Grand Canyon National Park
Fire Effects Monitoring Program Annual Report
2003 Calendar Year

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Executive Summary

This Fire Effects Monitoring Program Annual Report summarizes the Fire Effects Monitoring Program activities from January 1, 2003 to December 31, 2003. The following report justifies the existing plot network, details annual accomplishments, outlines plans for the future, and provides a data summary for information collected to date.

There has been one change to the monitoring protocols in the past year, and others may occur in the near future as the new Fire Effects Analysis Tools software (FEAT) has been released. The schedule for plot installations in 2004 is less rigorous than the 2003, but fewer crewmembers due to budget shortfalls will likely offset the lower plot numbers. We hope that less time spent on scheduled plot remeasurements may allow more time to explore new monitoring strategies, or allow more time for increased diversity of work experience.

Data analysis is not significantly different from previous years, and minimum sample size has been calculated with Pre-burn data only. We now have enough plots with Year 5 data to assess live ponderosa overstory and snag densities with some confidence for all major monitoring types. Utilizing these parameters, and lumping together spring and fall burning, we can assess all of our established variables except poles (9 out of 12) with statistical confidence at this time.

As a program review has been lacking for several years and significant changes may be on the horizon, it is recommended that the Regional Fire Ecologist conduct a full program review in the 2004 calendar year to ensure this program is on track.

INTRODUCTION

The 2003 field season was the most diverse and arguably most successful in the 15-year history of the Fire Effects program at Grand Canyon. The addition of a GS-6 Assistant Lead position and duty-stationing the crew on the North Rim to reduce time lost to travel greatly facilitated our expansion of efforts. Although only 41 plot visits occurred, with only one immediate Post-burn read and no installs, all scheduled work was completed while allowing crewmembers numerous training opportunities and contributing extensively to the national firefighting effort. In addition 61 rapid assessment Composite Burn Index (CBI) style plots were installed within the Big, Rose, and Poplar Fires of 2003 to allow initial assessment of burn severity within these fires of the Poplar Complex and the Powell Fire.

For the 2003 field season, we planned 40 remeasurements and completed 40, including two more Year 10 reads. As we already had enough plots in our major, defined monitoring types to do statistically relevant analysis, we held off on further plot installations this year. Next year we may again look to new installations to give managers some information on upcoming burn units. We planned up to 14 immediate Post-burn visits in conjunction with scheduled prescribed fires. However, due to a high level of on-going fire use and suppression activity late into the season, none of these prescribed burns occurred in 2003. Instead, we got one bonus Post-burn read when a plot burned within the Poplar Fire. In related work, we assisted the Grand Canyon Re-Vegetation crew with surveys for protected Sentry milk-vetch along the Walhalla Plateau and with backcountry exotic plant survey camping trips on two occasions.

Crewmembers also took part in a diverse array of extracurricular activities, due primarily to our lighter plot workload. Virtually everyone had more qualifications this year after taking advantage of early season training opportunities, and this seemed to result in more chances to go on assignments. An effort was made to cross-train Fire Effects crewmembers with all other field disciplines in our fire management program, but personal interest by the crew in learning really advanced this effort in 2003. Every crewmember assisted initial attack and fire monitoring in-park at Grand Canyon on multiple occasions.

Out-of-park, three different crewmembers each went on at least two Helicopter Crewmember assignments, with the Assistant Lead getting out on the equivalent of four HECM assignments. For the third straight year Grand Canyon provided a crewmember to assist another Fire Effects crew for two weeks —this time the Klamath-Cascade crew. Continuing another tradition for a third consecutive year, a crewmember detailed with a Fire Use Module out-of-park. The Zion Module was the gracious host in 2003. Finally, the Lead Monitor filled a spot as a GIS Technical Specialist trainee on the Rocky Mountain #2 Fire Use Management Team on two assignments, becoming qualified as a GIST by the third assignment and being asked to join the team permanently next season.

Next season has the potential for a heavier plot workload if we wish to install as many plots as planned. We hope to be able to once again accomplish all of our required plot work and still allow the crew to diversify their fire experience and contribute in multiple ways to the Grand Canyon and national fire programs.

GOALS

The Fire Effects Monitoring Program exists in order to meet goals and objectives set forth in the General Management Plan, NPS Strategic Plan, and GRCA Strategic Plan. Grand Canyon National Park's General Management Plan (1995) states, "The natural role of fire within park ecosystems will be restored within the constraints specified in the park's Fire Management Plan." It also states, "...surveys will be required for the management of natural resources [including] effects of fire exclusion and prescribed fire on park wildlife and the representative vegetation communities." Long-term goals for preserving park resources are identified in the NPS Strategic Plan (1997) and the Grand Canyon Strategic Plan (1997). The GRCA Fire Effects Monitoring Program operates under Goal Category I: Preserve Park Resources, GRCA Long-term objective Ia1: 10% of targeted disturbed park lands, as of 1997, are restored, and 20% of priority targeted disturbances are contained.

The primary aim of the Fire Effects Monitoring Program is to provide information to fire and resource managers, which allows them to affirm that prescribed fire objectives are being met or to identify and correct deficiencies. Through the Fire Effects Monitoring Program at Grand Canyon National Park, data have been collected on pinyon-juniper woodlands, ponderosa pine associations, subalpine conifer forests, and North Rim meadows.

Specific goals and objectives regarding the Fire Effects Monitoring Program can be found in the Fire Monitoring Plan, an appendix to the Fire Management Plan. This document is reviewed regularly and updated as needed.

STAFFING

For the second consecutive year, the same Lead Monitor and Fire Ecologist were on staff for the entire season. Add in an Assistant Lead who was in her fourth year with the Grand Canyon Fire Effects program, and we had our most stable, solid core of personnel to date.

Three GS-0404-05 seasonal Crewmembers, and one GS-6 seasonal Assistant Lead were hired to work on the Fire Effects Crew for the 2003 season. The addition of an official assistant allowed pre-season preparation, end-of-season data organization, and in-season leadership to function very smoothly. Table 1 reflects all Fire Effects related positions and the number of pay periods worked, including overtime and hazard pay hours. Table 2 shows distribution of major duties among field personnel to indicate that Fire Effects Crewmembers do not just function as plot monitors at Grand Canyon, but also aid in suppression & helibase operations, Level 1 fire monitoring, fire use operations, air quality sampling, and other activities. Every Fire Effects Crewmember went on at least one fire or fire effects detail—in-park or out-of-park—during the 2003 season.

TABLE 1. Fire Ecology Staff for 2003 calendar year.

Monitor	Account #	Starting Date	Ending Date	# Pay Periods	OT Hrs	Hazard Hrs
Kara Leonard, GS-11	RX Management: (H11)	01/01/03	12/31/03	26		
Li Brannfors, GS-7	Fire FX Base: (H14)	01/06/03	12/31/03	25.5	564	136
Michelle Farnham, GS-6	Fire FX Base: (H14)	04/20/03	11/29/03	16	878	566
Trevor Miller, GS-5	Fire FX Base: (H14)	05/18/03	11/15/03	13	420	25
Jess Page, GS-5	Fire FX Base: (H14)	06/01/03	11/15/03	12	549	441
Beth Lewis, GS-5	Fire FX Base: (H14)	05/18/03	11/01/03	12	249	264
Michele Young, GS-5	Fire FX Base: (H14)	05/12/03	05/22/03	1.5	0	0

TABLE 2. Base-hour crew activities by percent and category. Highlighted areas are where crewmembers spent majority of base-hour time.

Monitor	FMH travel	FMH plots	FMH computer	FMH Office	CBI Plots	Monitoring (Rx or Fire Use)	Fire Use Ops	Rx Fire Ops	Suppression And Helibase Ops.	Fuel Sampling	Training Courses	Other
Li Brannfors, GS-7	2	6	1	51	1	3	13	0	5	0	1	17
Michelle Farnham, GS-6	5	7	3	31	1	5	2	0	29	0	1	16
Trevor Miller, GS-5	5	10	5	13	1	8	2	1	34	1	9	11
Jess Page, GS-5	5	9	5	21	1	13	2	3	21	1	6	13
Beth Lewis, GS-5	6	16	8	20	0	5	3	1	19	1	8	13
Michele Young, GS-5	8	35	0	57	0	0	0	0	0	0	0	0

*"Other" includes meetings, paid holidays off, non-fire duties, leave taken, etc.

MONITORING TYPES AT GRAND CANYON

Every vegetation type at Grand Canyon National Park where prescribed fire is used requires the Fire Ecologist to develop a document called the FMH-4 Monitoring Type Description sheet. This document provides a physical and biological description, desired future condition, burn prescription, and burn objectives. Grand Canyon's prescribed fire program places great importance on these documents, as they guide every burn plan.

FMH-4 Monitoring Type Description Sheets are completed for PIED, PIPO, PIPN, and PIAB (Appendix A). The PIEN FMH-4 was written in 1993 but needs revision after input from the Natural Resources Branch staff and inclusion of new plots installed since then. The GRIN & GRED FMH-4s have not been written but initial data gathered over previous years will allow the monitoring types to be better defined.

GREAT BASIN CONIFER WOODLAND (PIED)

This monitoring type has been discontinued. No new data were collected and no installations are scheduled. Many plots installed in the PIED monitoring type were installed when the program was still very new in the National Park Service. Written protocols did not exist, there was little crew training, and there was not a year-round staff to maintain data records. Consequently, there are many errors in the data. For example, fuel transects were read at different lengths on different plots, and diameters of multiple-stemmed junipers were read in a variety of ways. *Caution should be used when interpreting any of the PIED data now.*

SOUTH RIM PONDEROSA PINE (PIPO)

A total of 10 visits were made to PIPO plots during the 2003 field season, all except one on second-entry burn schedules. No PIPO plots burned in 2003. A total of 34 plots exist as of December 2003, and all but the 2001 & 2002 new installs plus one other have burned. This number exceeds the required number of minimum plots to monitor primary and secondary variables (see Table 3), so further installs are not necessary. However, more plots may be installed in 2004 in the Long Jim III, Horsethief, and RX-300 burn units to gather more unit specific data for managers. The Fire Effects Crew will need to remain up-to-date on plans to burn South Rim units so as not to miss an opportunity to collect data.

Because Grand Canyon National Park's prescribed fire program relies on opportunistic burning to take advantage of all burning opportunities, not all plots are burned in *either* spring or fall as suggested under the standard fire effects monitoring protocols. In order to have the capability to tease out effects of seasonal burning, we decided to install more plots in the South Rim Ponderosa Pine monitoring type. After the plots are burned there may be enough plots in spring to analyze them separately from the plots burned in fall. Presently all plots are being analyzed independent of burn season, and minimum plot numbers are being calculated accordingly.

NORTH RIM PONDEROSA PINE (PIPN)

Fifteen plot visits occurred in North Rim Ponderosa Pine, including enough Year 5 reads to allow our first significant analysis of overstory effects in this monitoring type. No PIPN plots burned in 2003. Plots are located in Walhalla, Outlet, Walla Valley, Northwest III, Northwest I, and Roost burn units. Twenty-nine plots have now been installed, 20 of which have burned. Although attainable minimum plot numbers have been achieved, some new installs may occur in 2004 to give managers more data from upcoming burns.

PONDEROSA PINE WITH WHITE FIR ENCROACHMENT (PIAB)

Thirteen plots were re-read in the PIAB monitoring type during 2003. No installs were made in this monitoring type, as minimum plot numbers have been achieved for both primary and secondary monitoring variables (see Table 3). Twenty-four plots have now been installed, and 19 have burned, although none in 2003.

Thought should be given to expanding the plot network in the future since 4 PIAB plots burned in the Outlet Wildfire, rendering any post-burn data from those four incomparable with data from plots burned within prescription. Installing a few plots in units scheduled to be burned in the next three years would also give managers more data from these burn units.

ROCKY MOUNTAIN SUBALPINE CONIFER (PIEN)

No additional PIEN plots were installed during 2003, but our one immediate Post-burn read this year occurred on PIEN 12 courtesy of the Poplar Fire. We now have 12 total plots with pre-burn data and 17 total installed (5 were installed following the Outlet Fire and thus have no pre-burn data). Only 3 of the 12 plots with pre-burn data have burned. We now have enough plots to do initial pre-burn minimum plot calculations (see Table 3), but may tinker with adding a few more plots to slowly expand and better understand this monitoring type.

As previously mentioned, the FMH-4 Monitoring Type Description is out of date, but our pool of data from 12 plots should give us a good start on further defining this type. Although the forest description is known, the specific objectives for the area remain loosely defined with the exception of fuel load reduction. Consultation with the Natural Resources Branch staff is desired before finalizing the FMH-4 Monitoring Type Description objectives over the coming years.

NORTH RIM MEADOWS (interior and edge) (GRIN & GRED)

Burning of The Basin is no longer an imminent possibility. If we will not be monitoring effects of fire anytime soon in The Basin, there is little point in further installations. If objectives such as monitoring forest encroachment into meadows are deemed important enough, these monitoring types may be resurrected. However, until further refinement and consultation with the Science Center, the meadow plots are on hold.

MISCELLANEOUS (XXXX)

This is not a monitoring type at all, but is the folder label given to all plots that no longer have a place in Grand Canyon National Park's Fire Effects Monitoring network. They have been removed because they are located on ecotone boundaries that do not fit easily into any of the monitoring types established. This isn't to say that the data are not important, but to include them in the network significantly increases the necessary sample size needed to evaluate primary monitoring variables. Plot stakes remain in the ground, and the plot data remain in the Fire Effects Office to be used if they are ever needed.

MINIMUM PLOT CALCULATIONS AND PLOT INSTALL PRIORITIES

Minimum plot calculations are shown in Table 3 for each monitoring type and each monitoring variable in that type. Although we will burn in the spring and fall without differentiating between different monitoring types, we only plan to install as many plots as needed by pre-burn minimum plot calculations. Very cursory analysis thus far has not indicated a great deal of variability between spring and fall burn effects, and we have been able to meet minimum plot numbers despite lumping plots from different burning seasons together. Following is a justification for minimum plots and installs in each monitoring type.

- For PIED, all plots needed are installed and there are no plans to continue with this monitoring type as it monitored fuel reduction efforts around the village as a result of hand piling and jackpot burning methods.

- For PIPO it is necessary to monitor overstory ponderosa pine with the most confidence we can reasonably achieve. Monitoring at 90% confidence with R=20 is achievable now for overstory ponderosa as 23 plots are required and we have installed 34. Total fuel load monitoring is also valid at 90%/R20 as only 9 plots are required. Although we want to monitor poles, there is so much variability that we cannot monitor them with any significance. If we add plots to the network, we will continue to calculate minimum plot size for monitoring ponderosa poles. In 2004, up to six plots may be randomly located in the Long Jim III, RX-300, Horsethief, or Grapevine units. Although we do not technically need more PIPO installations to meet minimum sampling goals, we may take the opportunity to gather new data for fire managers and install more plots in the few remaining unburned units. To capture effects of spring burning, plots must be installed the previous year.

- In the PIPN monitoring type, overstory ponderosa is also the most important monitoring variable. It is reasonable to monitor overstory at 90%/R20 in this type, for we have a total of 29 plots, when we only need 7 (see Table 3). Additionally, we can monitor total fuel load at 90%/R20 with calculations showing 18 plots required. Although we would like to monitor ponderosa poles with statistical significance, it is not possible when 86 plots are needed. We will monitor ponderosa poles at the highest level possible with 29 plots plus future installations. Further installs are not necessary, but could be beneficial. With the small amount of remaining unburned ponderosa scheduled for treatment soon, we may choose to install up to four more PIPN plots in the Outlet and Walhalla units areas as time permits in 2004. To capture fire effects for spring burns, plots must be installed the previous year.

- The PIAB monitoring type already has 24 installed plots, more than the required 20 for monitoring overstory density at 90%/R20. New minimum plot calculations show that we can now monitor total fuel loading at 90%/R20 with only 11 plots, but white fir poles remain just out of reach at 80%/R20 with 27 plots required. More plots would be needed to monitor ABCO poles to our desired level of significance. However, monitoring the tertiary variable significantly is not possible with the other monitoring types, so pursuing additional installations for PIAB to capture poles is not a high priority. Further installs may be planned to make up for the four PIAB plots which burned in the Outlet Wildfire, but with four extra plots beyond required minimum sample size for overstory already in existence, we may decide no additional plots are necessary. Up to six installs are scheduled for 2004, but are not a top priority.

- With 12 plots now available for minimum plot calculations, the PIEN monitoring type only needs the FMH-4 monitoring type protocols to be updated to begin focused analysis. Our first attempt at total fuel load calculations reveals that we may have achieved minimum plot numbers for single-season burning in that variable at 80%/R20 as we have installed 12 plots but only need 8. Analyzing at 90%/R20 is just out of reach with a requirement of 14 plots. PIEN plots are in locations which hold snowpack and moisture the longest, therefore making spring burning within this type prohibitive. With this initial data, the PIEN monitoring type can be refined. A great deal of variability exists within overstory tree composition, such that only one species could be validly monitored (aspen) with less than 100 plots! This indicates either a need for refinement of the monitoring type, or abandonment of overstory density objectives. Up to three installs are planned in 2004.

- Both meadow/grassland monitoring types (GRIN=grasslands, interior; GRED=grasslands, edge) do not have minimum plot calculations at this time since no monitoring objectives have been established. Ten plots have been installed in the GRIN type, and six in the GRED type. No further installations are scheduled until protocols are revisited and monitoring type descriptions narrowed down. These plots must be read/installed in August or early September every year. The schedule for burning this area has been pushed back, allowing more time to complete installations. Protocols for both types were established in 2001, but may be revised for the GRED type and have not yet been incorporated into official FMH-4 monitoring type descriptions.

- The XXXX type does not need to have minimum plot calculations, as it is a repository for plots that currently do not fit in any monitoring type. It is included in Table 3 only for consistency.

TABLE 3. Results of minimum plot calculations by monitoring type and monitoring type variable. All calculations are based on pre-burn data until additional data are available to do post-burn calculations. *NOTE: Calculations outlined in heavy double lines meet minimum plot requirements for 80% confidence interval and R-value of 20.*

	Primary Monitoring Type Variable	Secondary Monitoring Type Variable	Tertiary Monitoring Type Variable
FPIED1D02	**Total Fuel Load** 80%/20=6 90%/20=11 *n=15 Pre*	**Overstory** 80%/20=15 JUOS, 7 PIED 90%/20=27 JUOS, 12 PIED *n=15 Pre*	n/a
FPIPO1D09	**PIPO Overstory** 80%/20=14 90%/20=23 *n=34 Pre*	**Total Fuel Load** 80%/20=5 90%/20=9 *n=34 Pre*	**PIPO Poles** 80%/20=111 90%/20=185 *n=32 Pre*
FPIPN1D09	**PIPO Overstory** 80%/20=4 90%/20=7 *n=29 Pre*	**Total Fuel Load** 80%/20=11 90%/20=18 *n=29 Pre*	**PIPO Poles** 80%/20=86 90%/20=145 *n=29 Pre*
FPIAB1D09	**PIPO Overstory** 80%/20=12 90%/20=20 *n=24 Pre*	**Total Fuel Load** 80%/20=7 90%/20=11 *n=24 Pre*	**ABCO Poles** 80%/20=27 90%/20=46 *n=24 Pre*
FPIEN1D10	**Total Fuel Load** 80%/20=8 90%/20=14 *n=12 Pre*	**Overstory** n/a (n=12)	n/a
BGRIN1D01	n/a (n=10)	n/a (n=10)	n/a (n=10)
FGRED1D08	n/a (n=6)	n/a (n=6)	n/a (n=6)
FXXXX	n/a (n=12)	n/a (n=12)	n/a (n=12)

GRAND CANYON'S PLOT NETWORK

EXISTING PLOTS AND 2003 ACCOMPLISHMENTS

There are 149 plots currently installed in the network (Table 4), twelve of which are in the FXXXX category and will no longer be monitored on the standard FMH schedule, and two of which are installed on the Shoshone unit and used as "practice" plots. Thirty-seven visits were made to re-read previously burned plots (Year 1, Year 2, Year 5, and Year 10 post-burn), 3 visits were made to update Pre-burn data, and 1 visit was made for an immediate Post-burn read. This makes for a total of 41 plot visits in 2003.

TABLE 4. Number of plots installed by monitoring type in 2003 and previously.

Monitoring Type Code	Monitoring Type Name	Rim	Number of Plots Installed in 2003	Total Number of Plots Installed
FPIED1D02	Great Basin Conifer Woodland	S	0	17[1]
FPIPO1D09	South Rim Ponderosa Pine Forest	S	0	34
FPIPN1D09	North Rim Ponderosa Pine Forest	N	0	29
FPIAB1D09	North Rim Ponderosa Pine with White Fir Encroachment	N	0	24
FPIEN1D10	Rocky Mountain Subalpine Conifer Forest	N	0	17[2]
BGRIN1D01	North Rim Meadows--interior	N	0	10[3]
FGRED1D08	North Rim Meadows--edge	N	0	6[4]
FXXXX	Plots on either rim that do not fit in any current monitoring type[5]	S & N	n/a	12

[1] Two of these 17 plots were installed on the Shoshone Burn Unit after a blowout in pinyon-juniper to monitor post-burn fire effects and to provide "practice" plots for the crew to read every year. One is installed in unburned pinyon-juniper and the other next to it in burned pinyon-juniper.

[2] Five plots were installed in 2000 after the Outlet Wildland Fire, immediately Post-burn. "Pre-burn" data in the FMH database were crafted from the Post-burn data in order to fool the database and avoid error messages; however, real Pre-burn data do not exist for these plots. For minimum plot calculations, we realistically only have 12 PIEN plots.

[3] This is a grass fuel model but is coded as brush in order to allow brush species to be entered in the database if they are encountered during post-burn visits.

[4] In order to monitor shrub and tree encroachment at the edge of the grassland we use modified forest plot protocols. This is coded as a "forest" model because half of each plot within this monitoring type is physically within a forested environment.

[5] These plots were originally installed in the early years of fire effects monitoring at Grand Canyon. Subsequent revision and interpretation of monitoring type protocols has led to the rejection of these plots.

PLOT RE-MEASUREMENTS FOR 2003 AND BEYOND

Forty-one plots were re-measured in 2003 and 46 such visits are planned for 2004 (Table 5). Workload is expected to increase through 2006, then may begin lessening in 2007 (Table 6). In 2004, 46 plot visits are planned, along with 19 installs (Table 7) for a total of 65 plot visits. If these installs occur, they will be scattered throughout the remaining unburned forests of both rims. *It is expected that the crew will spend most of its time on the North Rim in 2004, with the Lead and Assistant Lead handling pre-season work on the South Rim, and everyone travelling as needed between rims for burns.*

TABLE 5. Plot re-measurements by plot type for 2004 and 2003.

	Total Plots to Re-measure 2004				**Total Plot Re-measurement 2003**			
Plot Type	G	B	F	Total	G	B	F	Total
YROX Visits POST Visits	0	0	22 (24 P)	22 (24 P)	0	0	40 (1 P)	40 (1 P)
Total Visits	0	0	46	46	0	0	41	41

P = Immediate Post-burn Re-measurements

TABLE 6. Five-year projected number of plot re-measurements by year

	Number of Plots					
Year	2004	2005	2006	2007	2008*	2009*
YROX Visits POST Visits	22 (24 P)	47 (11 P)	56 (29 P)	48 (8 P)	40	34
Total Visits	46	58	85	56	40*	34*

*These projections do not predict plots burned after 2007. Plots will undoubtedly be burned during this time but plans are subject to too much change to accurately predict.

TABLE 7. Projected plot installation.

Plots to be Installed 2004				**Projected Total BY 12/04**			
G	B	F	Total	G	B	F	Total
0	0	19	19	0	10	158**	168**

**These numbers include the FXXX repository of 12 defunct plots.

POSTBURN PLOT VISIT SUMMARY

One plot burned this year at Grand Canyon: PIEN 12 in the Poplar Fire on the North Rim (Table 8). This was the first PIEN plot not to be burned by the Outlet Fire.

Table 9 shows how many of the total plots in the network have been visited at post-burn intervals. Of the 137 active plots in the network, 79 have immediate Post-burn data, and 17 have had immediate Post-burn data gathered again, after a second burn. Although 98 first or second-entry immediate Post-burn visits should have been made, two immediate Post-burn visits were missed in the past, making the total number of visits only 96. Under a perfect fire effects monitoring schedule, the Total columns in Tables 8 and 9 would show the same number.

TABLE 8. Number of burned plots.

