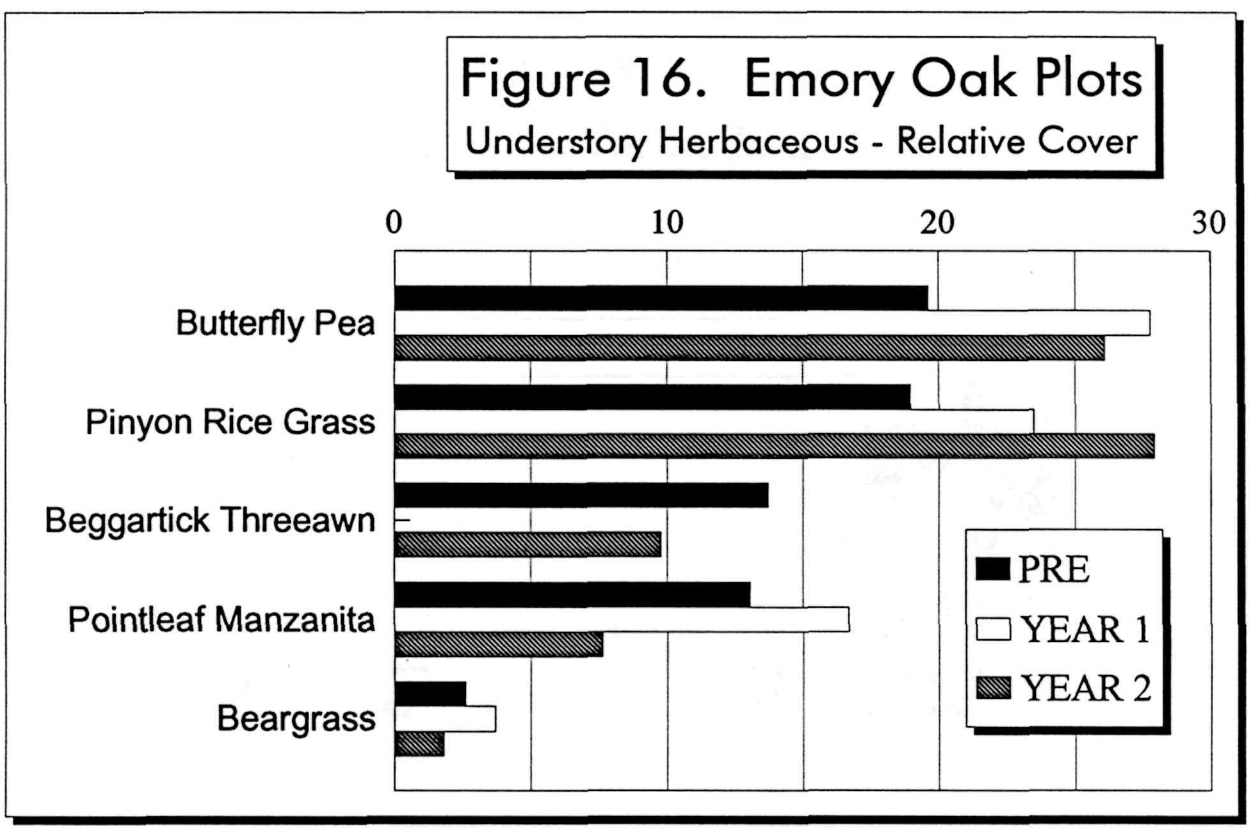


Figure 16. Emory Oak Plots
Understory Herbaceous - Relative Cover
0
10
20
30
Butterfly Pea
Pinyon Rice Grass
Beggartick Threeawn
Pointleaf Manzanita
Beargrass
PRE
YEAR 1
YEAR 2