	Total Plots Burned 2003				**Total Plots Burned to Date**			
Plot Type	G	B	F	Total	G	B	F	Total
Initial Burn Re-burn	0	0	1 (0 R)	1 (0 R)	0	0	81 (17 R)	81 (17 R)
Total Burned	0	0	0	0	0	0	98	98

R = Second-entry reads (re-burns)

TABLE 9. Post-burn plot summary (visits to date).

	G	**B**	**F**	**Total**
Immediate Post-burn	X	X	79 (+17R)	96*
Immediate Non-fire	X	X	X	X
1 Year post-burn	X	X	78 (+17R)	95**
2 Year post-burn	X	X	80 (+13R)	93
5 Year post-burn	X	X	44 (+4R)	48
10 Year post-burn	X	X	5	5

*Immediate Post-burn read missing on two plots, in 1996 & 1998
**1 Year post-burn read missing on two plots, in 1993
R = Second-entry reads (re-burns)

WHERE THE PLOTS ARE LOCATED

The plots in the network are randomized across 26 different burn units (Table 10). Maps showing where plots are located in burn units are in Appendix B.

Table 10. Transects/plots classified by burn unit and monitoring type.

	Boundary	Entrance	Hance	Horsethief	Imperial	Lone Tree	Long Jim I	Long Jim II	Long Jim III	NW I	NW III	NW V	Nankoweap	Outlet	Picnic	Quarry	Roost	Shoshone	Thompson	Topeka	Uncle Jim	Village	Vista IV	Walhalla	Walla Valley	Watson IV
PIED		01 03 04 05 12													02 07	09 10 11		16* 17*		06 08 13 14 15						
PIPO		01 07	15	18 27 34		19	29 30 33 36	25 28 32 35	26 31						04 05 11 12	06 10				02 03 09 13 14		08				17 20 21 22 24
PIPN										01 02				05 09 12			24							03 27 04 28 07 29 10 11 14 23	06 19 08 20 13 21 15 22 16 25 17 26 18	
PIAB											07 25	06		02 22 08 23 10 11 12			27						03 04 05 09	13 18 14 19 15 20 16 26 17		
GRIN														04 10			01 06 02 07 03 08 05 09									
GRED														02			01 05 03 06 04									
PIEN	02 04 12				05 06 07 09								01 03				10 17 11 14 16		08 13		15					

* PIED 16 & 17 are named SHOS 1 & 2 in the GRCA database, but are read under PIED protocols.

THE 10-YEAR BURN PLAN

See the attached 10-Year Burn Plan in Appendix C. At this time it is estimated that up to 8,002 acres may be burned in calendar year 2004 in the Walhalla, Outlet, Long Jim III, and Topeka units. We may install a few new plots on Walhalla and Outlet in the North Rim Ponderosa Pine monitoring type since this will likely be our last chance to do so within those units. Planning installations far in advance is necessary because, first, it takes time to install plots over extensive areas, and, second, if an opportunity to install a plot is missed, there may be no unburned areas remaining for future installs in these monitoring types. We have made our best guess at how the 10-Year Burn Plan will affect plot workloads, and it is reflected in the previous tables of this report.

The shift to landscape-level burning continues, and names for previously delineated small burn units are absorbed into larger units. This can make it difficult to track which plots are in which burn units. It is especially difficult when new burn boundaries are created and combined with poor plot location or burn unit mapping. Now that we have most plots located by GPS, we will be more confident about exactly where plots are located; however, when only portions of large units are burned, *it is necessary to accurately map burn edges in order to know if a plot is burned or not.* In this case, the Fire Ecologist or Lead Fire Effects Monitor should request this information from the Burn Boss or Fuels Specialist.

PROGRAM INFORMATION

2003 CHANGES IN PROTOCOL

Calculating Minimum Plots

At Grand Canyon National Park units are burned in both spring and fall for a single monitoring type. For example, South Rim Ponderosa Pine may be burned in spring and fall as conditions warrant. Research from northern Arizona supports burning ponderosa pine in both seasons. It is not possible to install plots and label them "spring" or "fall". Rather, we will install plots, burn them, and then analyze the information to see differences between spring and fall burning with regard to burn objectives. We had previously planned on installing double the amount of required minimum plots to allow for dual-season analysis. However, as we have begun to approach those doubled numbers, analysis is not showing as much variability as anticipated. Initial post-burn condition minimum plot calculations have shown we are still meeting or are close to meeting the required number of plots even when plots from spring and fall burning are lumped together. Additionally, fire managers can provide no guarantee that a second-entry burn will occur in the same season as the first-entry burn; thus, individual plots cannot always be analyzed as either spring- or fall-burned. Henceforth, minimum plot numbers used in this report will be based solely on pre-burn calculations for consistency. We will now base plot installation goals for 2003 on immediacy of burning units and existing numbers of plots in those units, since we have met all attainable minimum pre-burn numbers.

See FMH-4s for details on protocols for each monitoring type (Appendix A).

Randomization over Large Areas
Grand Canyon National Park is moving more burning to landscape scales of 500-3000 acres in one operational period. We have concerns regarding the way plots are distributed over the landscape using the standard FMH protocols. We realize that it is not realistic to install a significant number of plots in each burn unit because this would necessitate hundreds of plots. However, randomizing 10 initial plot locations over the 22,000 acres (as is the case in North Rim Ponderosa Pine) that will burn in five years means we have zero, one, or two plots per burn unit and in five years, 100% of the 22,000 acres will be burned and there is nowhere for new installs if they are needed. This is not effective adaptive management. We will try to randomize initial plots in the *first* portion of the area to be burned, and then we will have ample unburned areas to install additional plots in future years. In order to ensure plot information filters back to the Prescribed Fire Manager, *we will randomize these new plots in areas that are scheduled to burn in the next one-three years rather than the next five years* as the FMH protocols suggest.

FUTURE CHANGES IN PROTOCOL

No major changes in crew management are planned for 2004. A GS-6 seasonal Assistant Lead Monitor will again be hired to help coordinate and lead field operations and assist with off-season office duties. For the second consecutive year, the entire seasonal crew of GS-5s will be duty stationed on the North Rim. With up to 27 South Rim plot visits and up to 38 North Rim plot visits, this seems to be the most efficient distribution of resources. If time permits, all FMH-4 Monitoring Type Descriptions will be revisited this winter, potentially affecting protocols for future plot installations.

EQUIPMENT INFORMATION

Most day-to-day fire effects equipment is in the Fire Effects Office at #1 Shuttle Bus Road. All plot binders are stored together on adjoining bookshelves, allowing for easy visual reference. The herbarium remains, but now has a dedicated cabinet nearby for all herbarium supplies. A second herbarium was purchased and installed at the North Rim in 2003. Closed-door, locking storage cabinets keep crew packs, field equipment, and digital/electronic devices out of the way and secure in the off-season. The seasonal work area has been consolidated into a large, central desk with room for four plus computer work stations on each end. When not used for individuals, this desk provides a spacious flat work area, or a conference table setting. Two large black and gray bins are used to haul items in the vehicles during the field season. Items like flagging, clipboards, cruiser vests, camping supplies, and other miscellaneous field items for the fire effects crew are stored in the fire cache, upstairs, in a gray cabinet. Rebar is stored outside the fire effects office in a wooden box painted to complement the exterior of the building.

While on the North Rim, our office space currently consists of travel trailers which are hooked up to electricity and water in the summer, and disconnected for storage in the winter. When the new Fire & Emergency Services building is constructed next year, there will finally be a permanent fire effects office on the North Rim similar in size to our South Rim office.

INNOVATIONS

We are fortunate to have a large office where each crewmember as well as each permanent employee has his or her own work space. There are separate computer work areas, a herbarium cabinet and supplies, and storage areas. We have extra storage room up in the fire cache for less frequently used items. We bought new crew desktop computers in 2003, with new laptops for the Fire Ecologist and Assistant Lead on the way. We also purchased a new scanner that allows us to scan in up to 4 slides at a time, significantly reducing time required for our photo processing operations.

Our "plot board" continues to be invaluable, and is now completely portable. Crewmembers do an excellent job keeping information updated. It guides daily field and office activities while providing one place to track plot visits and plot data for the season. With increasing work on the North Rim and complete transfer of necessary office supplies to the North Rim during the field season, we have completely switched from the behemoth dry-erase plot board to the portable "E" sized paper version for use on both rims.

All of our plots are in individual 3-ring binders filed on bookshelves in the office for easy access. The field copy is in the front of each binder and, if that plot needs to be visited, it is taken out each spring and put in a field folder. The field folder is then placed in a designated place in the office with all other field folders for that season. Once a plot is read, the folder is put in a place for "data to be entered" and, once entered, it is moved to a place for "data to be checked". Data finally are filed in the 3-ring binder by the Assistant Lead or Lead Fire Effects Monitor.

We have one crew cab truck with a camper shell that has suited our needs for summer plot work. As in the last two years, we utilized the Fire Ecologist's S-10 pickup during the field season when the crew needed to split up. This seems more cost-effective than renting a summer vehicle from GSA for intermittent use, and has caused minimal conflict with the Fire Ecologist working off-site.

North Rim work space was provided by three travel trailers in 2003, one of which was the primary office for all crew activities, one which provided storage space plus a work area for the Lead Monitor, and one for the Assistant Lead. Although crowded at times, having dedicated, unshared office space was a great boon and necessary in light of the massive amount of North Rim field work. With a fire effects office on the North Rim, we are able to maximize our time by keeping up with data entry, error checking, plus plant identification and pressing on-site rather than travelling back to the South Rim to do so.

A change in duty-station to the North Rim for all GS-5 crewmembers was the biggest change for 2003. This set-up worked extremely well, saving quite a bit on travel costs and improving crew efficiency. Having dedicated housing for the Lead and Assistant Lead on the North Rim with the travel trailers allowed us to shift our entire field operation to the North Rim and encouraged people to stay even on weekends to help with emergency preparedness or active incident coverage.

Our Excel Plot Status worksheet continued to allow accurate tracking of all past and projected future plot activity. It shows every year since the inception of the program in 1989 plus 10 years of future projections (currently to 2014) across the top and all plots down the left side. Pre-burn, immediate Post-burn, Year 1, Year 2, etc. are entered in the appropriate cells and formulas tally annual reads and cumulative plot installs at the bottom. It helps in tracking our accomplishments and filling out tables for the annual report. Additionally, we add "flags" to some cells if, for example, a Post-burn visit was missed for the plot in a previous year, making plot network inconsistencies immediately recognizable. Last year's inclusion of all second- and third-entry reads, and seperate tallying of Year 1, Year 2, Year 5, Year 10 reads made calculating figures for this report much easier.

All plot locations continue to be tracked in an updated GIS database, allowing individual maps to be produced for each plot in the monitoring network. The resulting coverage of all plot locations gives managers another tool in planning future burning activity, as well as analyzing effects of past activity spatially. New plot installations are randomized exclusively with ArcView. Using available GIS coverages, we can now eliminate areas that meet rejection criteria like proximity to roads, ecotone boundaries, and evidence of fire within the last 10 years before we even get out in the field. We also have queried the vegetation coverage to find out which vegetation types contain plots which match our existing monitoring types. Our randomization zones can then be narrowed down to only the areas with the highest probability of successful plot installation, decreasing time previously spent ground truthing plots which truly had been randomly located across the landscape. In 2003, all ArcView map projects were transferred to ArcMAP format for improved quality and flexibility.

In March 1999 an unplanned 15-acre "blowout" occurred in a pinyon-juniper area on the Shoshone prescribed fire unit during ignition. We decided to install a plot in the burned area and another directly adjacent plot in the unburned area to track herbaceous recovery while providing a "practice" area for the Fire Effects Crew. The area is only a few miles from the office off a paved road. Each spring after the crew starts for the season, we all go out to these plots and complete at least the read in the heavily burned plot. We have also used plots in the inactive PIED monitoring type as practice, while still collecting some information which could be useful in the future. This gives the crew a chance to learn the protocols, understand all the forms, and ask questions about the program without the pressure of doing it perfectly the first time. Although we believe RX80 Pre-Fire Data Collection/Plot Monitoring Techniques is a good course for fire effects monitors, it is usually not offered before our field season starts. Using our practice plots helps the entire crew understand Grand Canyon's protocols right away and is directly reflected in the data quality of "real" early-season plot reads.

NEED FOR REGIONAL PROGRAM REVIEW

Our relationship with the Science Center is as strong as it has ever been, as the Fire Ecologist talks with their staff on an almost daily basis. As usual, though, there is always room for improvement in relations with the fire wildlife biologist, fire archaeologist, revegetation crew leader, and natural resources chief.

There is a need for the Fire Ecologist to devote more time to literature review in order to make recommendations on burning strategies. With the current workload, there is simply not the staff available to free the Fire Ecologist position for keeping up with numerous ecology issues, which has the potential to hinder progress in the prescribed fire program.

In order to bring the adaptive management concept full-circle, it is necessary for the Fire and Science Center staff to meet with the Regional Fire Ecologist to identify trigger points for action. We have specific prescribed fire vegetation objectives, but we have not identified what, exactly, will be done if an objective is not reached.

Fire Effects crewmembers have always shared in the suppression workload at GRCA, and this has been supported by the Fire Ecologist and Fire Use Manager because it allows crewmembers to experience variety in their day-to-day work, learn new skills, observe fires on the landscape, and make extra money in overtime. However, this arrangement was unbalanced because it took more away from the overall Fire Effects program than was provided to the Fire Effects staff. Table 11 shows the difference between the amount of plot installations planned and accomplished for every year since the program was established at GRCA. The trend was always negative, which reflected poorly on the Fire Effects program, and the park's prescribed fire program as a whole. But recently installation goals have been achieved, which can be attributed to fire effects staff getting the *opportunity* but rarely being *required* to assist with initial attack or nation-wide suppression efforts; consequently, plot goals were accomplished for the third consecutive year. We hope that Fire Effects personnel will continue to have the opportunity to assist other aspects of the fire program, as long as doing so will not adversely impact Fire Effects goals. This seemingly can be achieved by asking the Fire Ecologist or Lead Monitor which crewmembers can be available for non-Fire Effects duties, and allowing the supervisors to make that decision on a case-by-case basis. In some cases, using Fire Effects Monitors for non-monitoring purposes may be unavoidable, but the consequences must be weighed carefully. If this doesn't work, Fire Effects staff should no longer be utilized for suppression activities. If data validity and comprehensiveness are to be maintained within the prescribed fire program, the collection, quality control, and archiving of such data need to be given an appropriate level of priority in the fire organization. This issue is further discussed in the Summary of Results section at the end of the report.

Table 11. Planned GRCA plot installations vs. actual plot installations by year.

Year	Planned Installs	Actual Installs	Difference
1994	13	4	-9
1995	12	1	-11
1996	9	3	-6
1997	2	5	+3
1998	24	4	-20
1999	21	7	-14
2000	56	5	-51
2001	31	32	+1
2002	18	23	+5
2003	0	0	0

For all the reasons listed above, a Regional Program Review would be handy in 2004. It may be appropriate to meet with both Fire and Resource Management staff during this meeting.

DATA ANALYSIS AND DISCUSSION

INTRODUCTION

This section provides feedback to the prescribed fire staff on how well objectives are met. Some analyses cannot be completed with the current analysis software. Herbaceous data were analyzed in the 1999 Report to provide some preliminary results, and have not been updated as we received no feedback on their usefulness.

The graphical information presented in this report allows resource managers to more accurately determine whether prescribed fire is meeting objectives. Keep in mind that the objectives set in the FMH-4 Monitoring Type Descriptions are based on the best available science, and they can be revised as new information becomes available. All resource managers are invited and encouraged to contribute information that will aid in this process.

STATISTICAL REVIEW

Reporting Variability with SD and CI

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 using the Standard Deviation of the Mean (SD) and Confidence Intervals (CI). SD represents the variability in the actual data we collected. For those variables where we do not have the minimum sample size, we chose SD to represent variability. For variables where minimum sample size has been achieved, we used CI to express the confidence in our estimate of the true mean.

Interpreting Bar Charts

All bar charts in this analysis compare data from the same plots only through time. The Pre-burn 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 if minimum sample size is not met.

Interpreting Scatter plots

The scatter plots show the actual values for each plot visit, the amount of data collected to date, and trends in each plot. A diamond shape that is "moving down" represents a decrease in values over time, a diamond shape "moving up" represents an increase, and a "bull's eye" indicates no change. If there is only one large white diamond, it indicates the plot has not burned. If a plot has burned twice, second-entry reads are indicated by circles.

OUTLET WILDLAND FIRE & SWAMP RIDGE COMPLEX FIRE USE MONITORING

Five plots (all PIEN) were installed in the Outlet Wildfire burned area after the 2000 burn. The plot locations were randomized within high-intensity burn areas only. Plots were established to monitor recovery in these areas, although pre-burn data for the plots do not exist. Additionally, 2 PIEN plots and 4 PIAB plots that were previously installed and unburned, were burned in this wildland fire. They will likely not be used in further data analysis for these monitoring types, but may be used in monitoring the effects of the wildfire. Caution should be used when analyzing pre-burn data from these plots, because a great deal of time had elapsed between the Pre-burn visit when trees were tagged, and the immediate Post-burn visit, and there are data inconsistencies. For example, trees tagged as poles in 1993 were overstory trees in 2000. It is expected that all these plots will be monitored on the standard FMH schedule. Preliminary data analysis and will be explored in future years.

Eighteen of our standard FMH plots burned in 2001 within the Vista and Tower Fires of the Swamp Ridge Fire Use Complex. Fire effects initially seem to be within the range of acceptable results even for a prescribed fire, so we will address these plots no differently than other treated FMH plots in the park, and we will include them in our standard analysis. Separate results for just these 18 plots will also be explored in future years as more data become available.

One hundred ninety-five Composite Burn Index (CBI) plots have also been installed within these fires to monitor fire severity. Data from these 30 meter circular plots were correlated with Normalized Burn Ratio (NBR) satellite imagery to match detectable change with burn severity. Resulting matrices of burn severity were created by the Fire GIS Specialist to show severity for the entire Outlet and Swamp Ridge Complex Fires at 30 meter pixel resolution.

PIPO RESULTS AND DISCUSSION

OVERSTORY DENSITY

Objective 1: Achieve and maintain an overstory *Pinus ponderosa* density (greater than or equal to 16" dbh) of 19-25 trees per acre (47-62 trees/ha) as stated in the Desired Future Condition, measured at 5 years post-burn.

Results: Figure 1 shows that there is little change in large *Pinus ponderosa* overstory tree density across the entire plot network after 5 years of monitoring. Only 6 out of 20 plots with Year 5 data show any discernible deviation from pre-burn data. Figure 2 suggests pre-burn conditions barely meet the lower end of desired future tree densities, and there is little change in the mean tree density from Pre-burn to Year 5.

Was objective met? Yes. Prescribed fires have not induced any noticeable mortality in this size class of *Pinus ponderosa*. The trend over 5 years is quite consistent. This is good since limiting overstory ponderosa mortality is of great import.

OVERSTORY SCORCH

Objective 2: Limit average crown scorch on overstory *Pinus ponderosa* (greater than or equal to 16" dbh) to 30%, measured immediately Post-burn.

Results: At this time we cannot complete analysis for this variable. The database program (fmh.exe) does not allow assessment for scorch on trees of our unique size class. They can be compiled by hand at a future date. Figure 3 shows the data we *can* extract from the database—mean scorch per plot on all live ponderosas greater or equal to 6 inches (15 cm) dbh. This graph indicates only 4 of 19 plots had a mean scorch of greater than 30% after the first-entry burn and only 2 of 16 plots had a mean scorch of greater than 30% after the second burn. Since this includes all trees from 6-16 inches (15-40 cm), it is likely that if they are taken out of the analysis, the mean scorch heights will be lower for trees greater than 16" (40 cm) dbh. Figure 4 shows minimum, mean, and maximum scorch heights for the first and second-entry burns.

Was objective met? Unknown, but likely met. The trend with numerous plots is very favorable.

FUEL LOADING

Objective 3: Maintain an average total fuel load of 0.2 to 9.3 tons/acre (0.5 to 23 tons/ha) as stated in the Desired Future Condition, measured immediately Post-burn.

Results: Figure 5 shows total fuel load by plot for the entire plot network. Notice that many pre-burn data points are missing due to faulty data collection methods of the past. At this time, there are 8 plots with comparable pre-burn and post-burn data. Figure 6 is the total mean fuel load for comparable plots, showing that the mean fuel load is just within the Desired Future Condition limit. Most of the fuel reduction was in litter and duff.

Was objective met? Yes. Minimum pre-burn sample size at 80%/R20 is 5 plots, and despite inconsistent data collection in the past, we still have 8 plots with which to do analysis. More data will be needed to assess results with 90% confidence, but for now the objective of fuel load reduction to 0.2-9.3 tons/acre is being met. Small error bars give credence to this conclusion.

POLE DENSITY

Objective 4: Reduce *Pinus ponderosa* poles with dbh of 1-6 inches (2.5-15cm) to average 0-200 trees/acre (0-494 trees/ha), measured 2 years post-burn.

Results: Figure 7 shows the plot data across the network; note the high variation in pole densities from 0 to nearly 1800 poles/hectare. Figure 8 shows that mean *Pinus ponderosa* pole densities monitored through post-burn Year 2 decreased from 407 to 332 trees per hectare, but the error bars are large.

Was objective met? Unknown with such high variability in the data, but trend is favorable. Due to the large number of required minimum pre-burn plots, it is not realistic that we will be able to assess this objective to our desired level of statistical confidence.

SNAG DENSITY

Objective: Track snag densities over time.

Results: Figure 9 shows that small snag densities have increased on 8 plots, decreased on 4 plots, and remain unchanged on others from Pre-burn through second-entry post-burn Year 5 monitoring. Values range from 0-100 small snags/ha. Large snags show less variability (Figure 10) but the zero values on most plots confound the data, making error bars wide (Figure 11). Figure 11 represents means for the two size classes from Pre-burn through 5 years. Relatively little change has occurred in the larger trees, but snags have nearly tripled in the 6-15.9" size class.

Was objective met? There is no objective for a certain number of snags at this time. Consultation with the Grand Canyon National Park wildlife biologist is needed to define an objective.

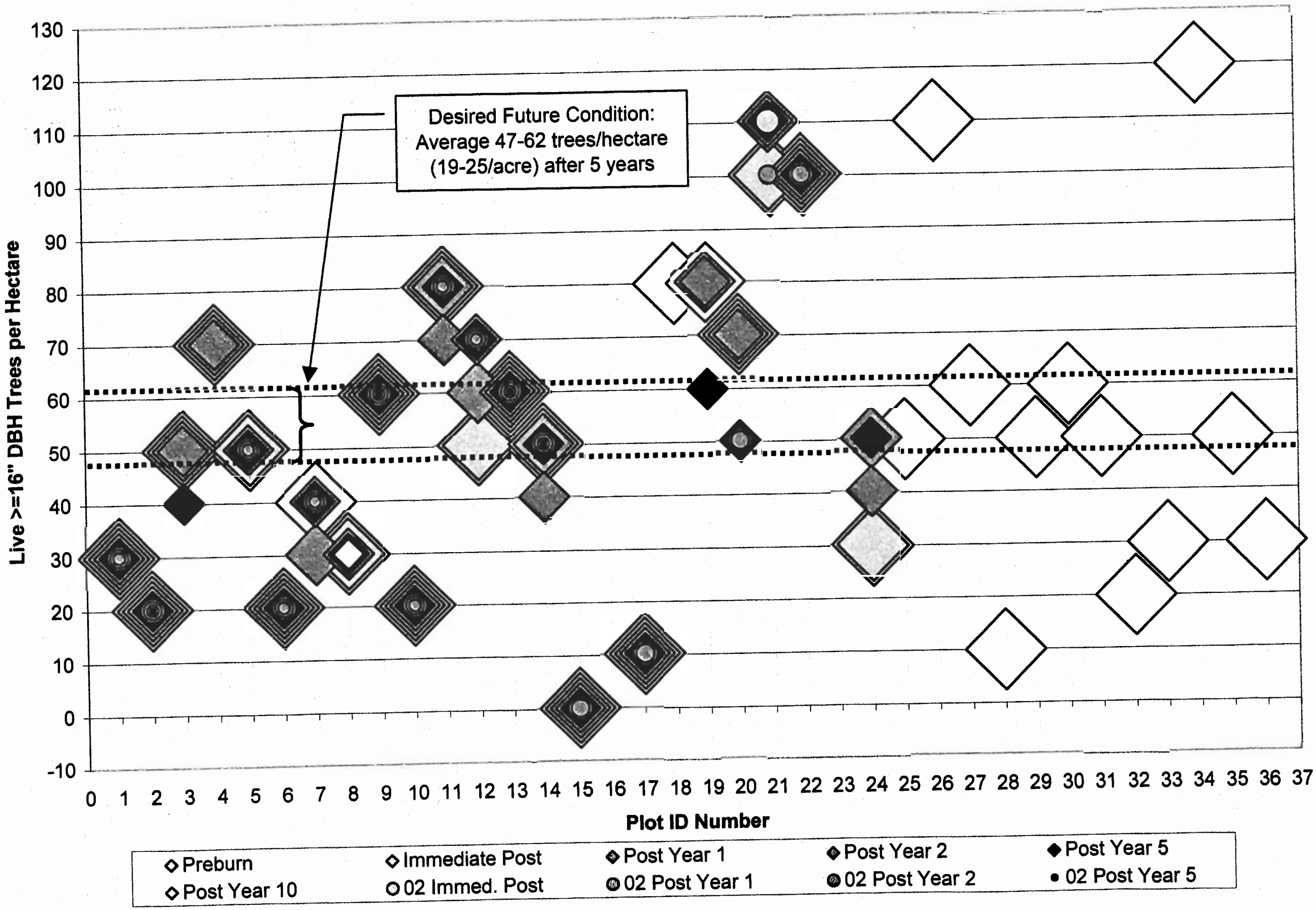
SEEDLING DENSITY

Objective: Track seedling densities over time.