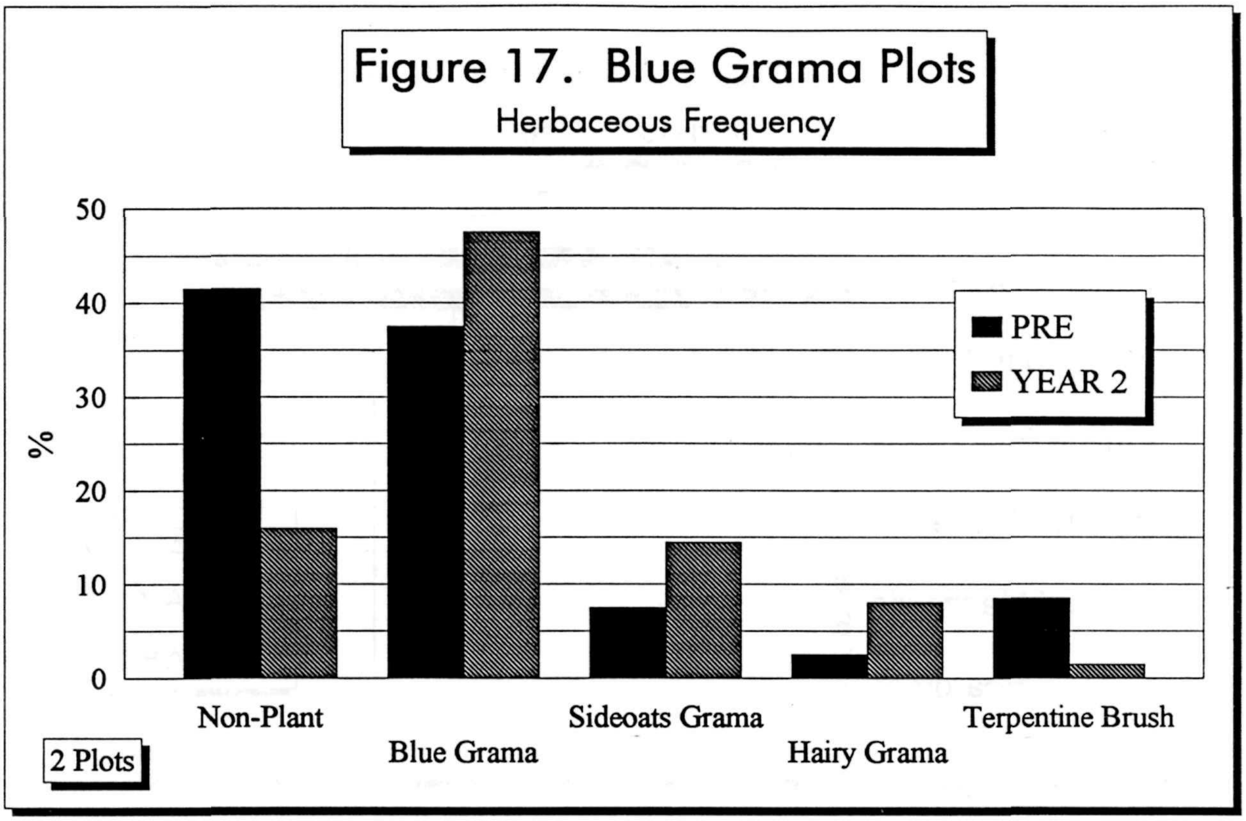


Figure 17. Blue Grama Plots
Herbaceous Frequency
50
40
30
20
10
0
%
PRE
YEAR 2
Non-Plant
Blue Grama
Sideoats Grama
Hairy Grama
Terpentine Brush
2 Plots

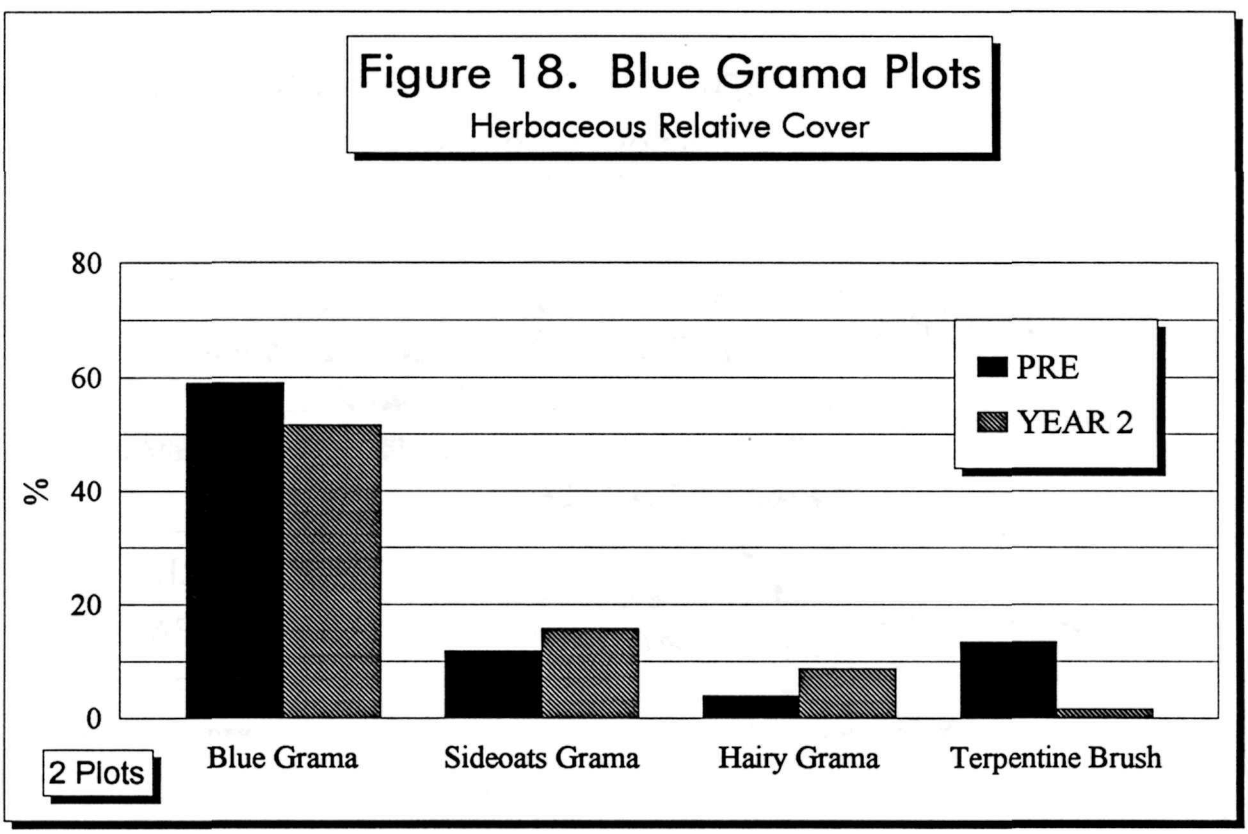


Figure 18. Blue Grama Plots
Herbaceous Relative Cover
80
60
40
20
0
%
PRE
YEAR 2
Blue Grama
Sideoats Grama
Hairy Grama
Terpentine Brush
2 Plots