Results: Figure 12 shows *Pinus ponderosa* seedling densities generally decreasing. This may help lessen the pole density problem in future decades. Figure 13 illustrates variation in *Quercus gambelii* seedlings due to resprouting after fire. In plots where QUGA did not exist before burning, there is little change, but in plots where QUGA did exist, there are both increases and decreases in QUGA density.

Was objective met? There is no objective for seedling densities at this time. This information is provided for general knowledge, so that other resource management staff at Grand Canyon know the trends that are occurring.

Figure 1. Live 16" DBH and larger *Pinus ponderosa* Densities, by plot
December 2003



South Rim Ponderosa Pine (PIPO)

Figure 2. Mean Density of Live 16" DBH and larger *Pinus ponderosa*
December 2003
n = 20 plots, *required minimum pre plots = 14*

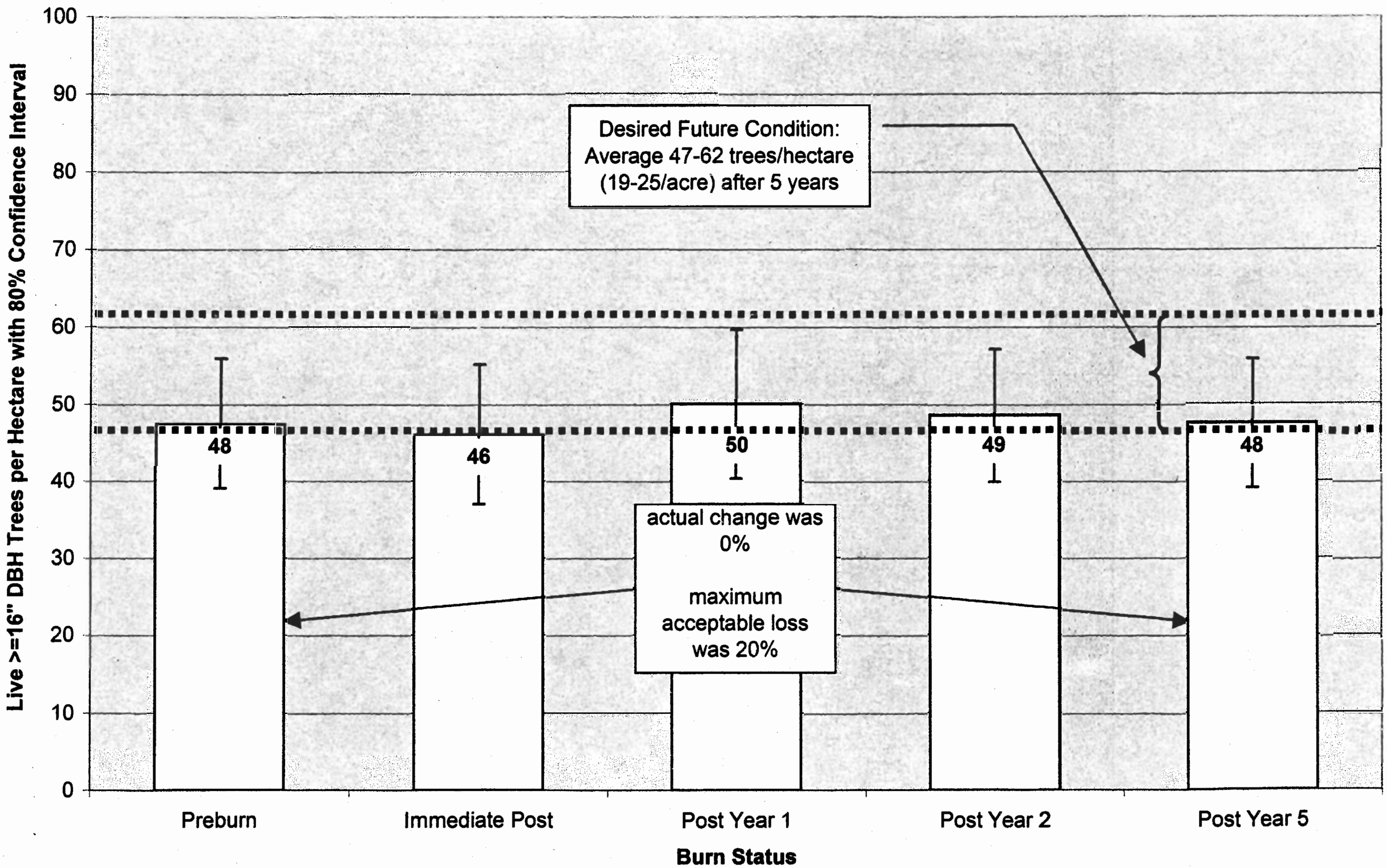
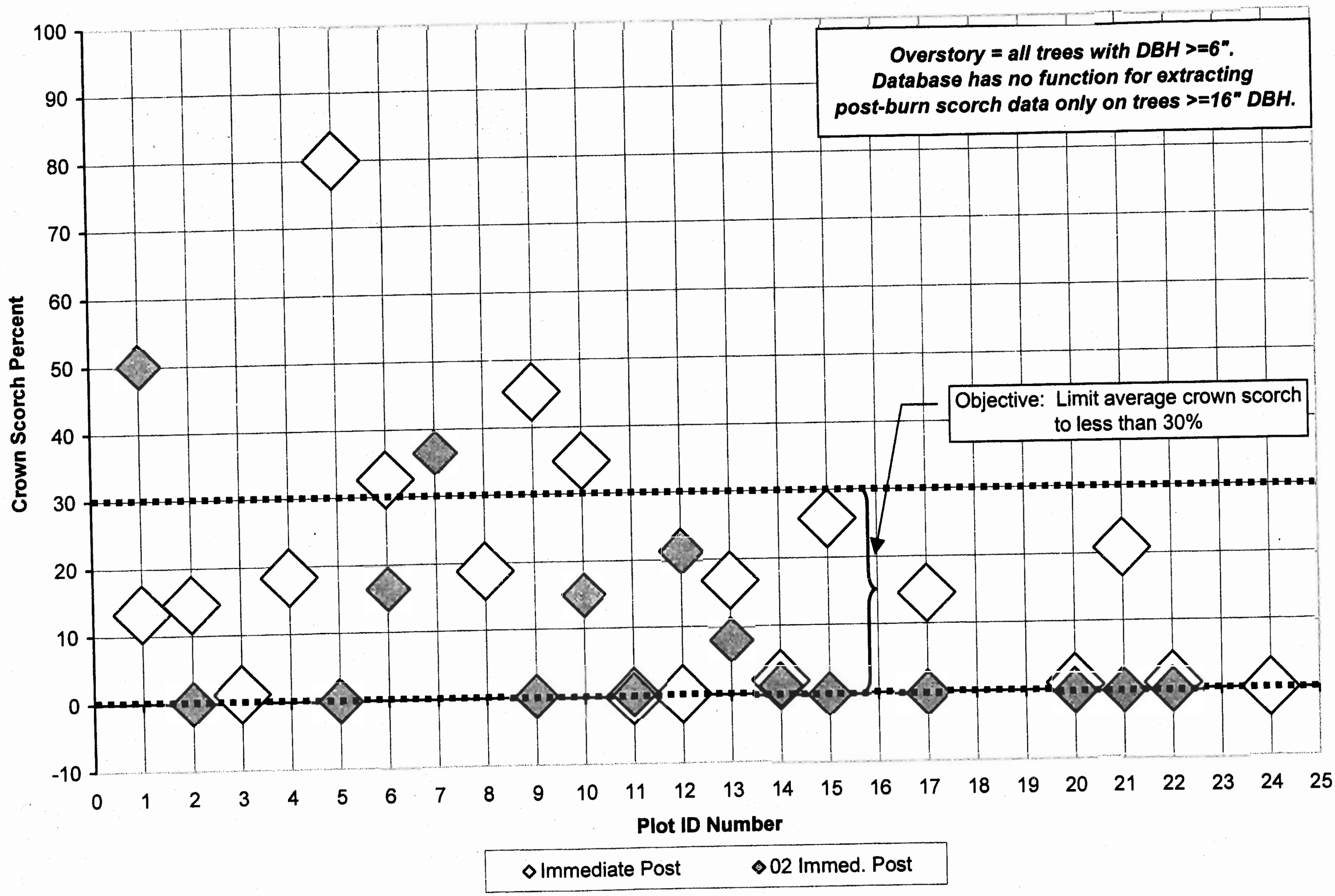
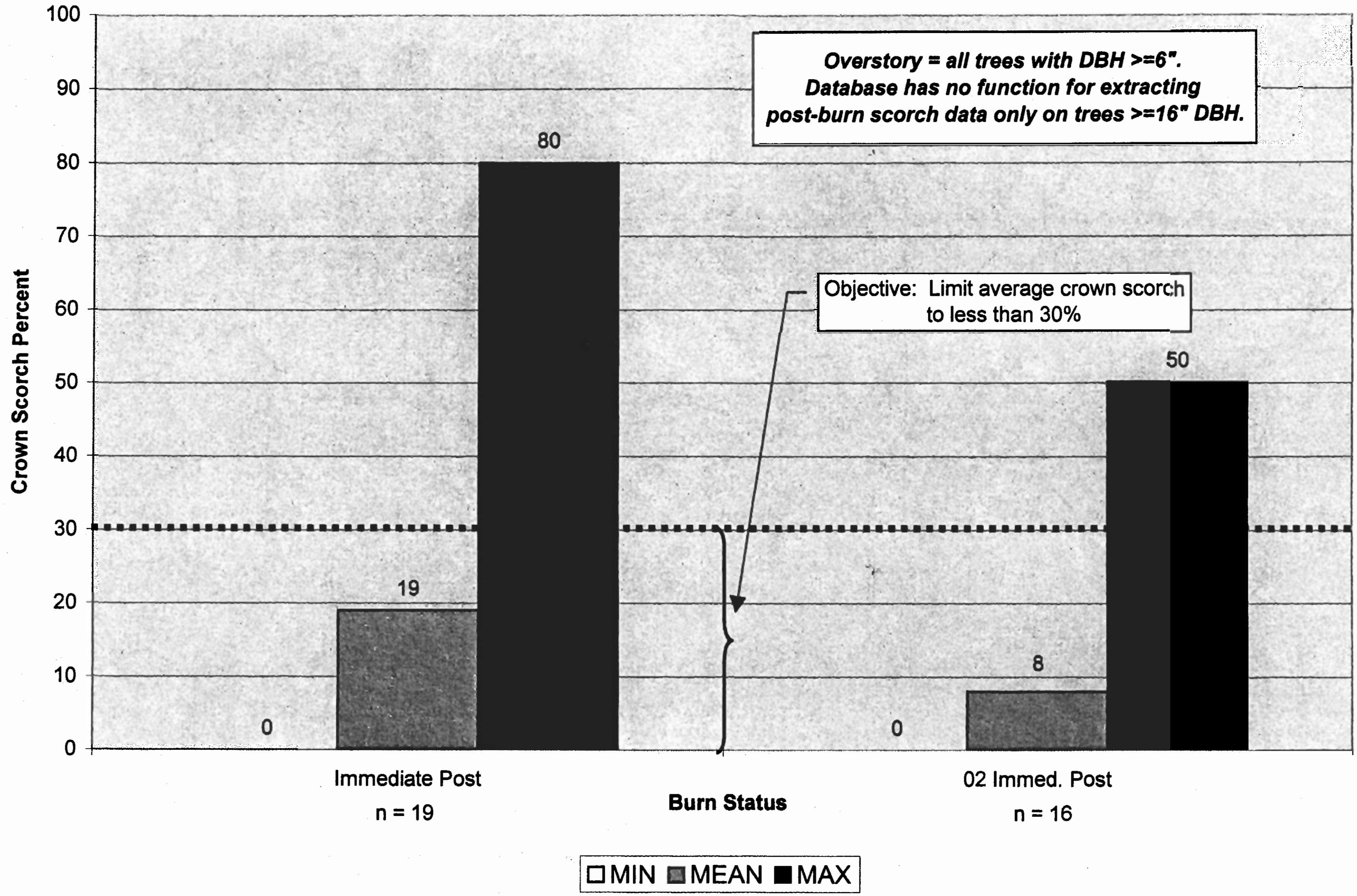


Figure 3. Post-burn Crown Scorch Percent on Live *Pinus Ponderosa* Overstory Trees, by plot
December 2003



South Rim Ponderosa Pine (PIPO)

Figure 4. Post-burn Crown Scorch Percent on Live *Pinus ponderosa* Overstory Trees
December 2003

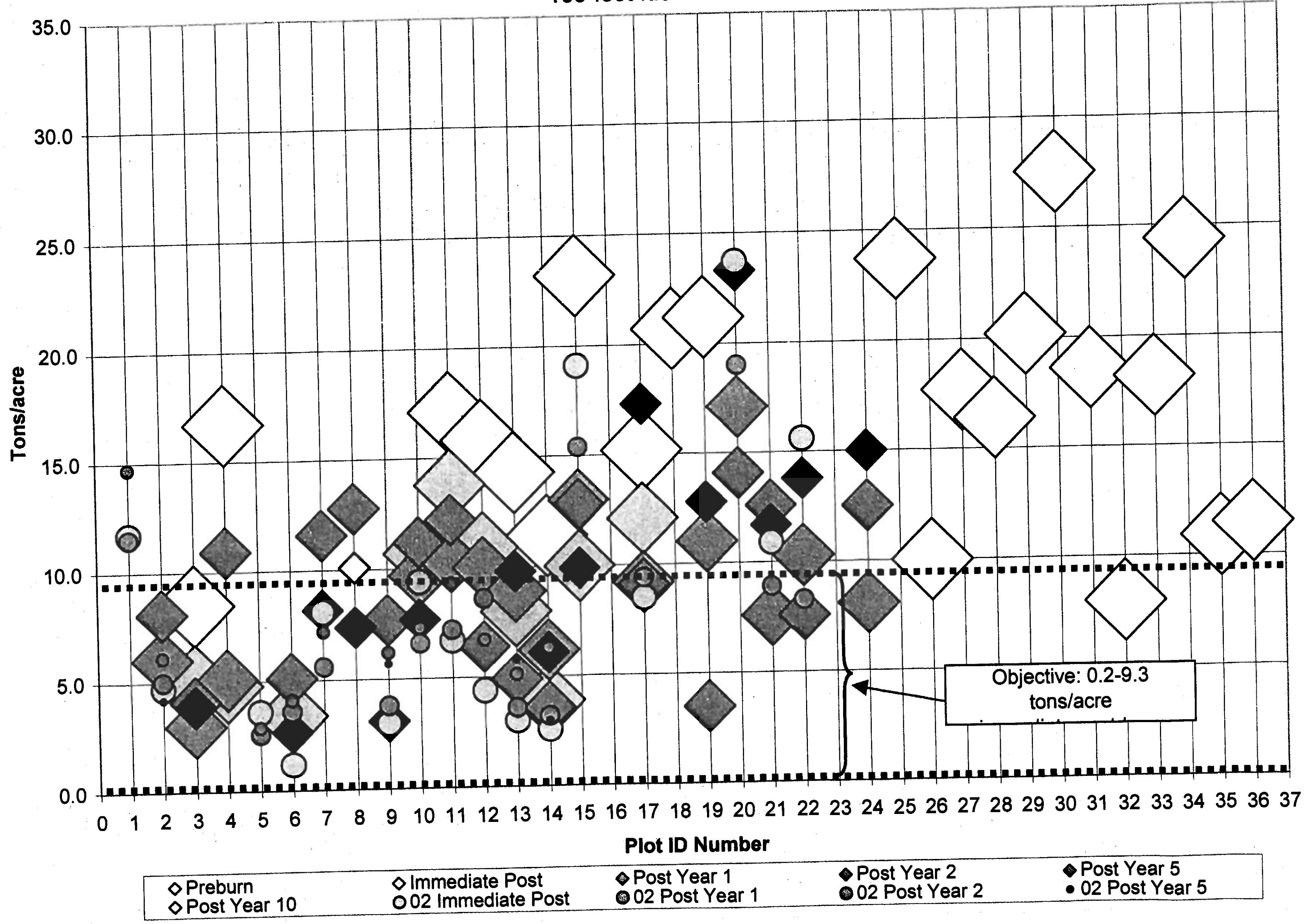


South Rim Ponderosa Pine (PIPO)

Figure 5. Total Fuel Load by Plot

December 2003

100-foot fuel transects



South Rim Ponderosa Pine (PIPO)

Figure 6. Total Mean Fuel Load
December 2003
100-foot fuel transects
n = 8, *required minimum pre plots = 5*

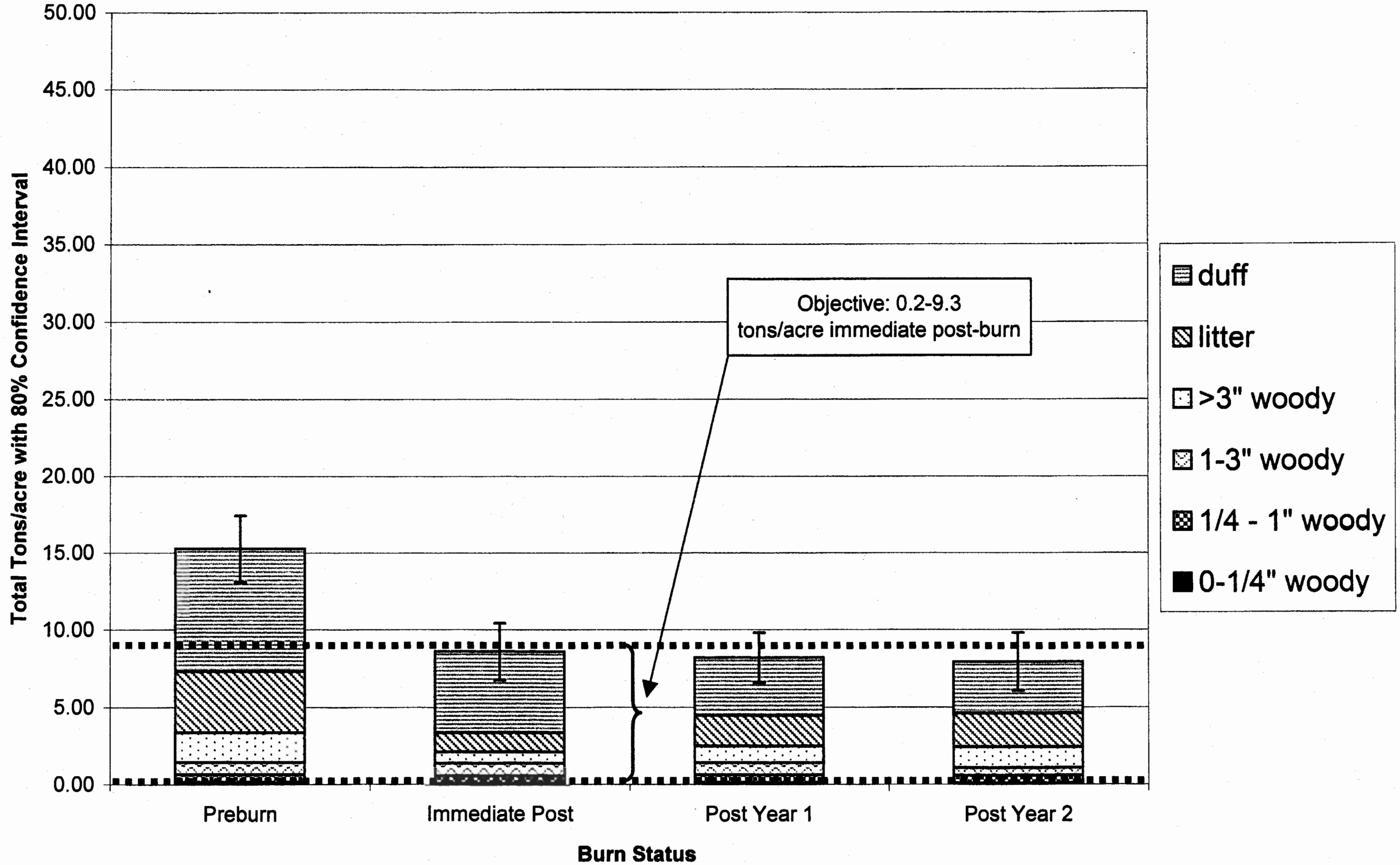
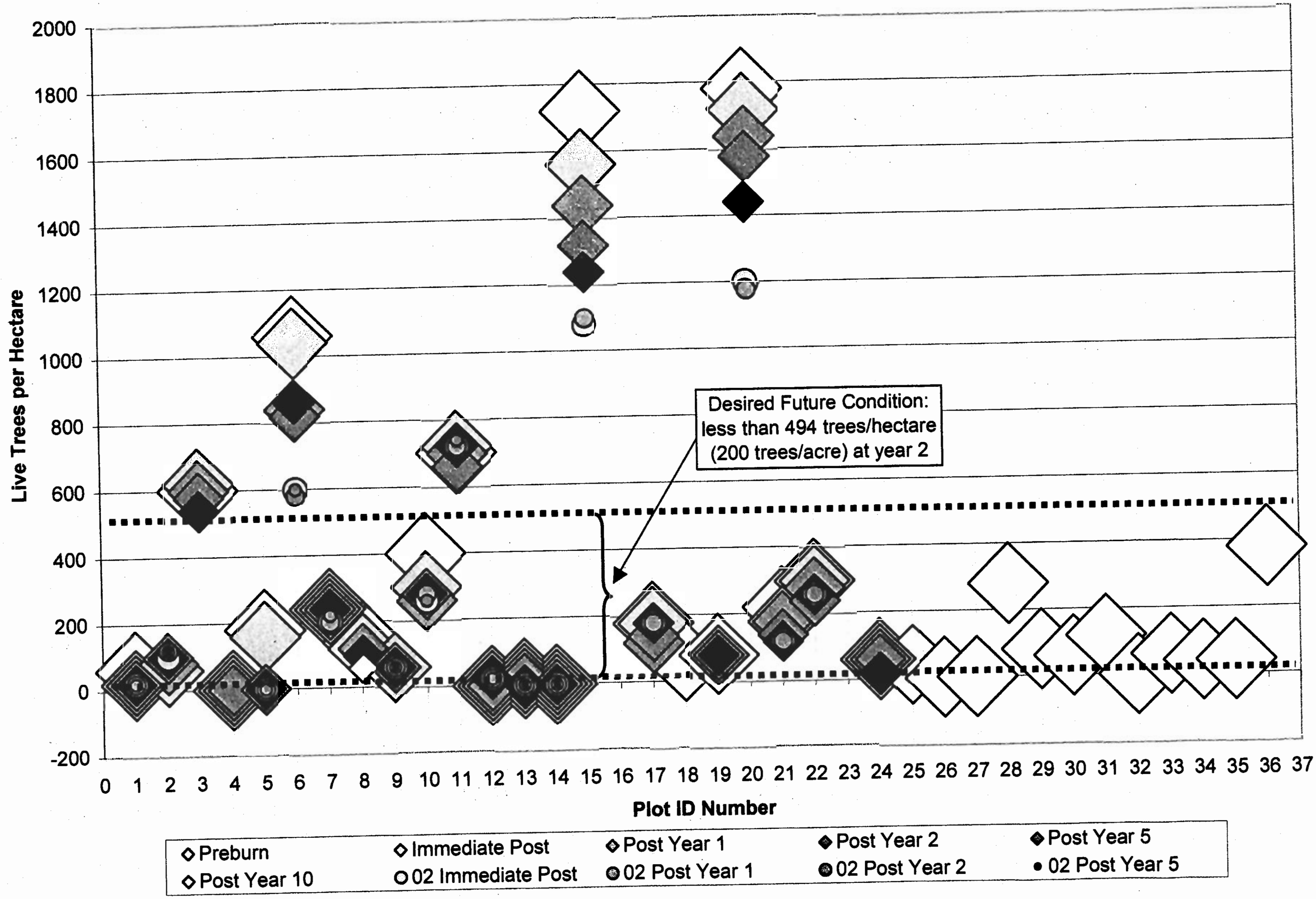


Figure 7. *Pinus ponderosa* Pole Densities, by plot.
December 2003



South Rim Ponderosa Pine (PIPO)

Figure 8. Mean *Pinus ponderosa* Pole Density
December 2003
n = 19 plots, *required minimum pre plots = 111*

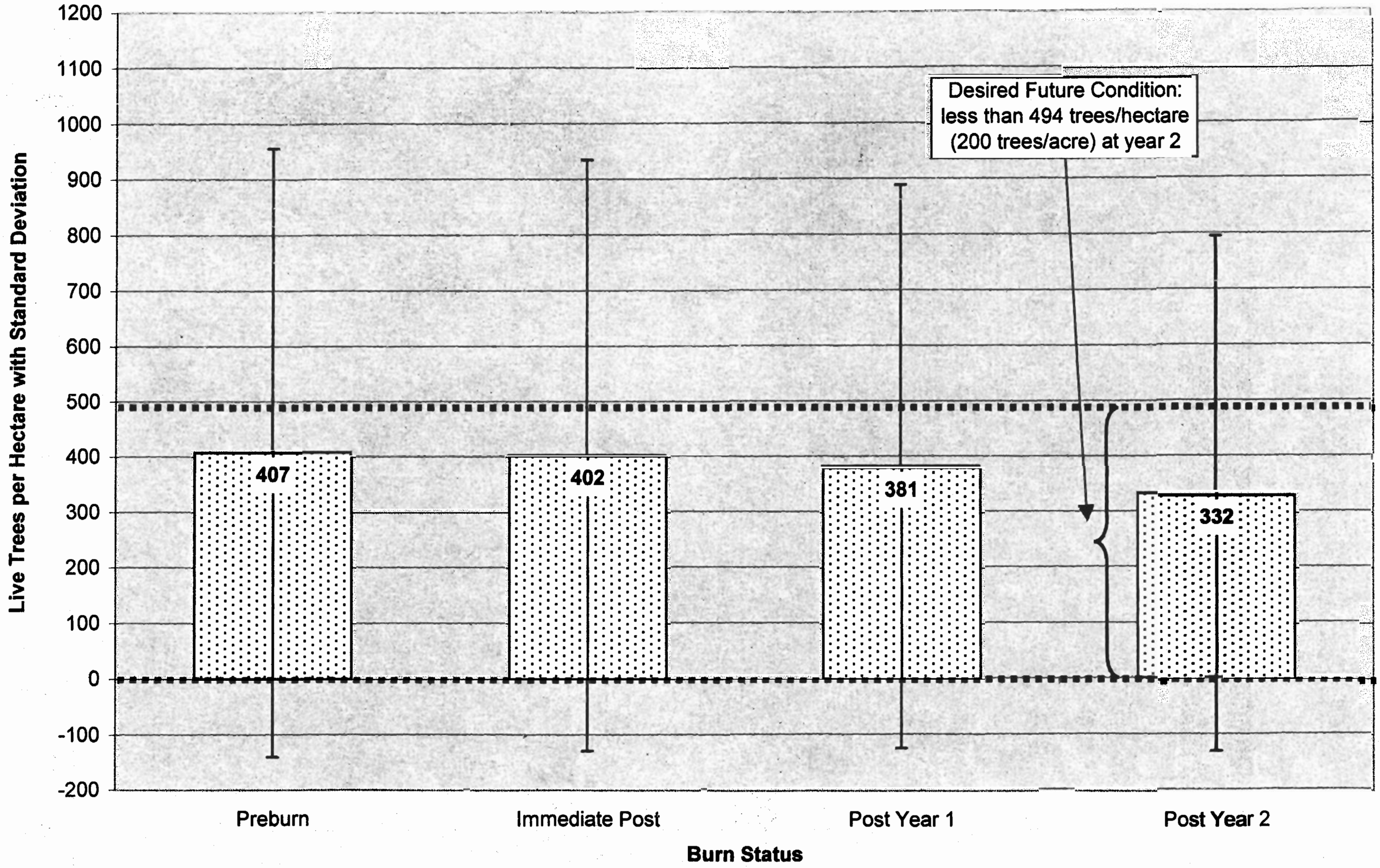
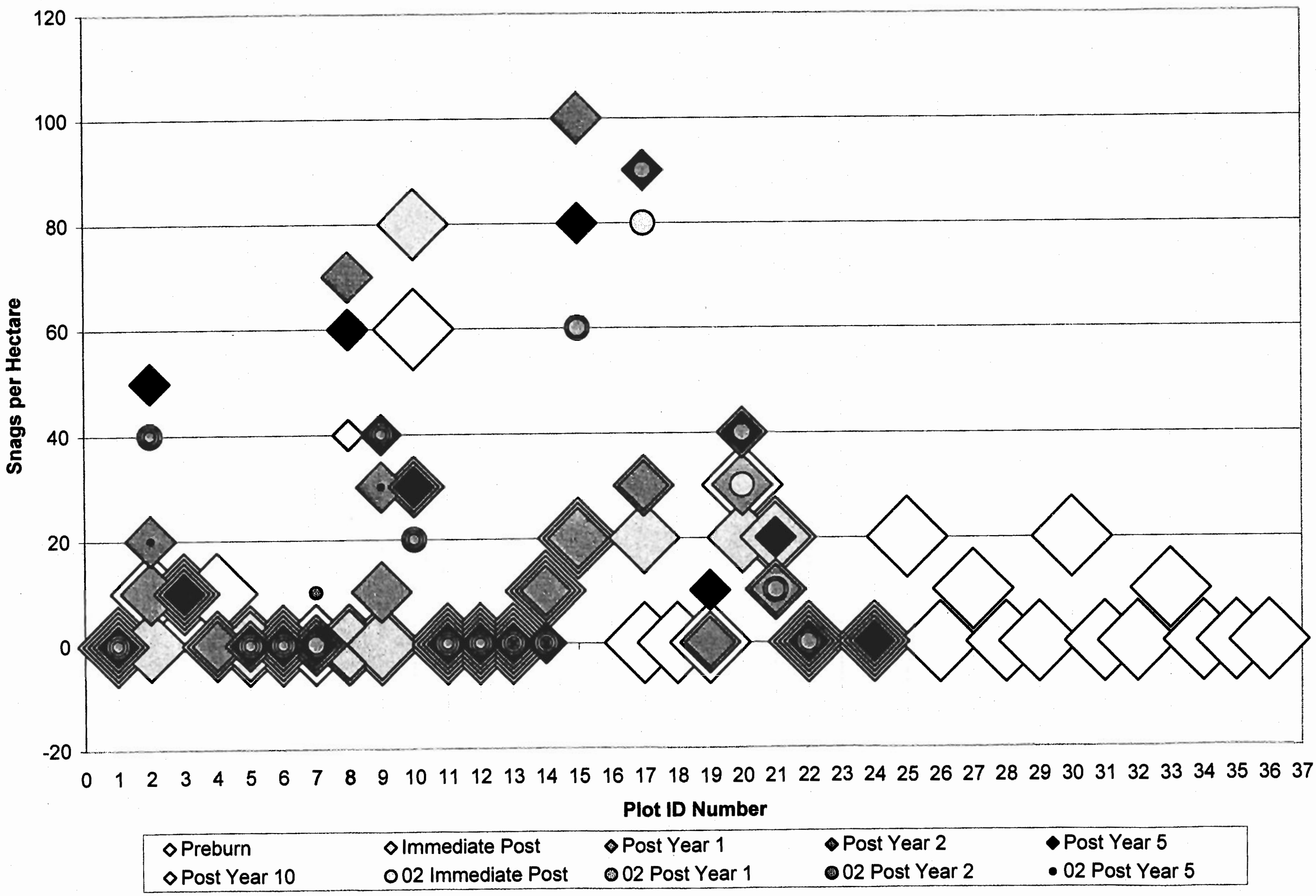
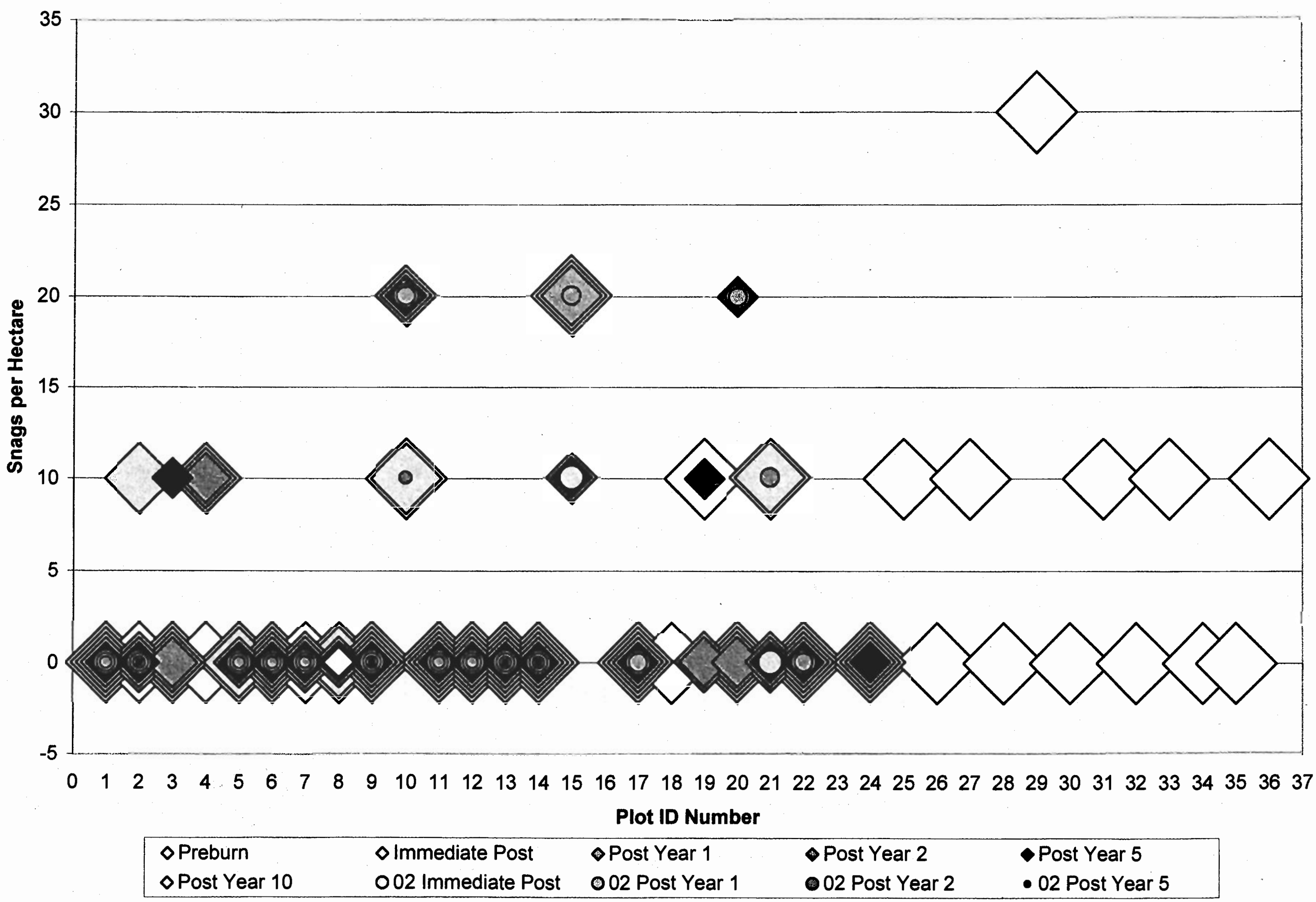


Figure 9. 6 - 15.9" DBH Snag Densities, by plot
December 2003



South Rim Ponderosa Pine (PIPO)

Figure 10. 16" DBH and larger Snag Densities, by plot
December 2003



South Rim Ponderosa Pine (PIPO)

Figure 11. Mean Snag Density, by size class
December 2003
n = 20 plots; *required minimum pre plots = 123 (>=16"), 159 (6-15.9")*

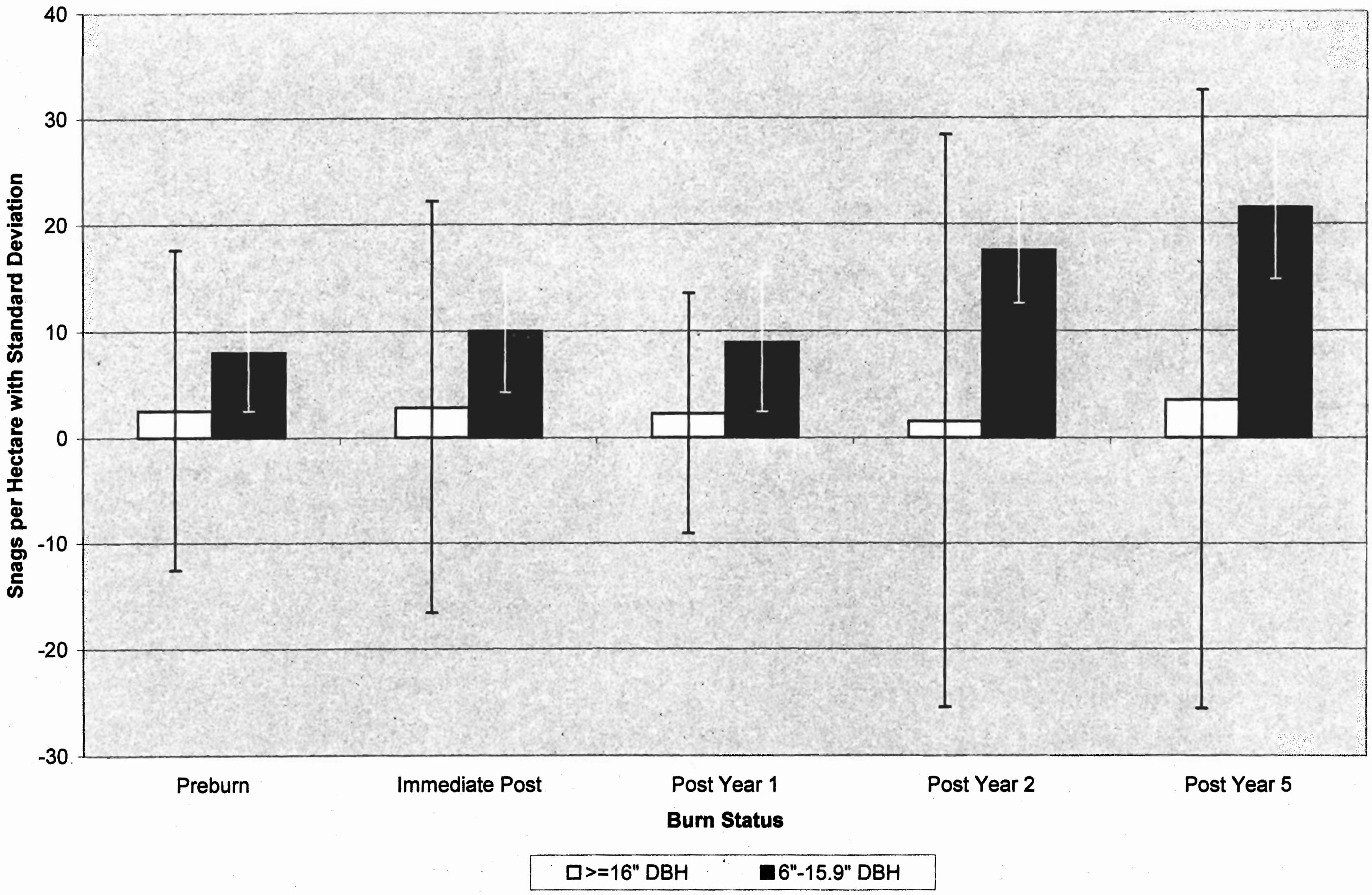


Figure 12. *Pinus ponderosa* Seedling Densities, by plot
December 2003

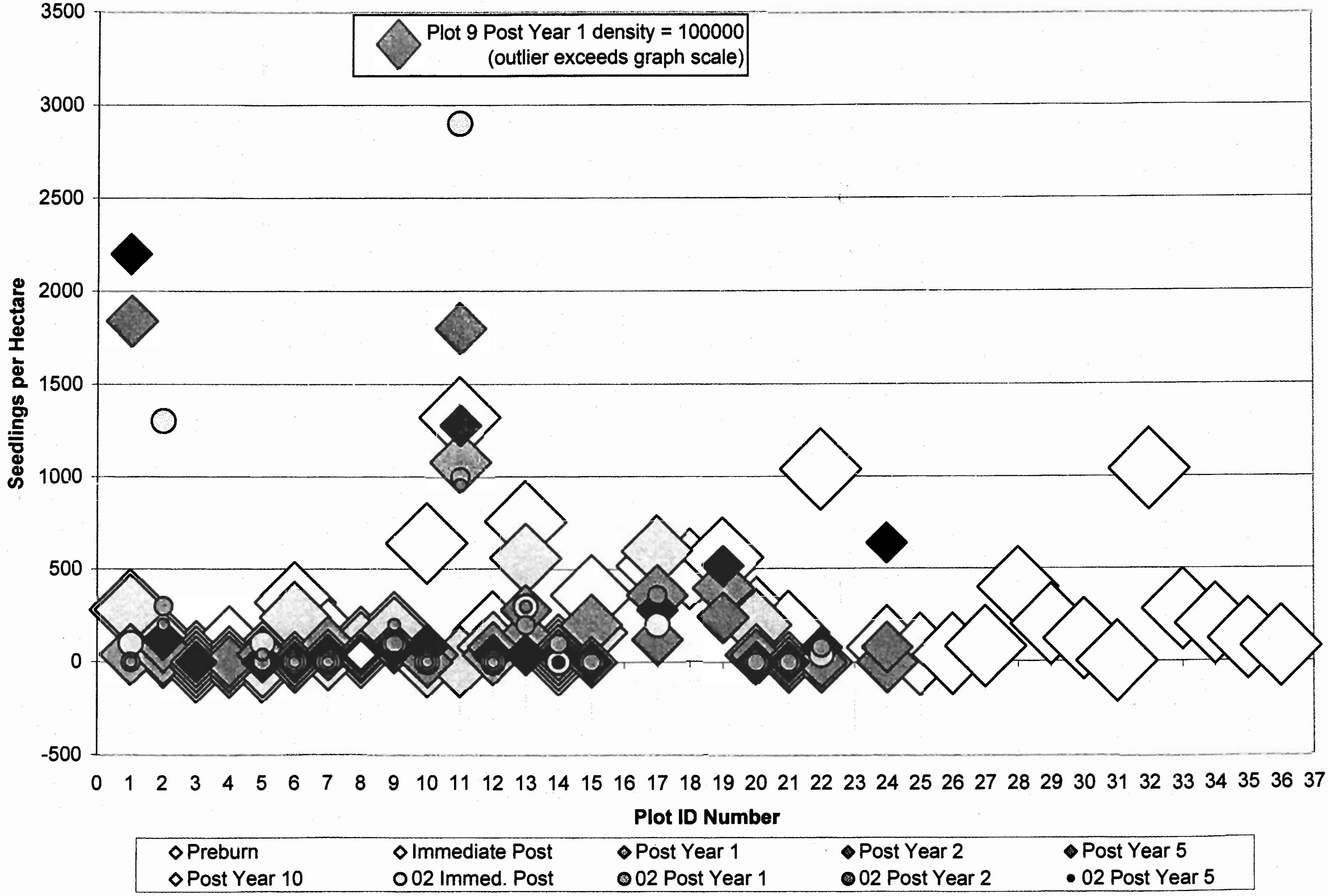
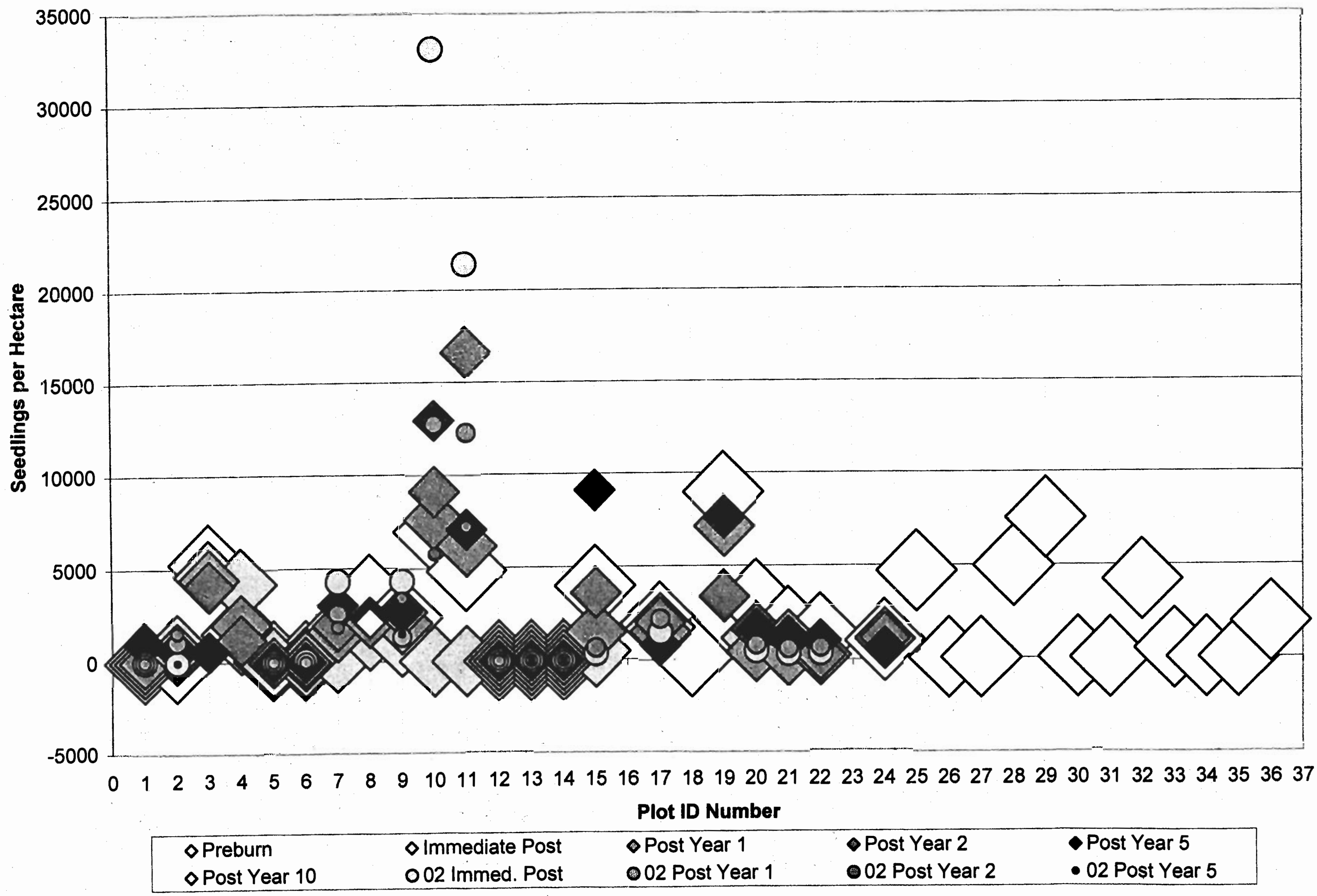


Figure 13. ***Quercus gambelii*** **Seedling Densities, by plot**
December 2003



PIPN RESULTS AND DISCUSSION

<u>OVERSTORY DENSITY</u>

Objective 1: Achieve and maintain an overstory *Pinus ponderosa* density (greater than or equal to 16" dbh) of 40-56 trees per acre (99-136 trees/ha) as stated in the Desired Future Condition, measured at 5 years post-burn.

Results: <u>Figure 14</u> illustrates almost no change in large *Pinus ponderosa* across the entire plot network. There are 6 plots with Year 5 data now—2 showing a decrease and 1 showing an increase in large PIPO densities. The entire body of post-burn data includes 4 plots with a declining trend, 3 with an increasing trend, and 13 are unchanged. <u>Figure 15</u> shows very minor fluctuations in overstory densities, with an almost insignificant 3% reduction between Pre-burn conditions and post-burn Year 5.

Was objective met? No, according to the strict definition of the Desired Future Condition. We began with 100 trees per hectare on our 6 comparable plots and are now at 97 trees per hectare—below our target density. However, error bars easily could place the true mean within the desired range, and the overall loss of only 3% is within the acceptable range of 0-20% loss.

<u>OVERSTORY SCORCH</u>

Objective 2: Limit average crown scorch on overstory *Pinus ponderosa* (greater than or equal to 16" dbh) to 30%, measured immediately Post-burn.

Results: At this time we cannot complete analysis for this variable. The database program (fmh.exe) does not allow assessment for scorch on trees of our unique size class. They can be compiled by hand at a future date. <u>Figure 16</u> shows the data we *can* extract from the database—mean scorch per plot on all live ponderosas greater or equal to 6 inches (15 cm) dbh. This graph indicates only 4 of 20 plots had a mean scorch of greater than 30% after the first-entry burn. Since this includes all trees from 6-16 inches (15-40 cm), it is likely that if they are taken out of the analysis, the mean scorch heights will be lower for trees greater than 16" (40 cm) dbh. <u>Figure 17</u> shows minimum, mean, and maximum scorch heights for the first-entry burn.

Was objective met? Unknown, but likely met. With data from 20 plots, the trend is quite favorable.

<u>FUEL LOADING</u>

Objective 3: Maintain an average total fuel load of 0.2 to 9.3 tons/acre (0.5 to 23 tons/ha) as stated in the Desired Future Condition, measured immediately Post-burn.

Results: <u>Figure 18</u> shows a lot of change on individual plots, with fuel loads almost always decreasing. <u>Figure 19</u> shows that duff, litter, and 1000-hour fuels (>3" woody) are decreased the most after the first-entry burn. Total fuel loading decreases through Year 1, but begins to increase again by Year 2. It is understood that it will likely take more than one treatment to reduce fuel loads to desired conditions. A burn prescription that would reduce fuel loads to desirable levels the first time might be too hot for overstory ponderosa pine.

Was objective met? Not yet. We have the required number of minimum pre-burn plots, but although total mean fuel load was cut in half on average, it is still higher than the desired future condition. It seems as though a second-entry burn will be required to meet our objectives, or objectives need to be re-assessed.

POLE DENSITY

Objective 4: Reduce *Pinus ponderosa* poles with dbh of 1-6 inches (2.5-15cm) to average 0-200 trees/acre (0-494 trees/ha), measured 2 years post-burn.

Results: Figure 20 shows that *Pinus ponderosa* pole tree densities are generally within or near the range of Desired Future Conditions, with the notable exception of plots 5 and 29. Figure 21 shows mean densities to be steadily decreasing, although error bars are wide.

Was objective achieved? Unknown. Minimum sample size has not been achieved for this variable, but the trend is toward a decrease in pole densities. Due to the large number of required minimum pre-burn plots, it is not realistic that we will be able to assess this objective to our desired level of statistical confidence.

SNAG DENSITY

Objective: Track snag densities over time.

Results: Figure 22 shows moderate change in small snag densities across the plot network. Response to fire ranges from the dramatic increase on plot 1 to the noticeable decrease on plot 3, with overall change trending toward an increase on the 6 plots with Year 5 data. Figure 23 illustrates decreases in large snag densities on 4 plots, increases on 1, and no changes on 15 between pre-burn conditions and the most recent post-burn data. Figure 24 shows a slight decreasing trend of large snags, but almost a tripling of small snag densities on the 6 plots with comparable data.

Was objective met? There is no objective for a certain number of snags at this time. Consultation with the Grand Canyon National Park wildlife biologist is needed to define an objective. The trend is toward little overall change in large snags and a noticeable increase in small snags.

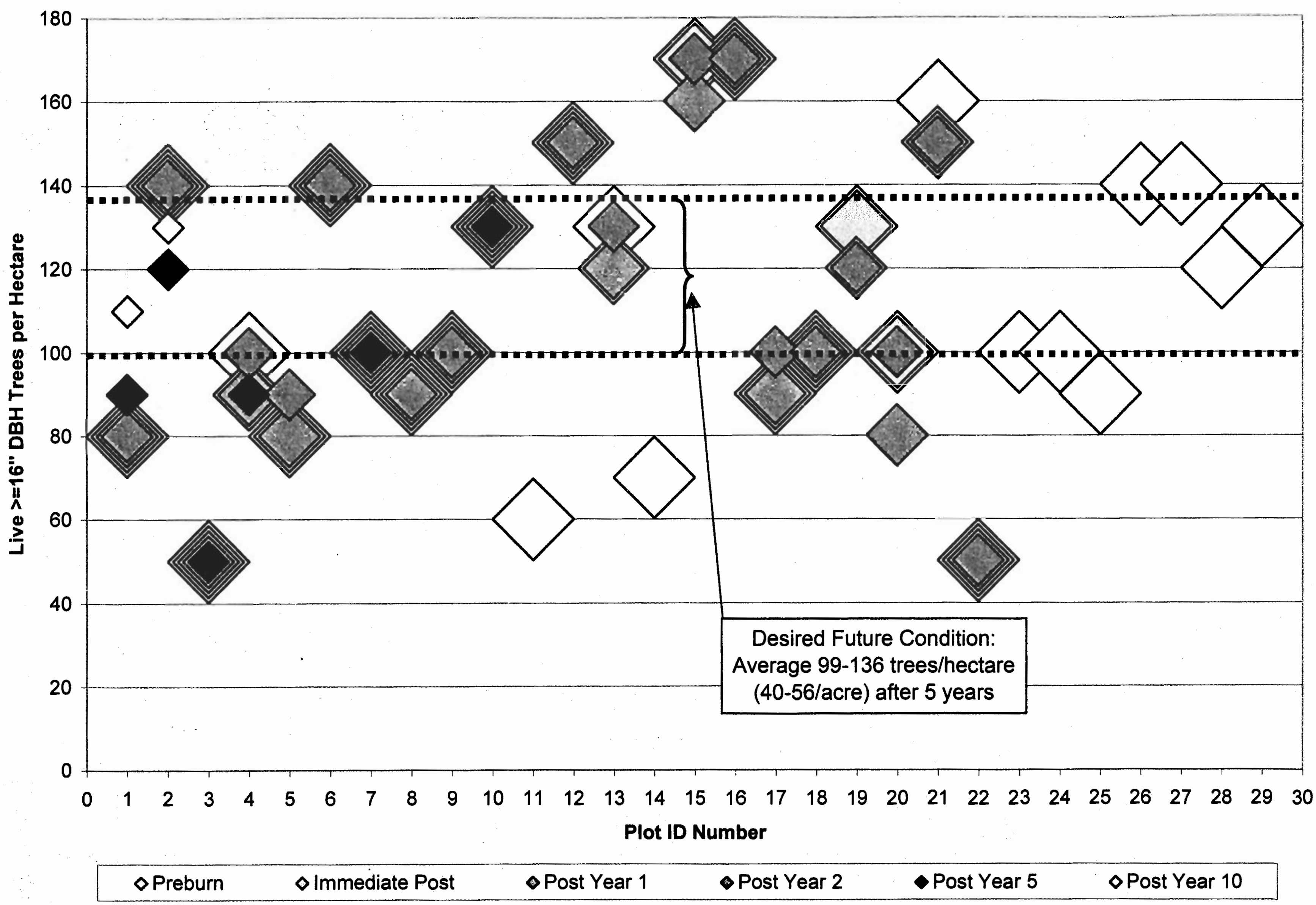
Seedling Density

Objective: Track seedling densities over time.

Results: Figure 25 shows *Abies concolor* seedling densities across the monitoring network. Many plots have zero values, and one plot shows a large increase while another shows a large decrease. Figure 26 shows *Pinus ponderosa* seedlings densities on all plots, most all of which show negative trends where seedlings existed before the fire. This decrease may help mitigate future increases in pole densities. Figure 27 shows many zero values for *Populus tremuloides* seedlings, and some slight increases on some plots and decreases on others.

Was objective met? There is no objective for seedling densities at this time. This information is provided for general knowledge, so that other resource management staff at Grand Canyon can see the trends that are occurring.

Figure 14. Live 16" DBH and larger *Pinus ponderosa* Densities, by plot
December 2003



North Rim Ponderosa Pine (PIPN)

Figure 15. Mean Density of Live 16" DBH or larger *Pinus ponderosa*
December 2003
n = 6, *required minimum pre plots = 4*

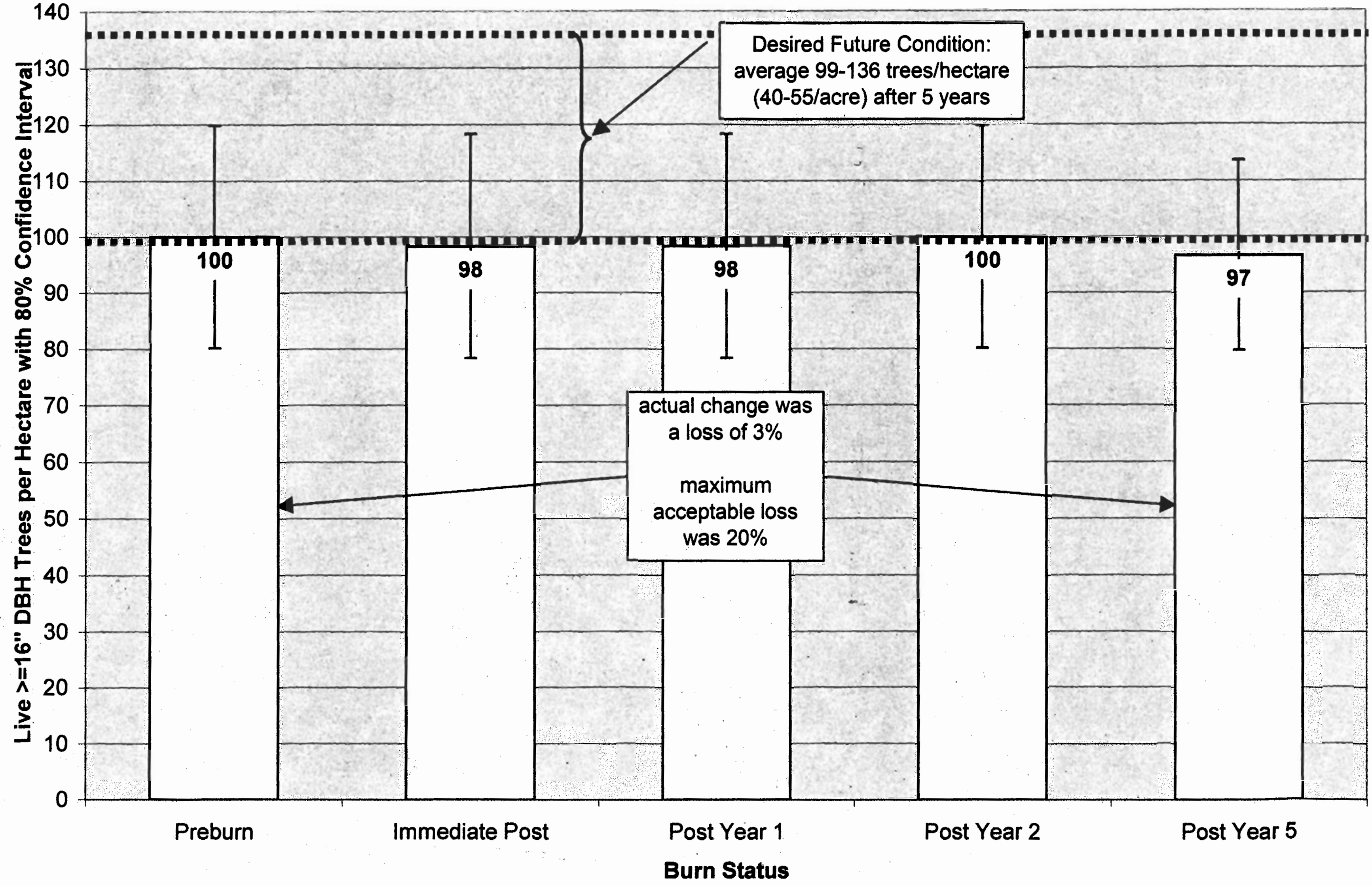


Figure 16. Post-burn Crown Scorch Percent on Live *Pinus Ponderosa* Overstory Trees, by plot
December 2003

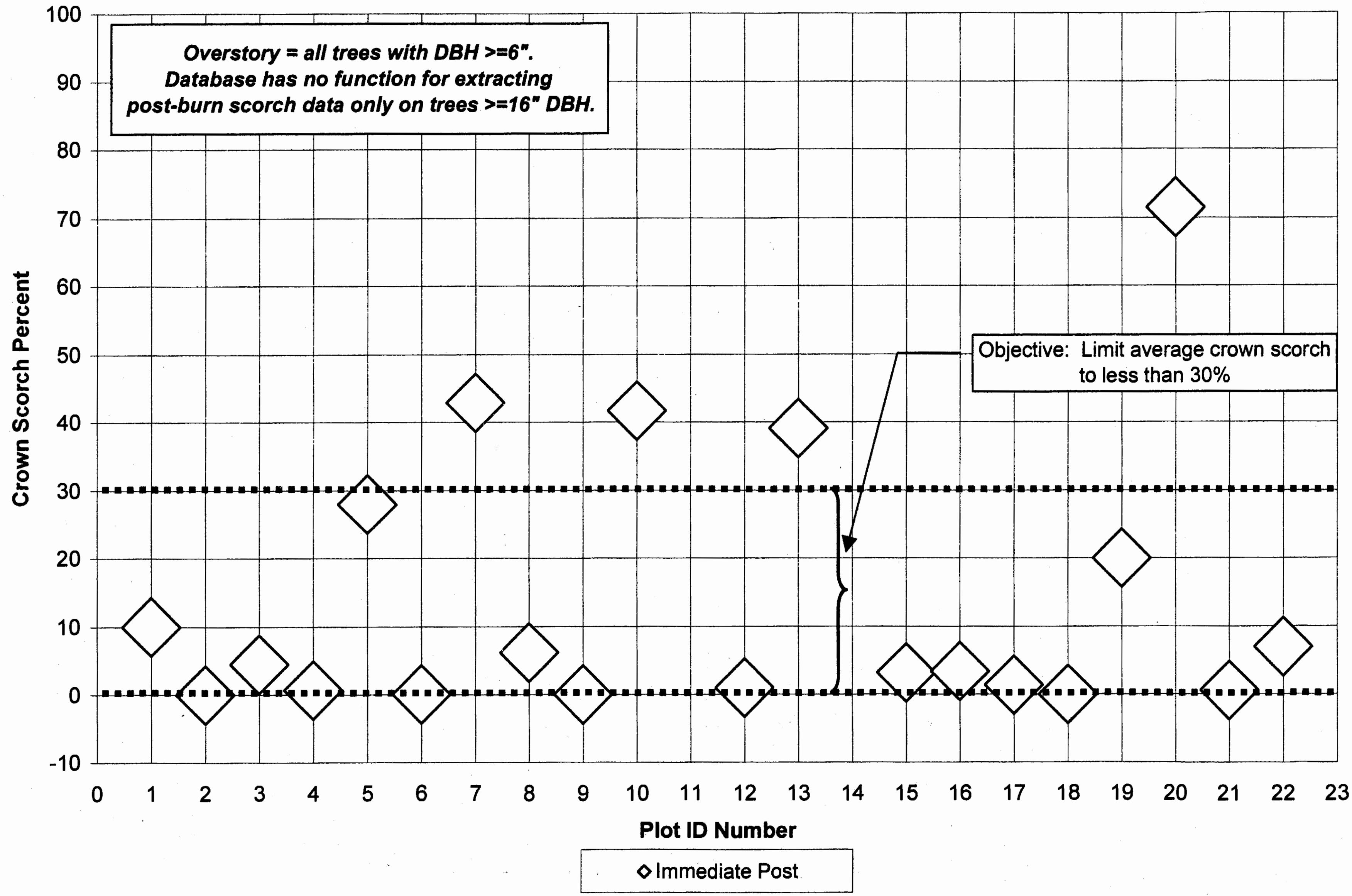


Figure 17. Post-burn Crown Scorch Percent on Live *Pinus ponderosa* Overstory Trees
December 2003
n = 20

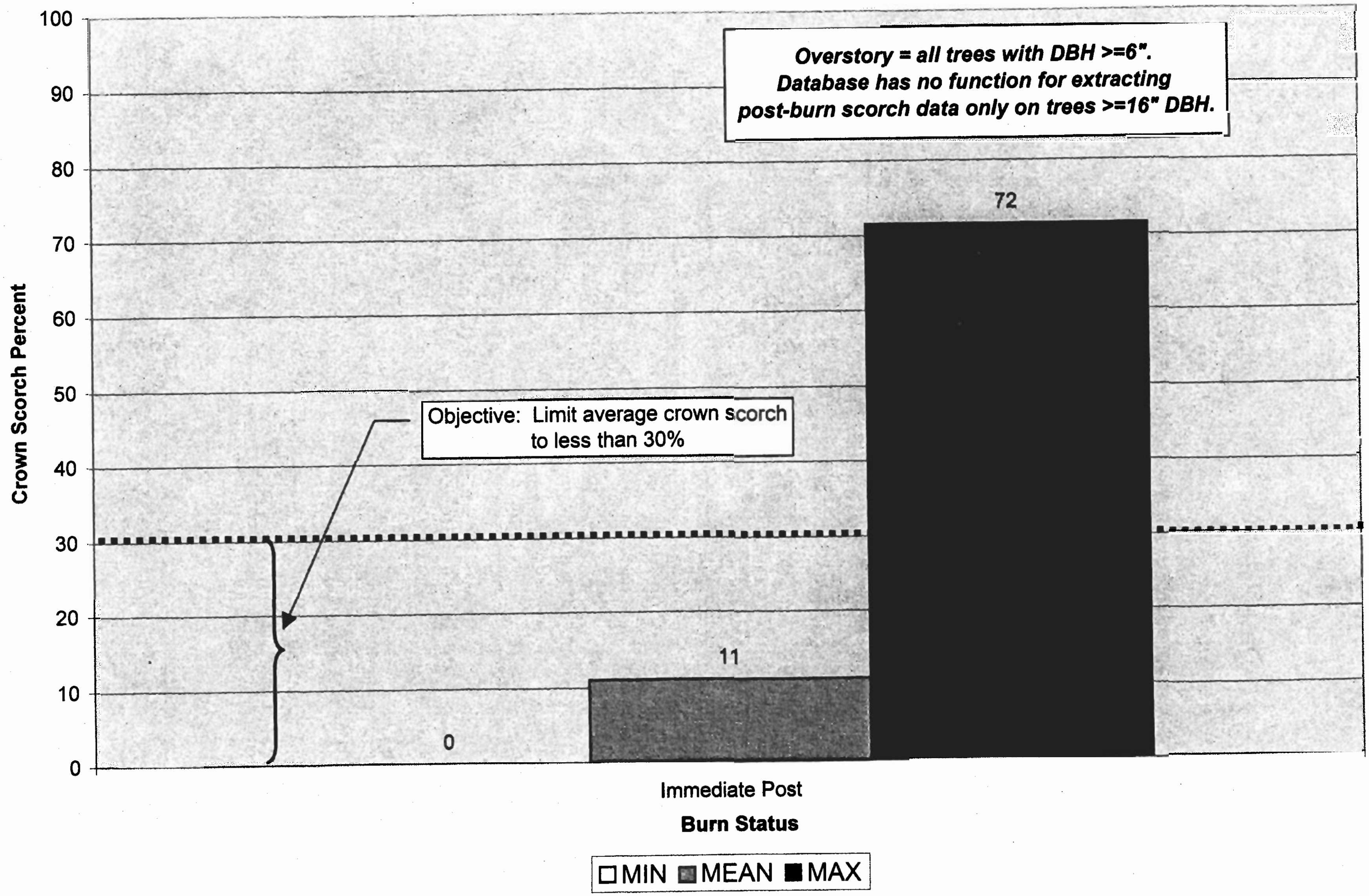
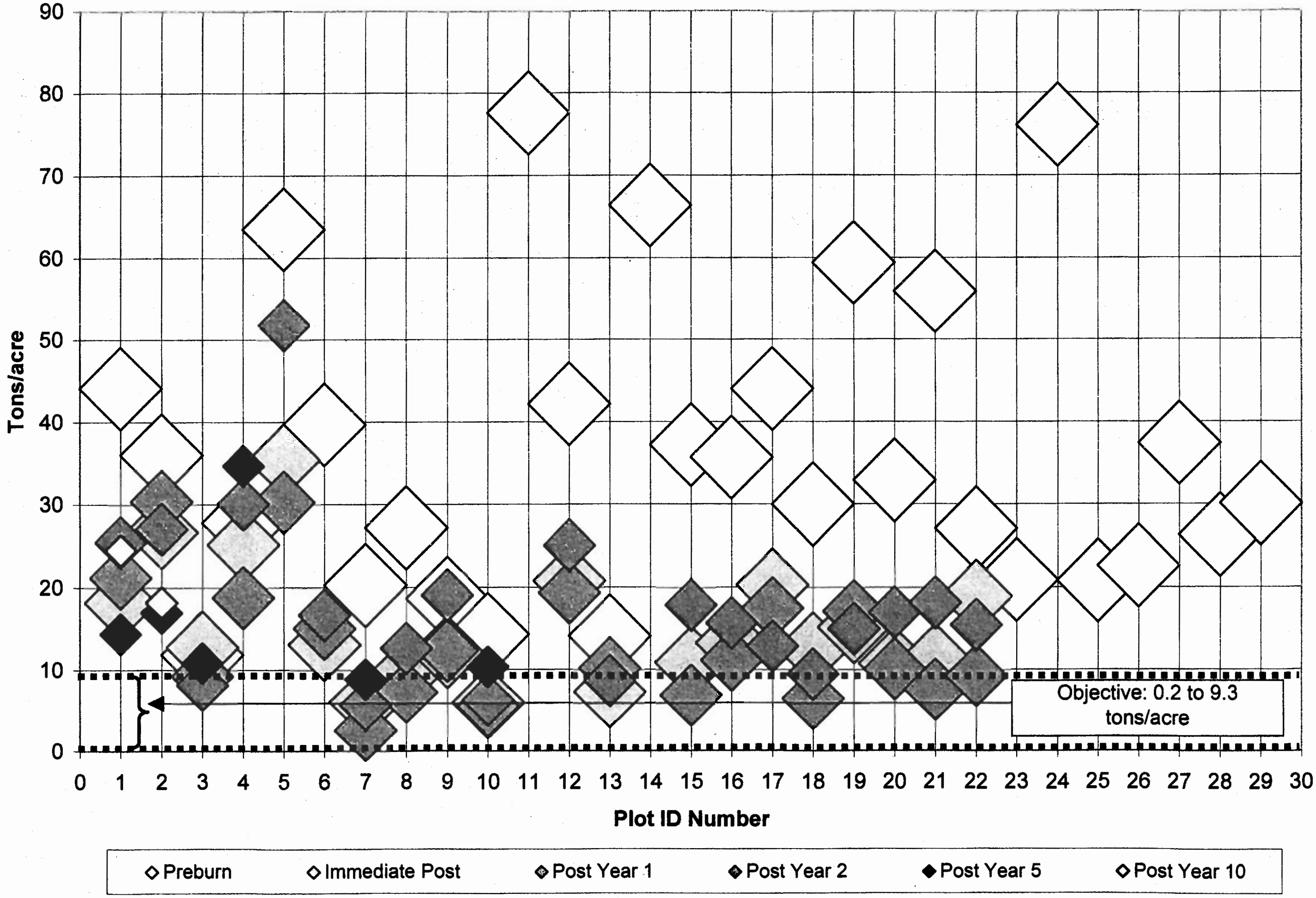


Figure 18. Total Fuel Load, by plot
December 2003
50-foot fuel transects



North Rim Ponderosa Pine (PIPN)

Figure 19. Total Mean Fuel Load
December 2003
50-foot fuels transects
n = 20, *required minimum pre plots = 11*

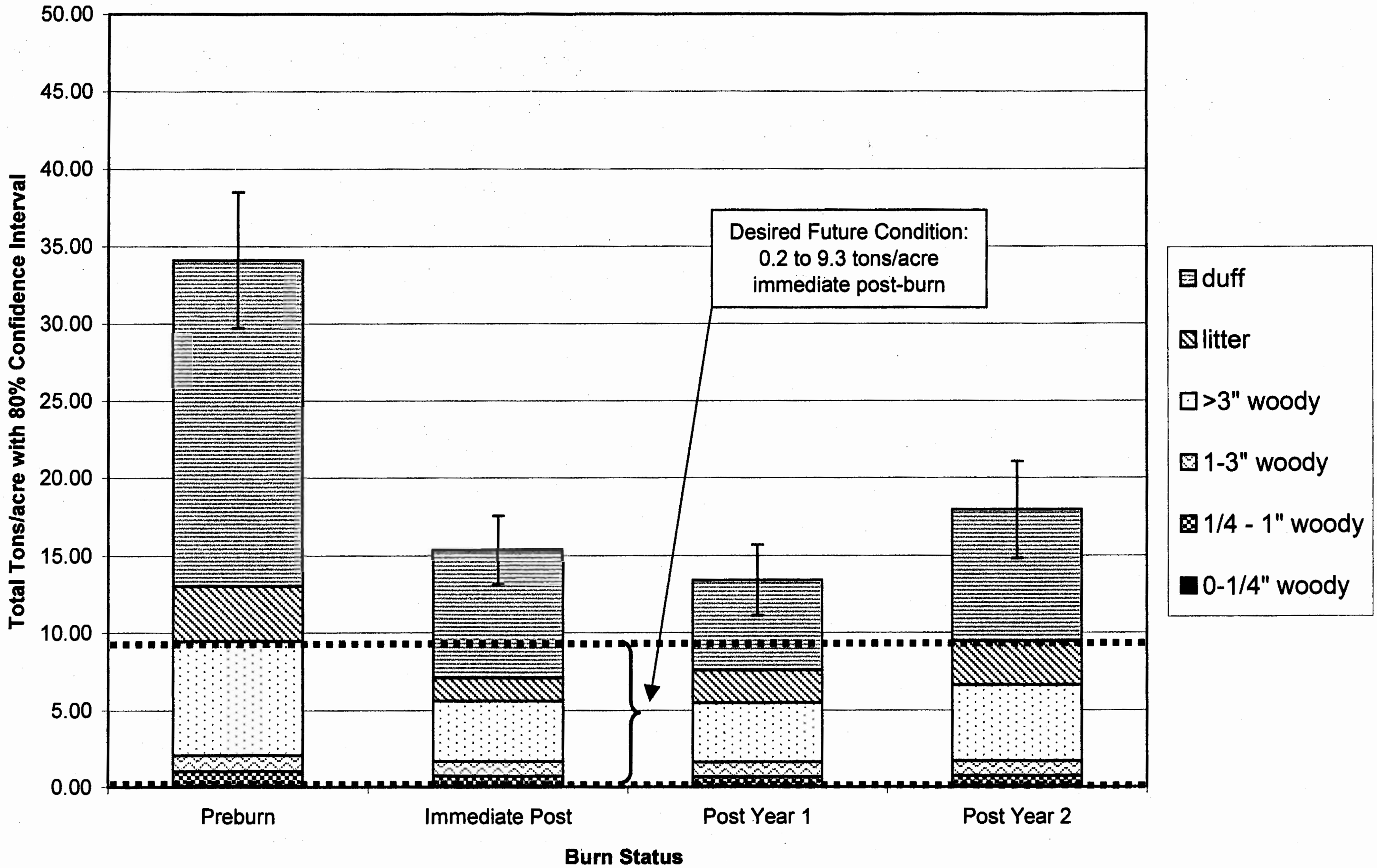


Figure 20. ***Pinus ponderosa*** **Pole Densities, by plot**
December 2003

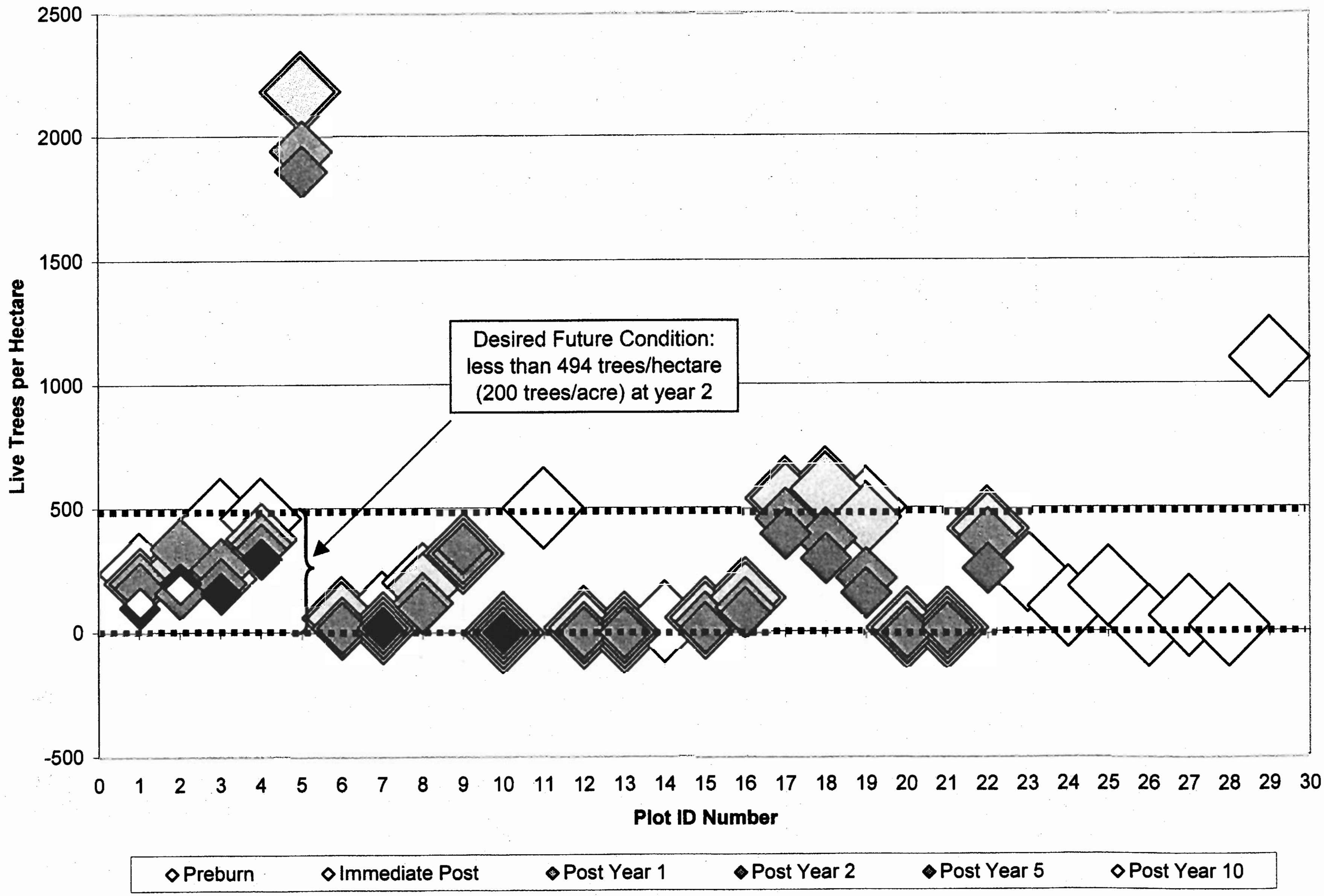


Figure 22. 6 - 15.9" DBH Snag Densities, by plot
December 2003

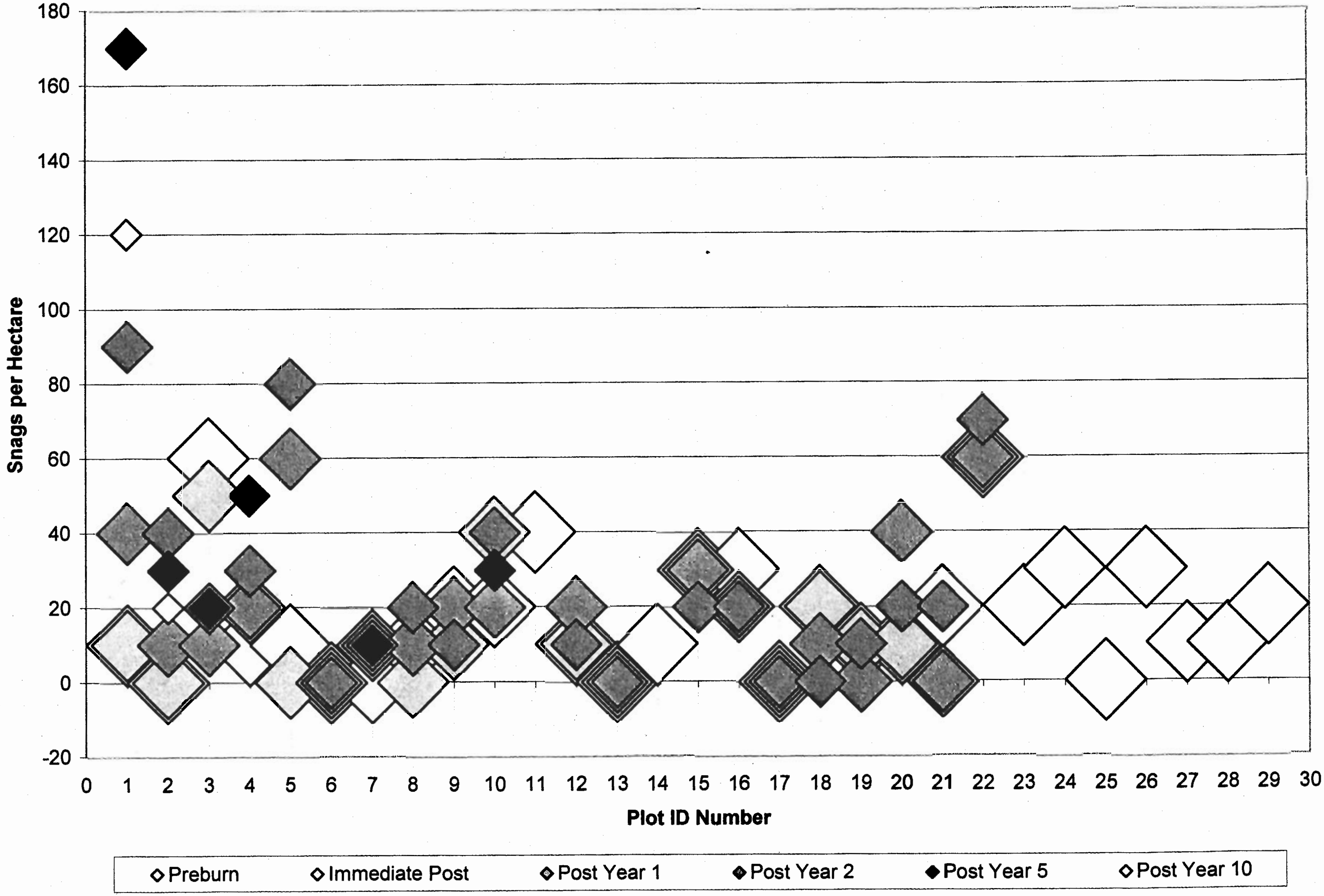
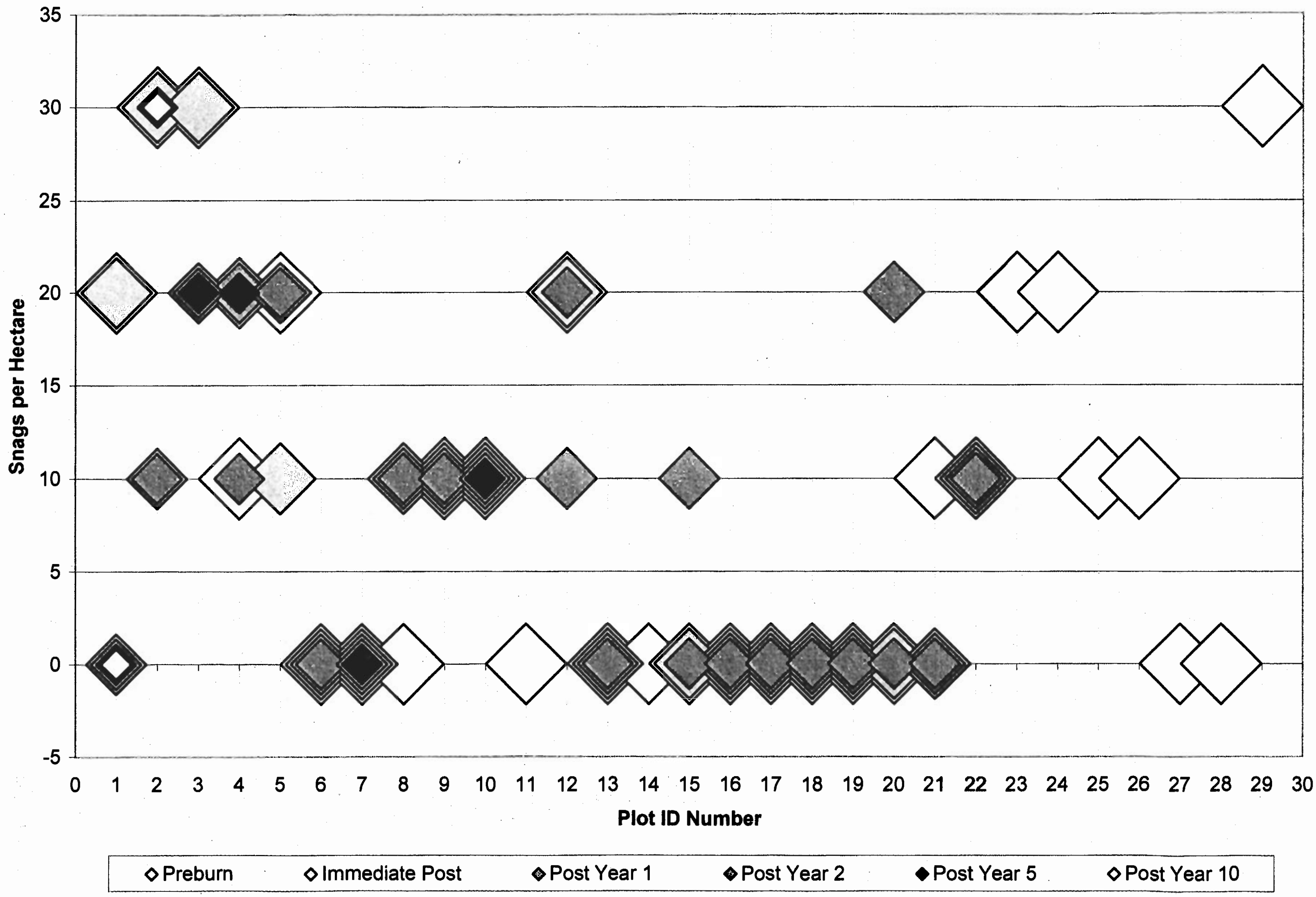
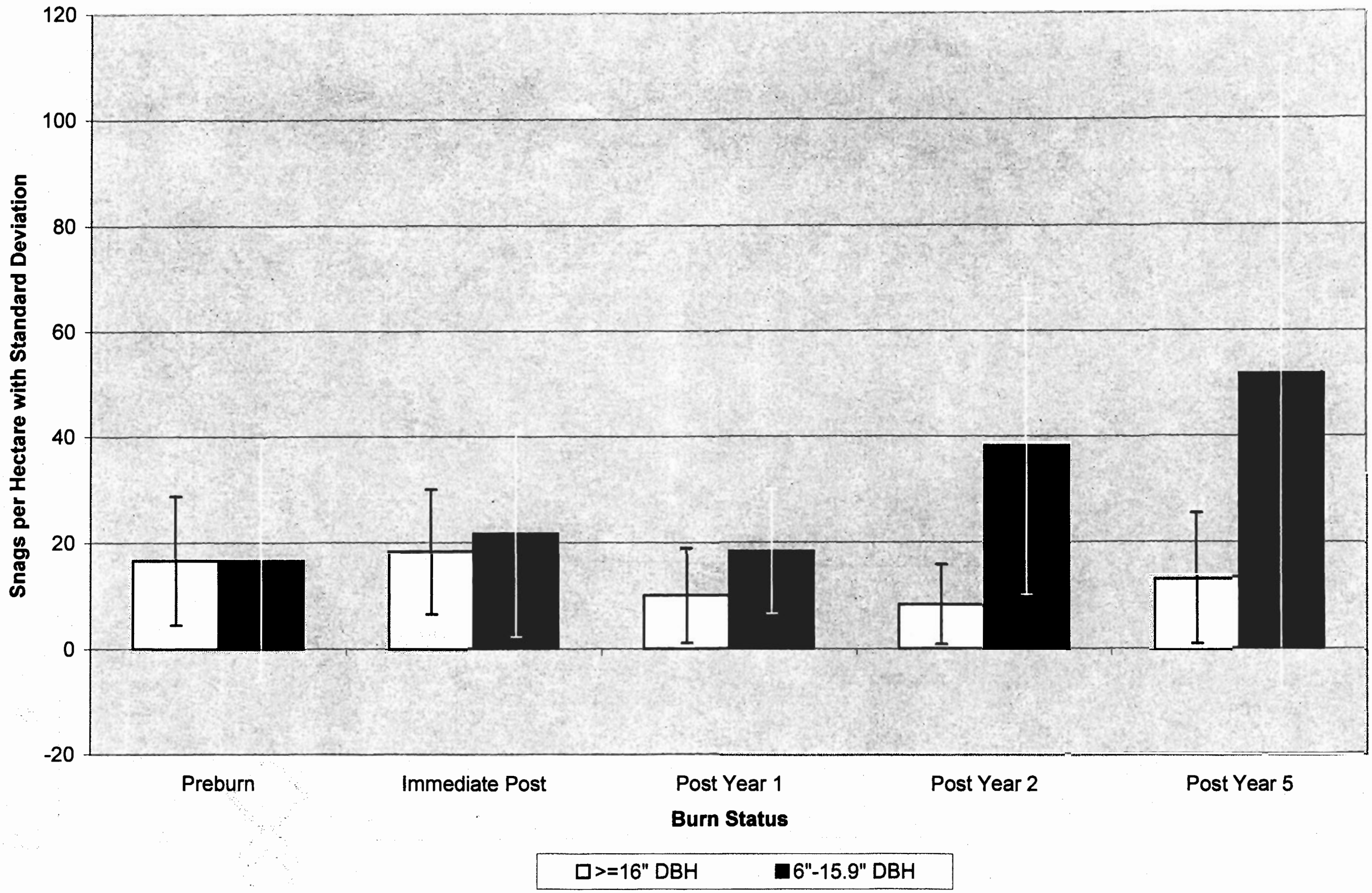


Figure 23. 16" DBH and larger Snag Densities, by plot
December 2003



North Rim Ponderosa Pine (PIPN)

Figure 24. Mean Snag Density, by size class
December 2003
n = 6 plots; *required minimum pre plots = 53 (>=16"), 42 (6-15.9")*



North Rim Ponderosa Pine (PIPN)

Figure 25. ***Abies concolor*** **Seedling Densities, by plot**
December 2003

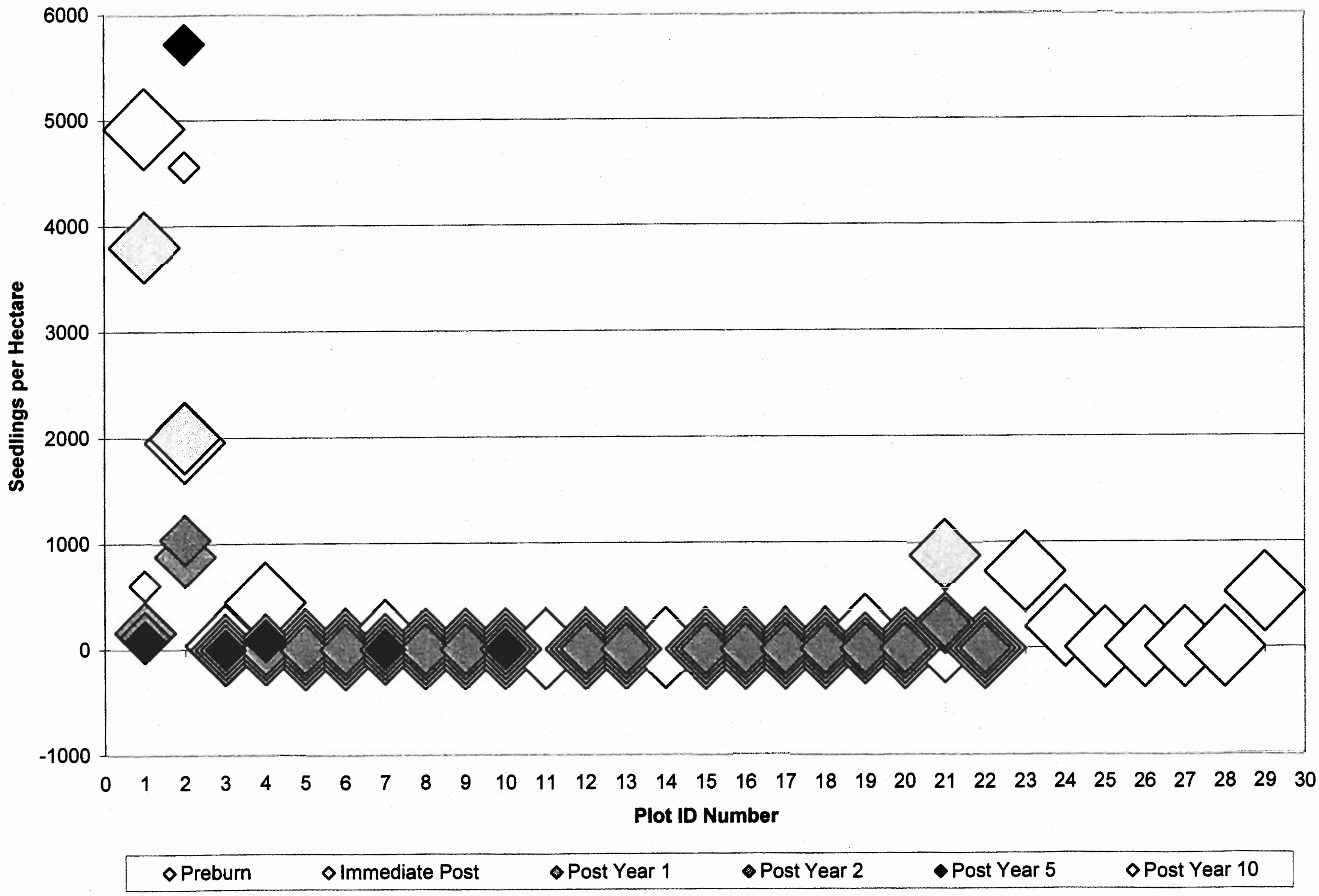


Figure 26. *Pinus ponderosa* Seedling Densities, by plot
December 2003

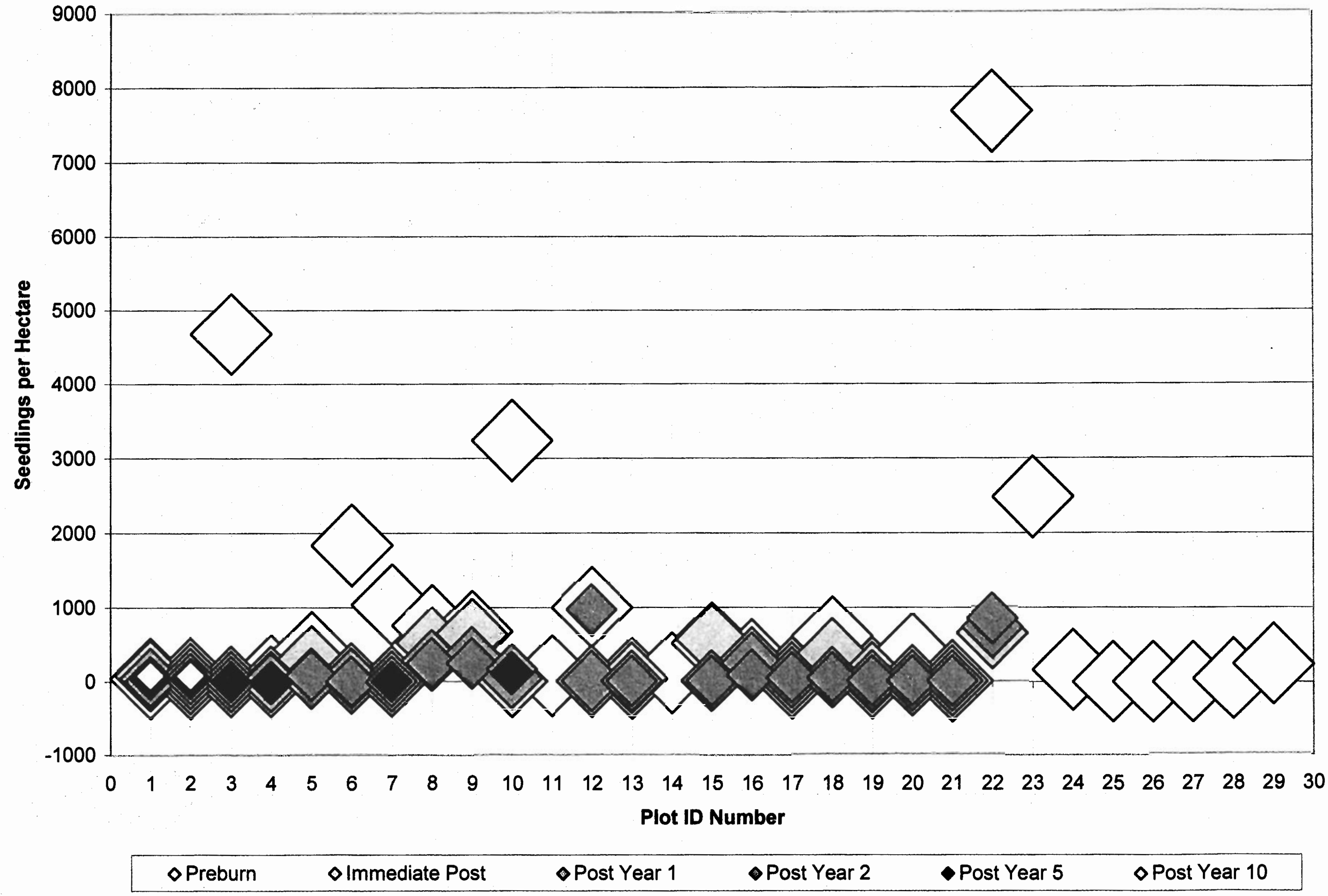
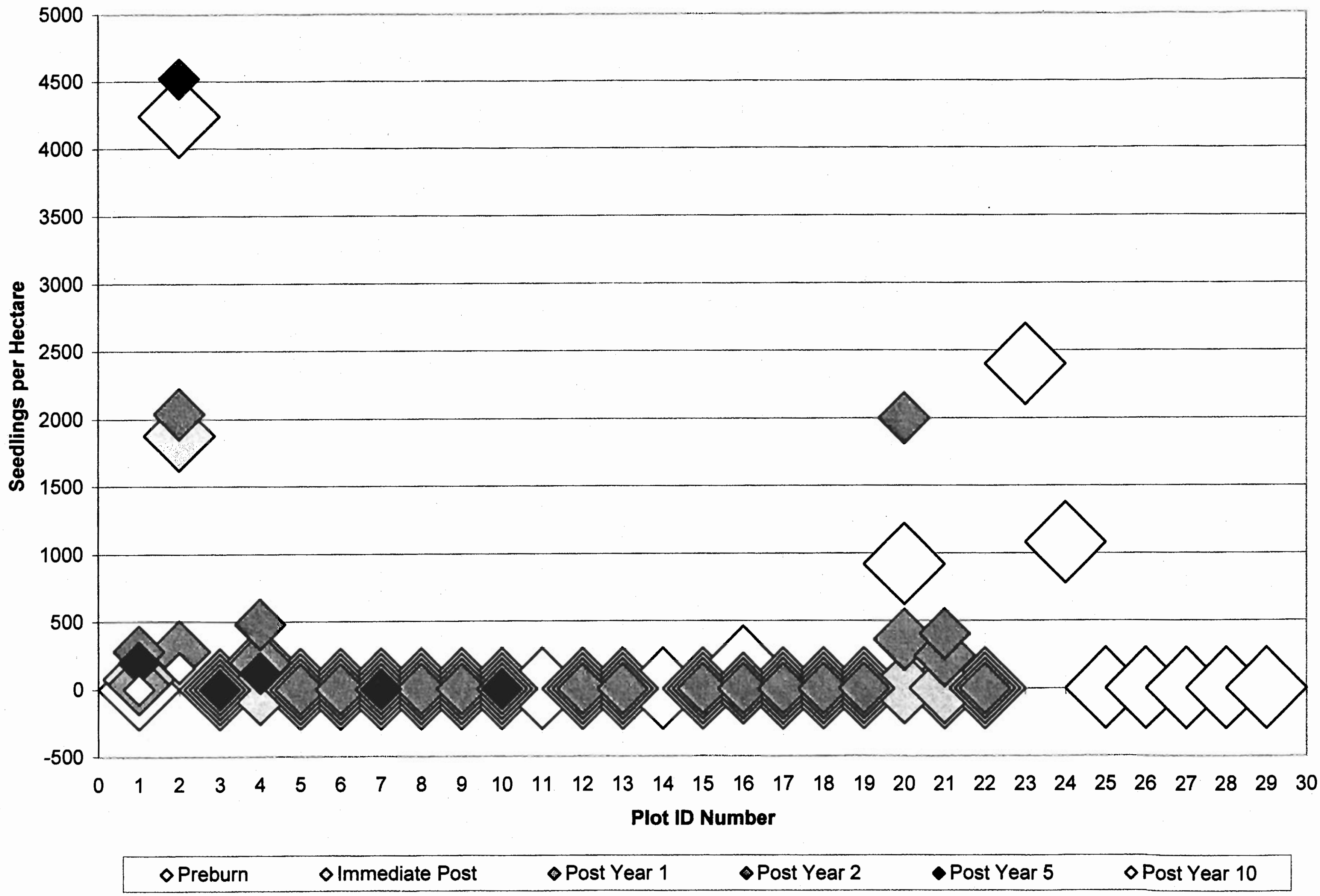


Figure 27. ***Populus tremuloides*** **Seedling Densities, by plot**
December 2003



PIAB RESULTS AND DISCUSSION

Overstory Density

Objective 1: Achieve and maintain an overstory *Pinus ponderosa* density (greater than or equal to 16" dbh) of 47-62 trees/hectare as stated in the Desired Future Condition, measured at 5 years post-burn. Note: *Pinus ponderosa* comprises less than 50% of overstory with remaining percentage occupied by mostly *Abies concolor* and *Populus tremuloides*.

Results: Figure 28 shows *Pinus ponderosa* live overstory densities for all plots. Most plots show little change over time, with densities decreasing on 6 plots and increasing on 2 plots. Figure 29 illustrates that while we do not yet have enough plots with Year 5 data to make authoritative statements, the trend on 6 plots with Year 5 data is toward a marked decrease. Error bars are still wider than the target range, however.

Was objective met? It is unknown whether or not this objective was met since there are not enough Year 5 data. However, the trend of existing data is very favorable.

Overstory Scorch

Objective 2: Limit average crown scorch on overstory *Pinus ponderosa* (greater than or equal to 16" dbh) to 30%, measured immediately Post-burn.

Results: At this time we cannot complete analysis for this variable. The database program (fmh.exe) does not allow assessment for scorch on trees of our unique size class. They can be compiled by hand at a future date. Figure 30 shows the data we *can* extract from the database—mean scorch per plot on all live ponderosas greater than or equal to 6 inches (15 cm) dbh. This graph indicates only 1 plot had a mean scorch greater than 30% after a first-entry burn. Since this includes all trees from 6-16 inches (15-40 cm), it is likely that if they are taken out of the analysis, the mean scorch heights will be lower for trees greater than 16" (40 cm) dbh. Figure 31 shows minimum, mean, and maximum scorch heights after the first- and second-entry burns.

Was objective met? Unknown, but likely met.

Fuel Loading

Objective 3: Maintain an average total fuel load of 0.2 to 20 tons/acre, as defined in the Desired Future Condition, measured immediately Post-burn.

Results: Figure 32 shows the range of pre-burn fuel loads that exist in this monitoring type. Most plots show a decrease in total fuel load. Figure 33 compares total mean fuel load conditions between Pre-burn and Year 2 post-burn. As with the other monitoring types, lowest total fuel loadings occur by Year 1 but start to rise again by Year 2. Most of the change is in duff, litter, and large woody fuels. Minimum plot requirements are met for this variable; therefore, confidence intervals are shown on the graph.

Was objective met? Not as measured immediately Post-burn, although error bars indicate we may be in the desired range and trends are favorable. It is generally understood that more than one treatment is necessary to decrease fuel loading to desirable levels without achieving high mortality of overstory ponderosas.

Pole Density

Objective 4: Reduce *Abies concolor* poles with dbh of 1-6 inches (2.5-15 cm) to average 0-100 trees/acre (0-247 trees/ha), measured 2 years post-burn.

Results: Figure 34 illustrates the range of *Abies concolor* pole densities—approaching 1800 per hectare on one plot while zero on others. Figure 35 shows mean *Abies concolor* pole densities decreased from 644 to 180 trees/ha on 14 plots, but error bars are wide.

Was objective met? Unknown because minimum sample size is not achieved, but trends are quite favorable. Unlike the other main monitoring types, pole variability is less in PIAB. We have installed 24 plots and only 27 are required, so assessing this variable with confidence may be attainable in the future with more installs or as more plots burn.

Snag Density

Objective: Track snag densities over time.

Results: Figure 36 shows that small snag densities mostly increase over time after fire. Large snag densities in Figure 37 are less variable and show smaller changes. Figure 38 shows small snags doubling and large snags first increasing then decreasing and stabilizing, both with wide error bars.

Was objective met? There is no objective for a certain number of snags at this time. Consultation with the Grand Canyon National Park wildlife biologist is needed to define an objective.

Seedling Density

Objective: Track seedling densities over time.

Results: Figure 39 shows *Abies concolor* seedling densities across the monitoring network—trends by plot vary, with a general decrease post-burn. Figure 40 indicates there are few plots with any *Pinus ponderosa* seedlings at all, and there are both increases and decreases on those that have burned. Figure 41 shows *Populus tremuloides* seedlings also do not seem to have a definitive trend.

Was objective met? There is no objective for seedling densities at this time. This information is provided for general knowledge, so that other resource management staff at Grand Canyon are aware of the trends.

Figure 28. Live 16" DBH and larger *Pinus ponderosa* density, by plot
December 2003

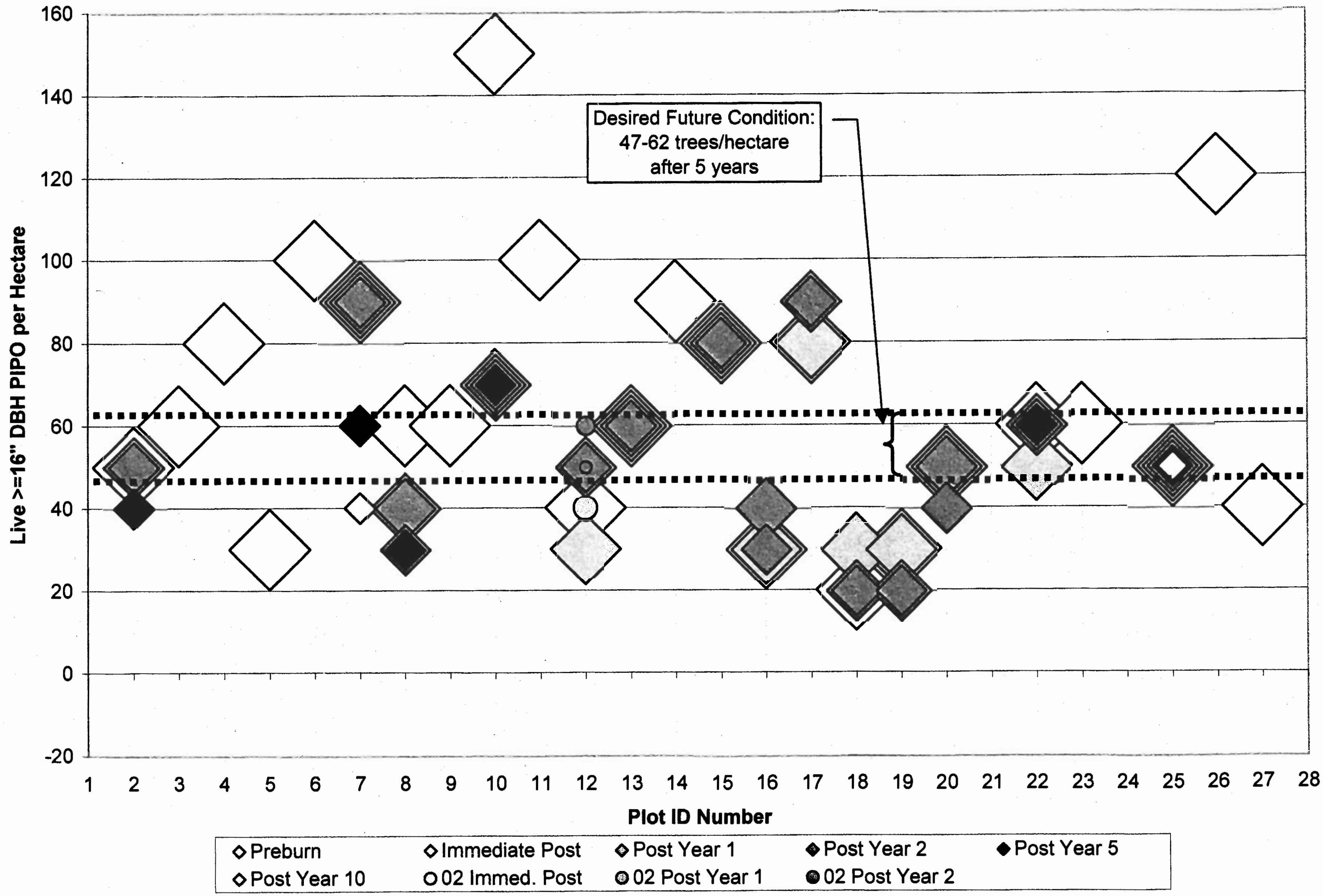


Figure 29. Mean Density of Live 16" DBH and larger *Pinus ponderosa*
December 2003
n = 6, *required minimum pre plots = 12*

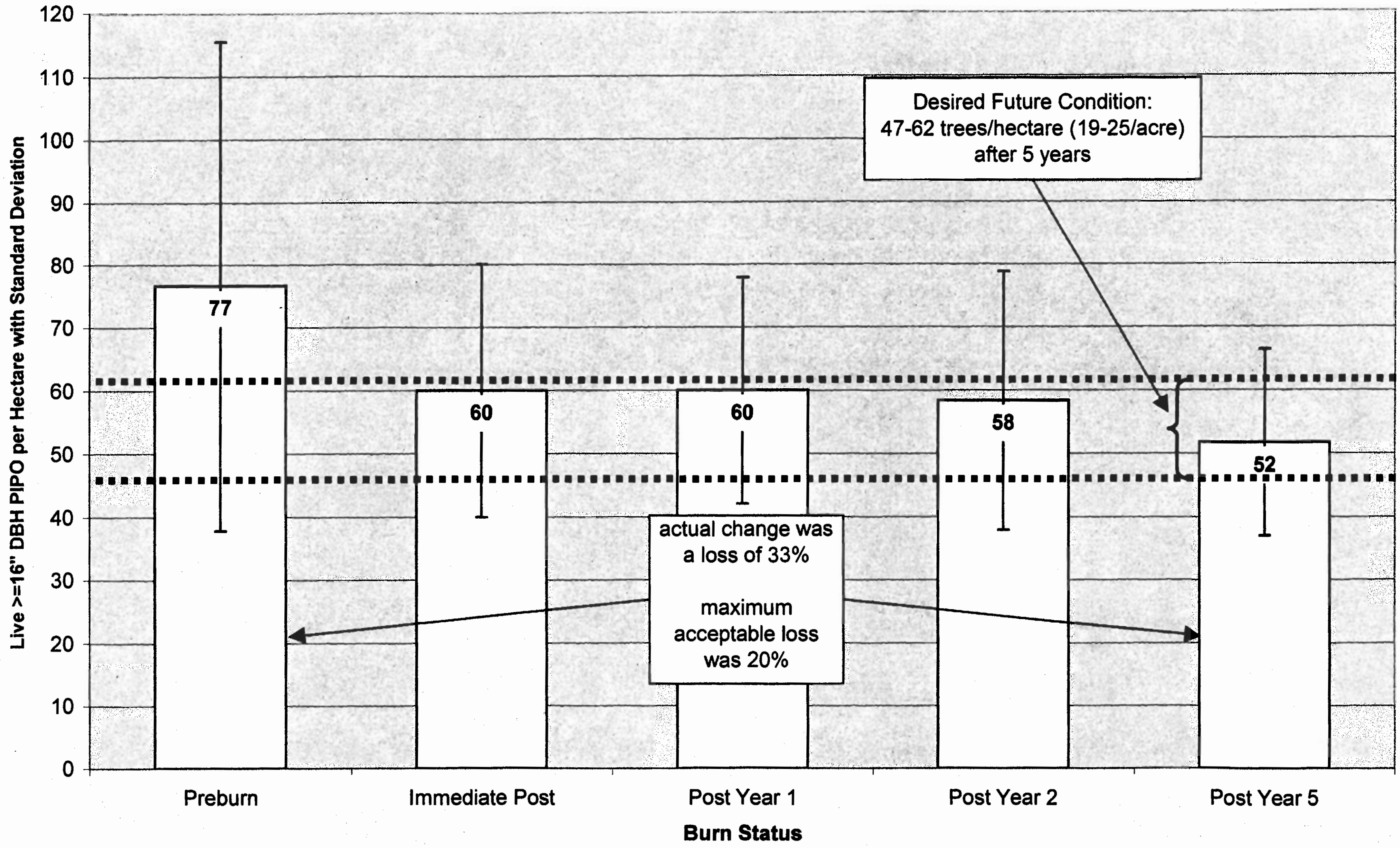


Figure 30. Post-burn Crown Scorch Percent on Live *Pinus Ponderosa* Overstory Trees, by plot
December 2003

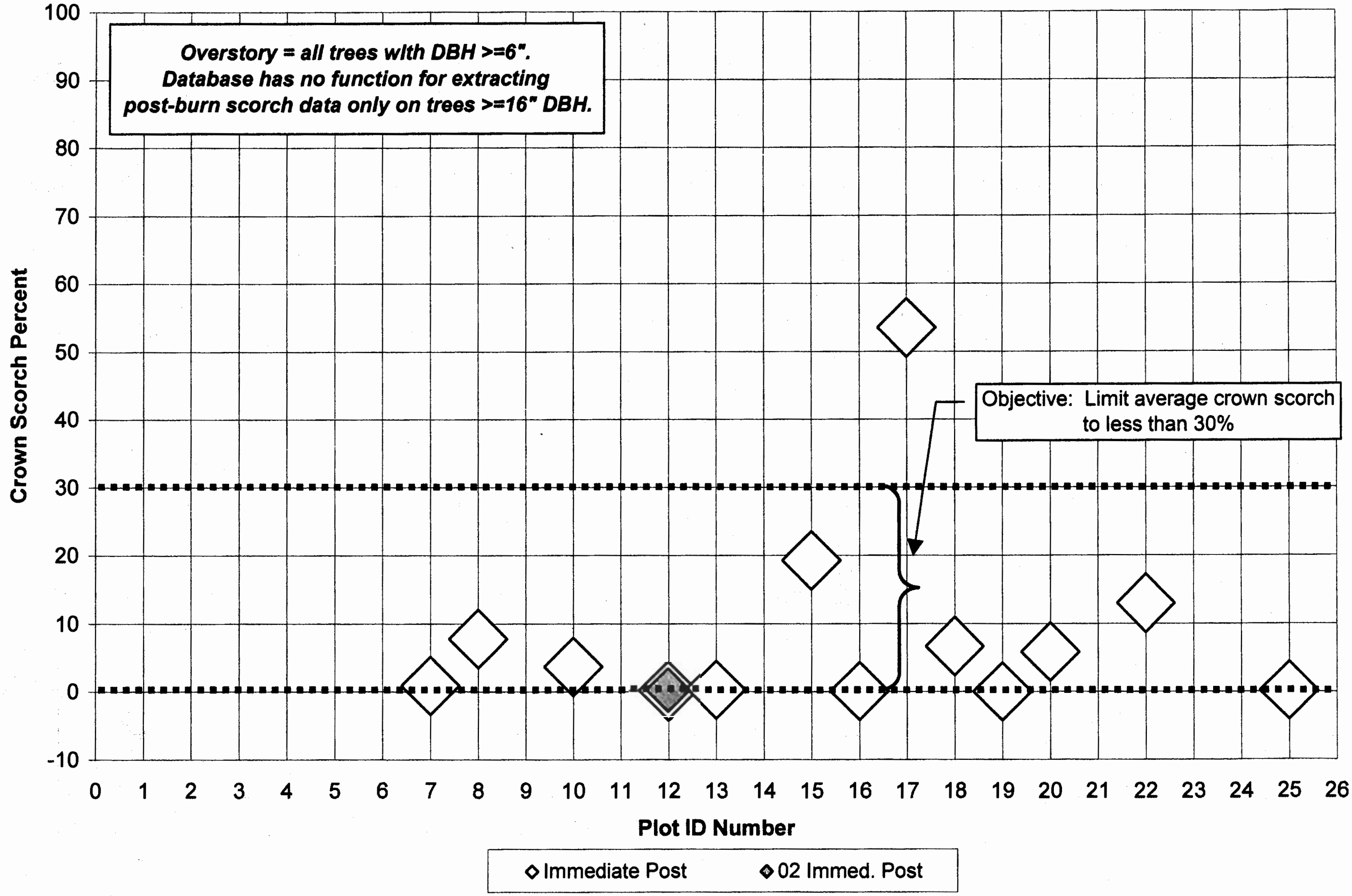


Figure 31. Post-burn Crown Scorch Percent on Live *Pinus ponderosa* Overstory Trees
December 2003

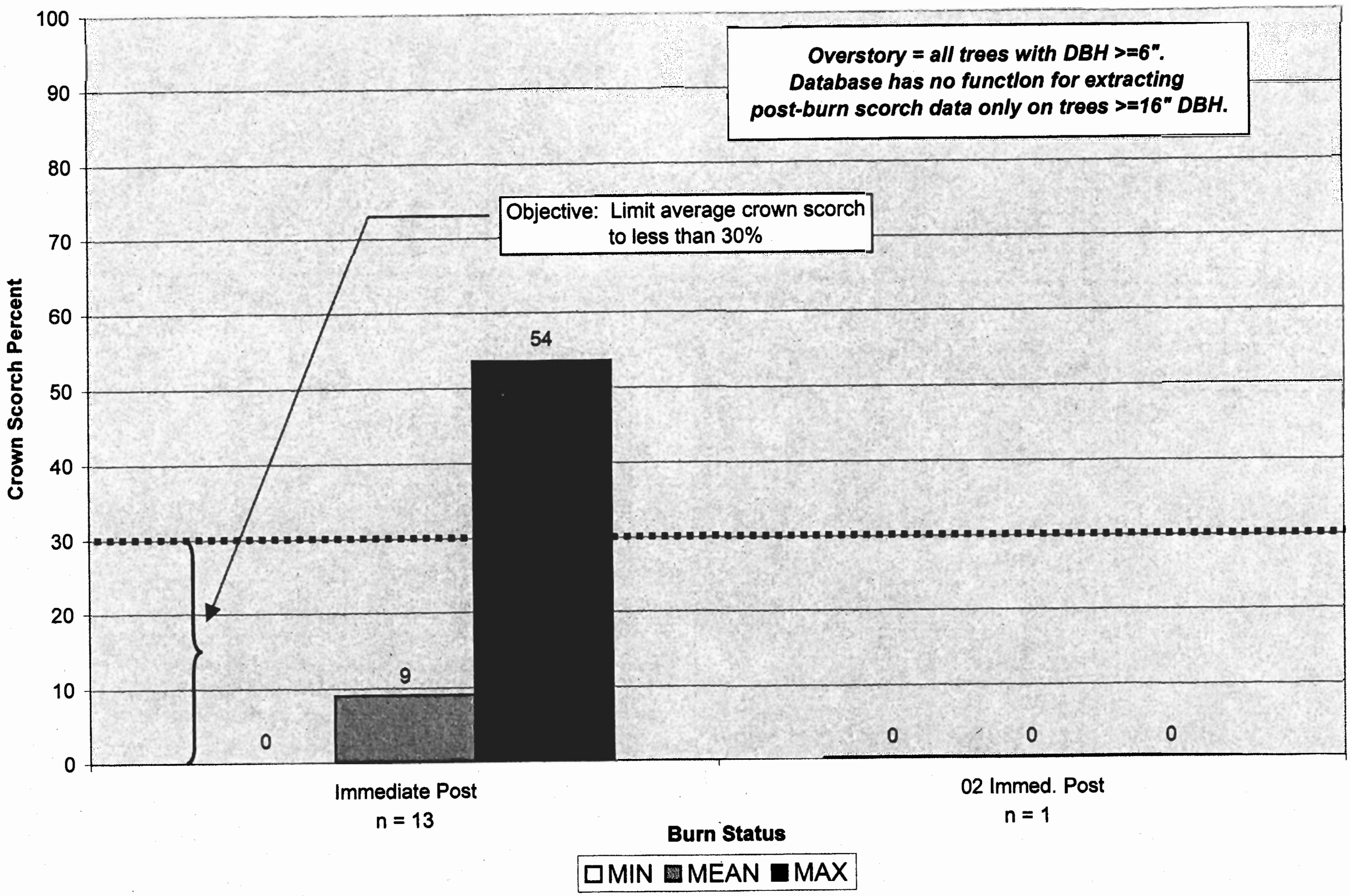
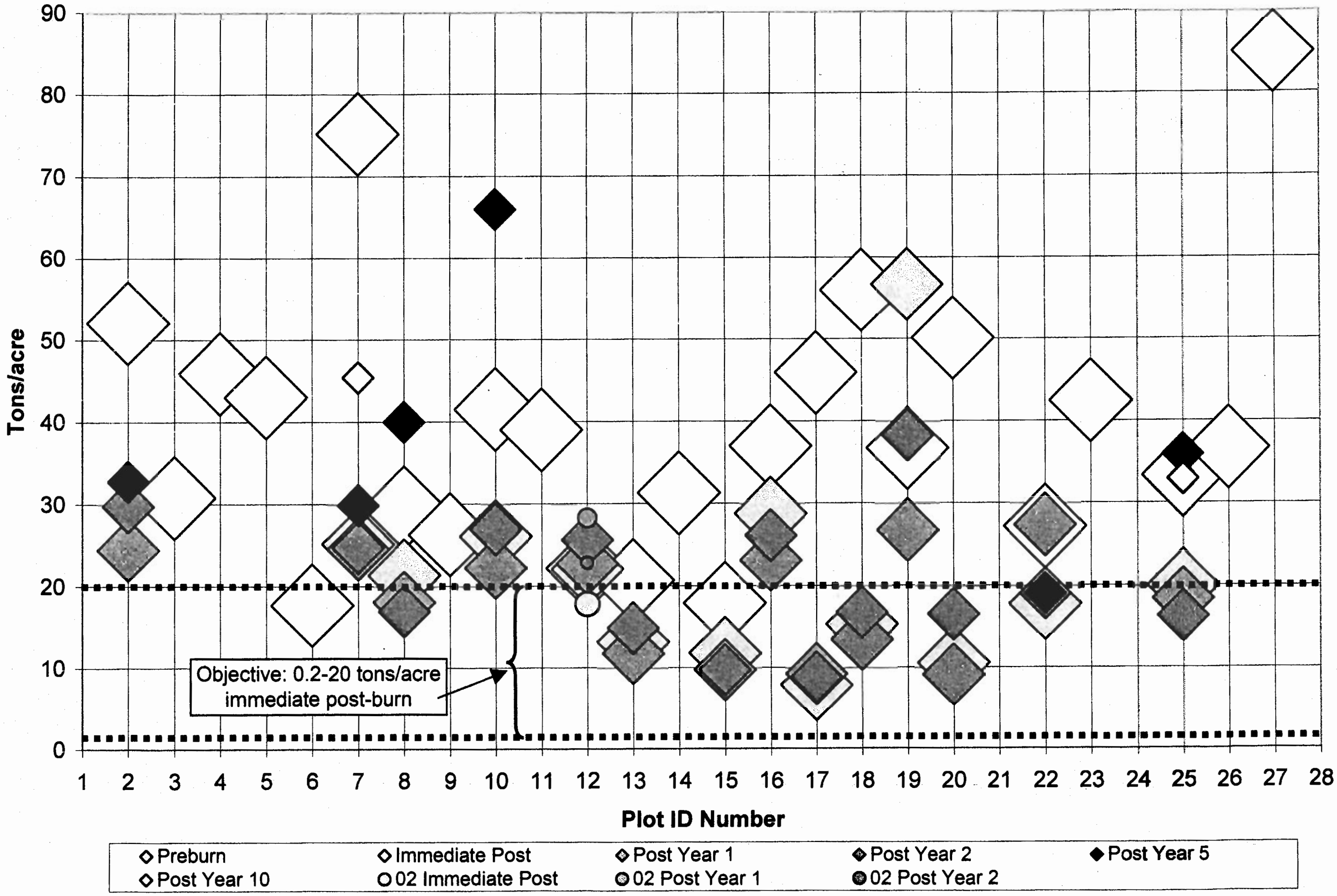


Figure 32. Total Fuel Load, by plot
December 2003
50-foot fuel transects



North Rim Ponderosa Pine with White Fir Encroachment (PIAB)

Figure 33. Total Mean Fuel Load

December 2003

50-foot fuels transects

n = 13, *required minimum pre plots = 7*

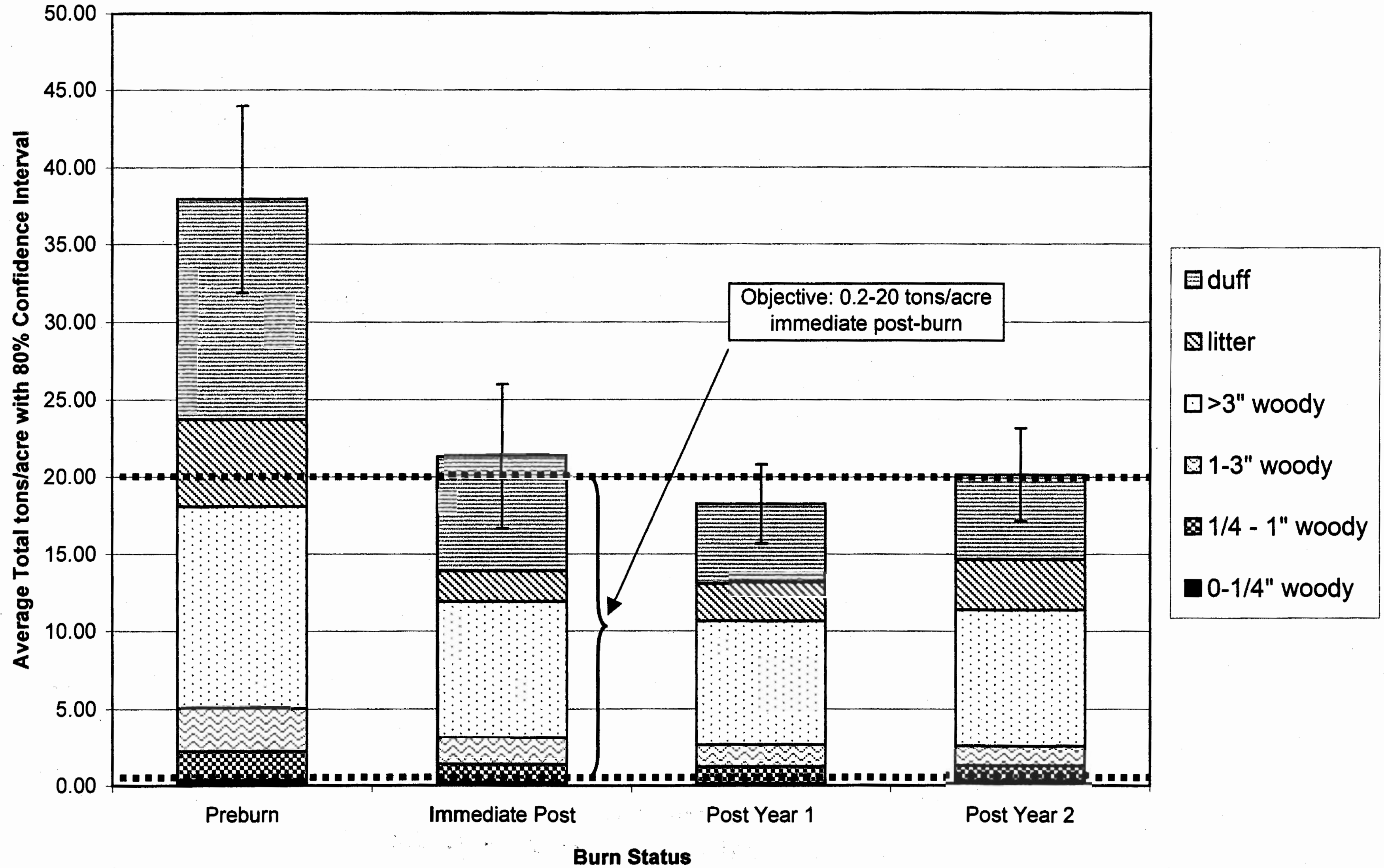


Figure 34. *Abies concolor* Pole Densities, by plot
December 2003

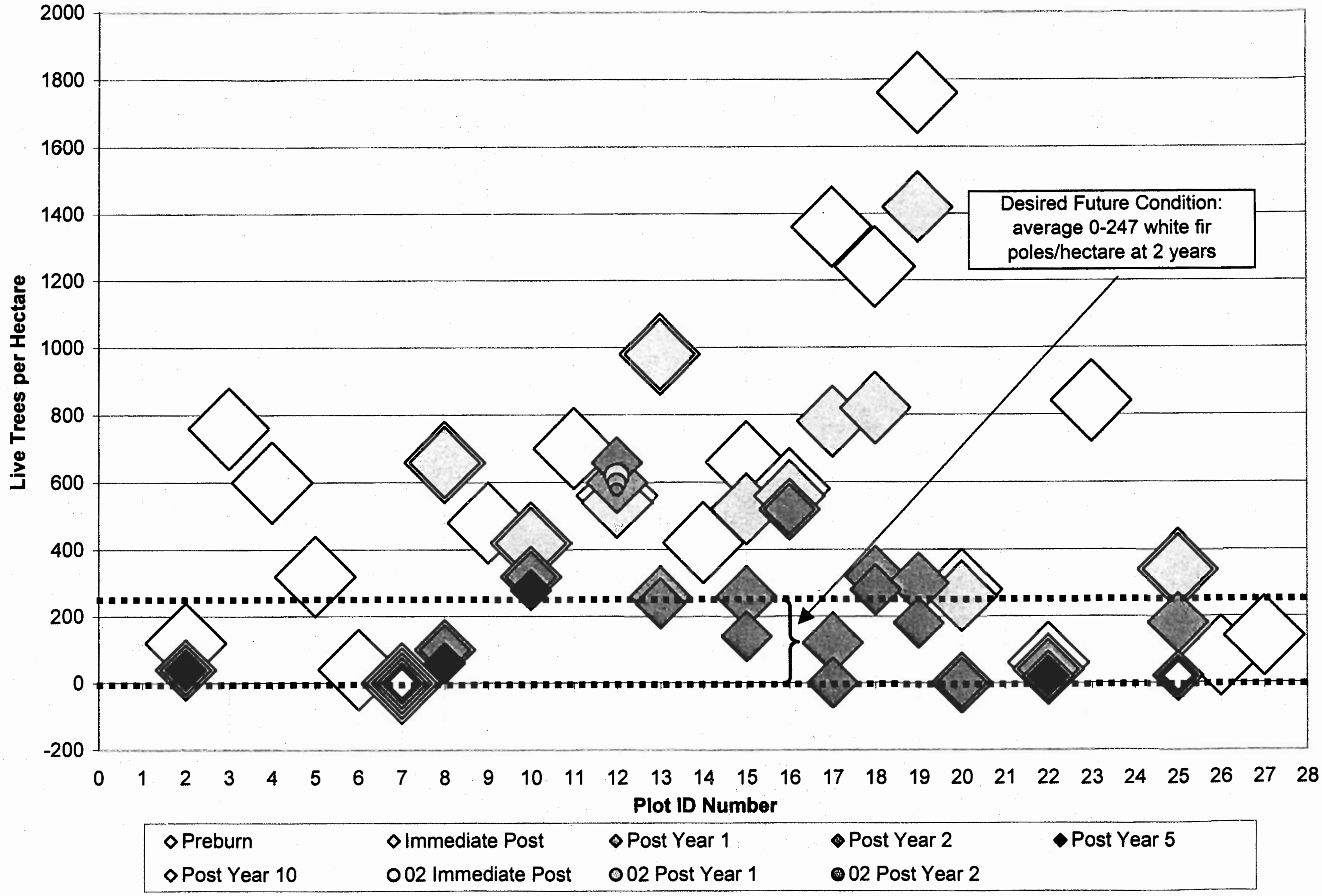


Figure 35. Mean *Abies concolor* Pole Density
December 2003
n = 14, *required minimum pre plots = 27*

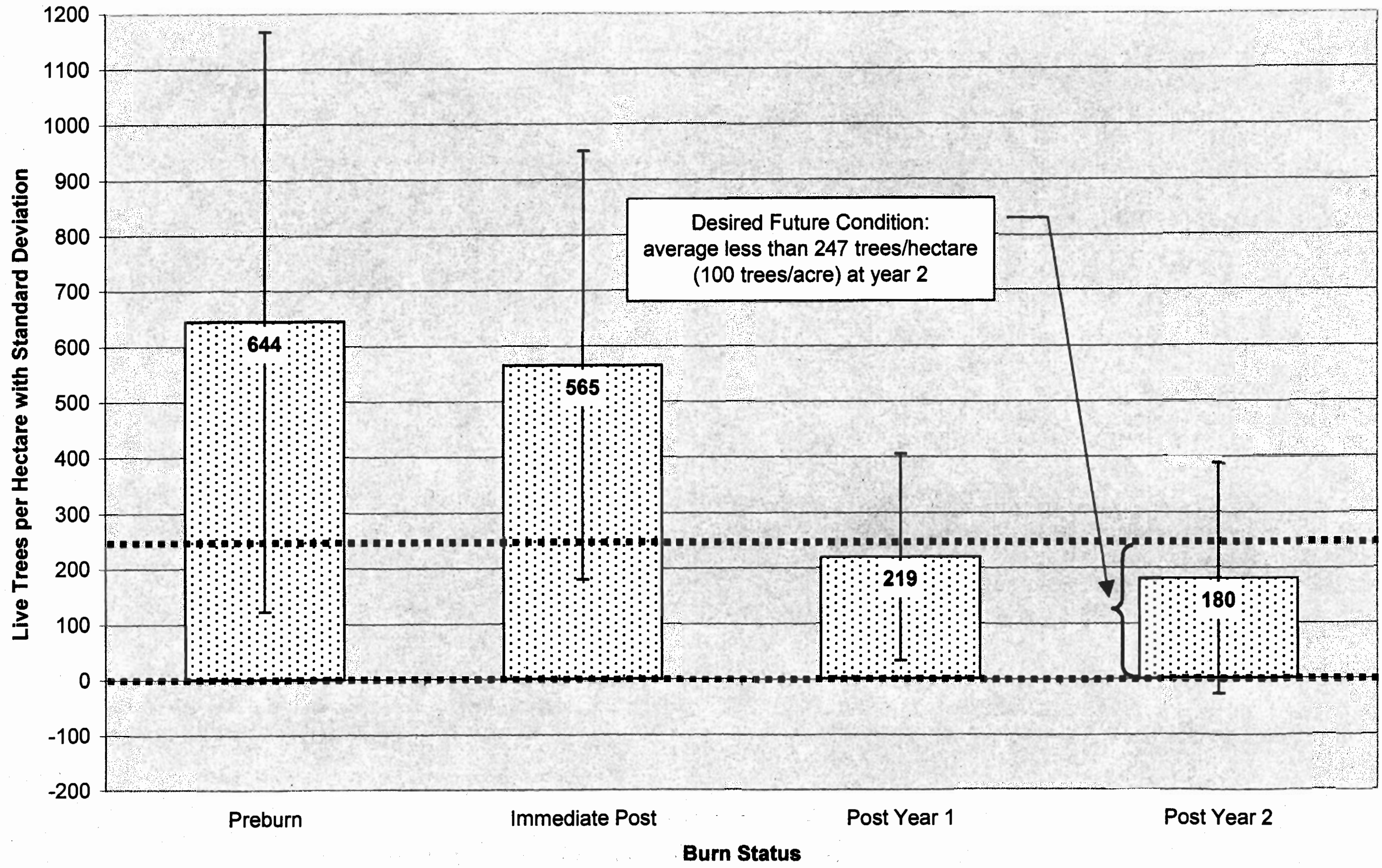


Figure 36. 6 - 15.9" DBH Snag Densities, by plot
December 2003

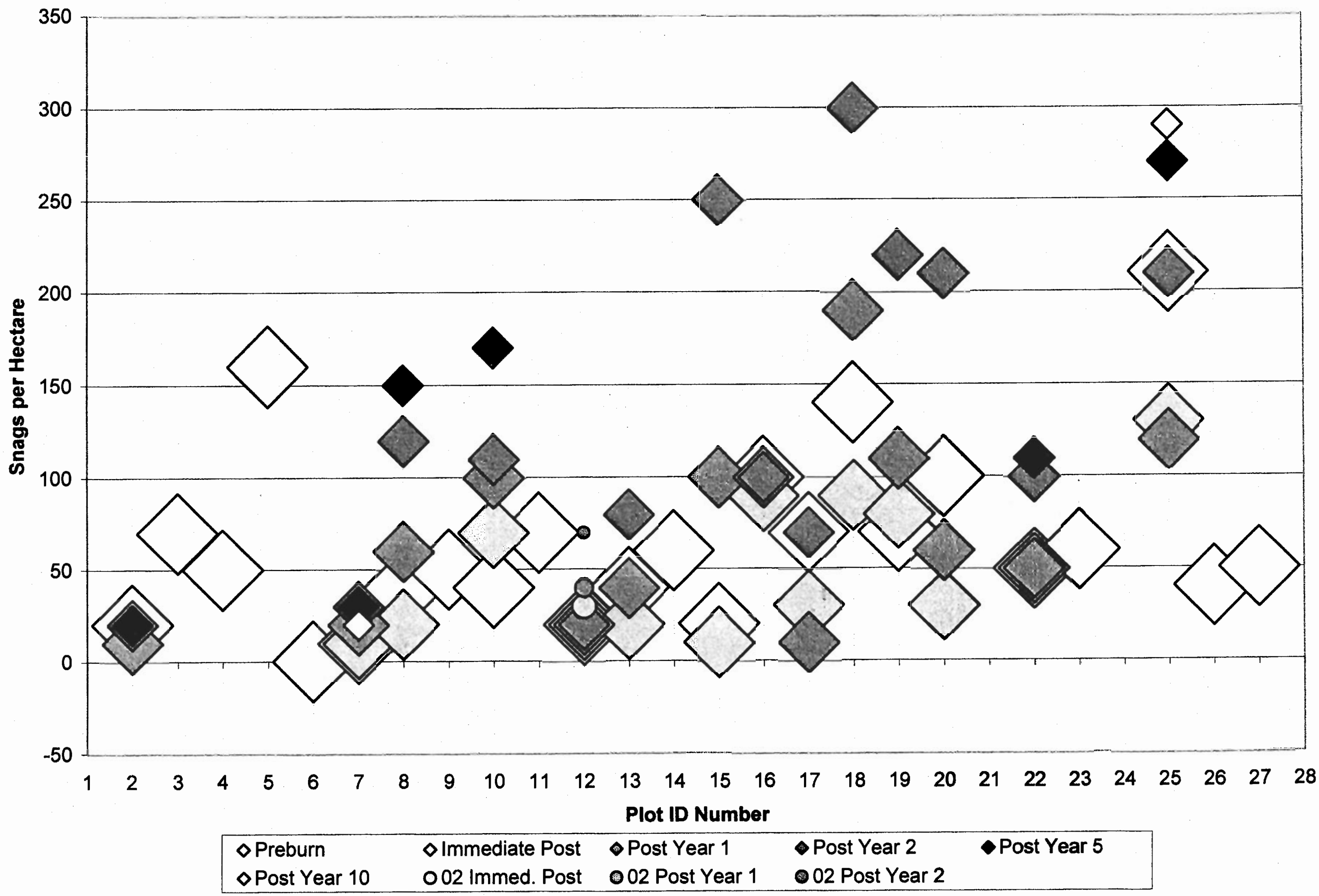
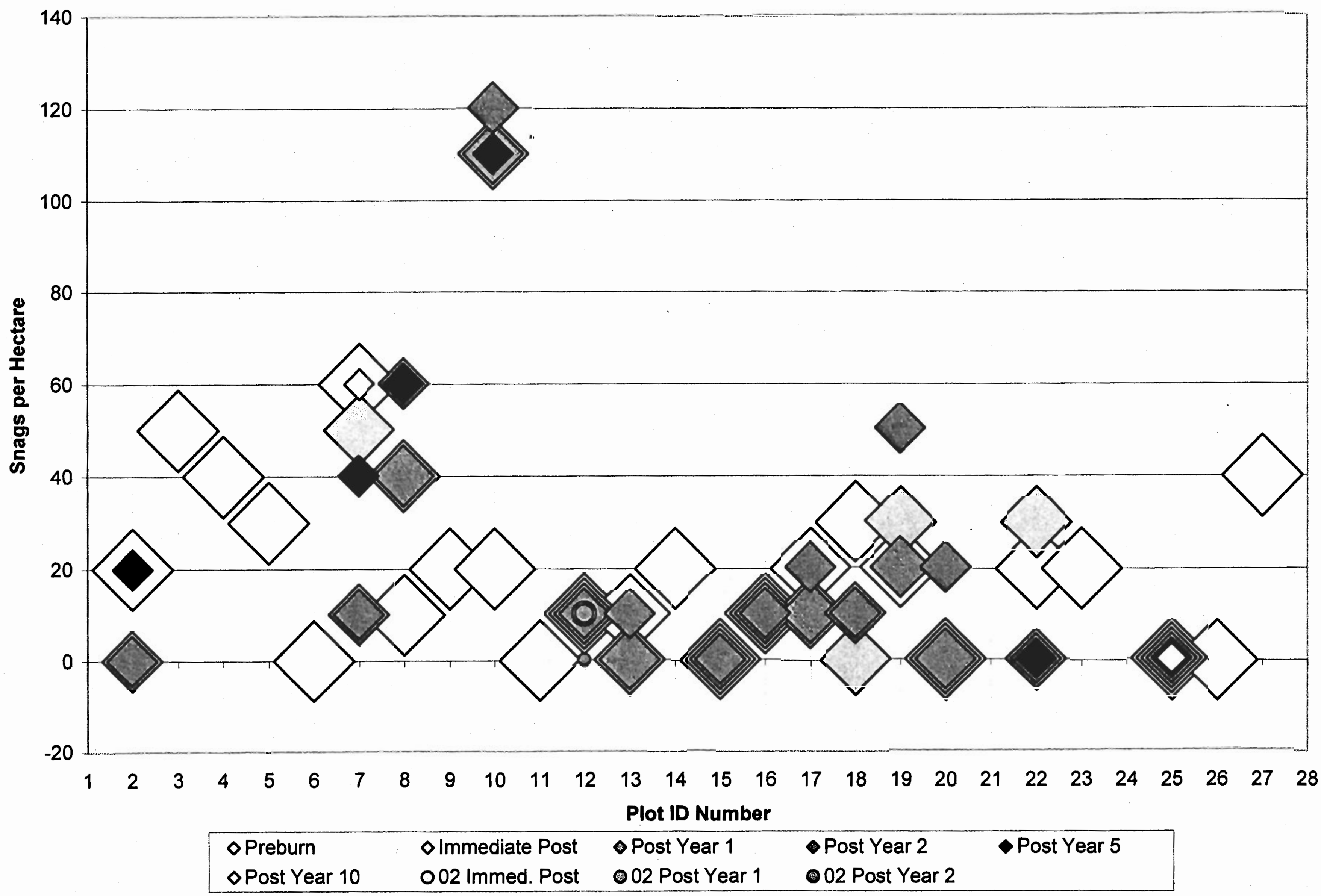


Figure 37. 16" DBH and larger Snag Densities, by plot
December 2003



North Rim Ponderosa Pine with White Fir Encroachment (PIAB)

Figure 38. Mean Snag Density, by size class
December 2003
n = 6; *required minimum pre plots = 34 (>=16"), 25 (6-15.9")*

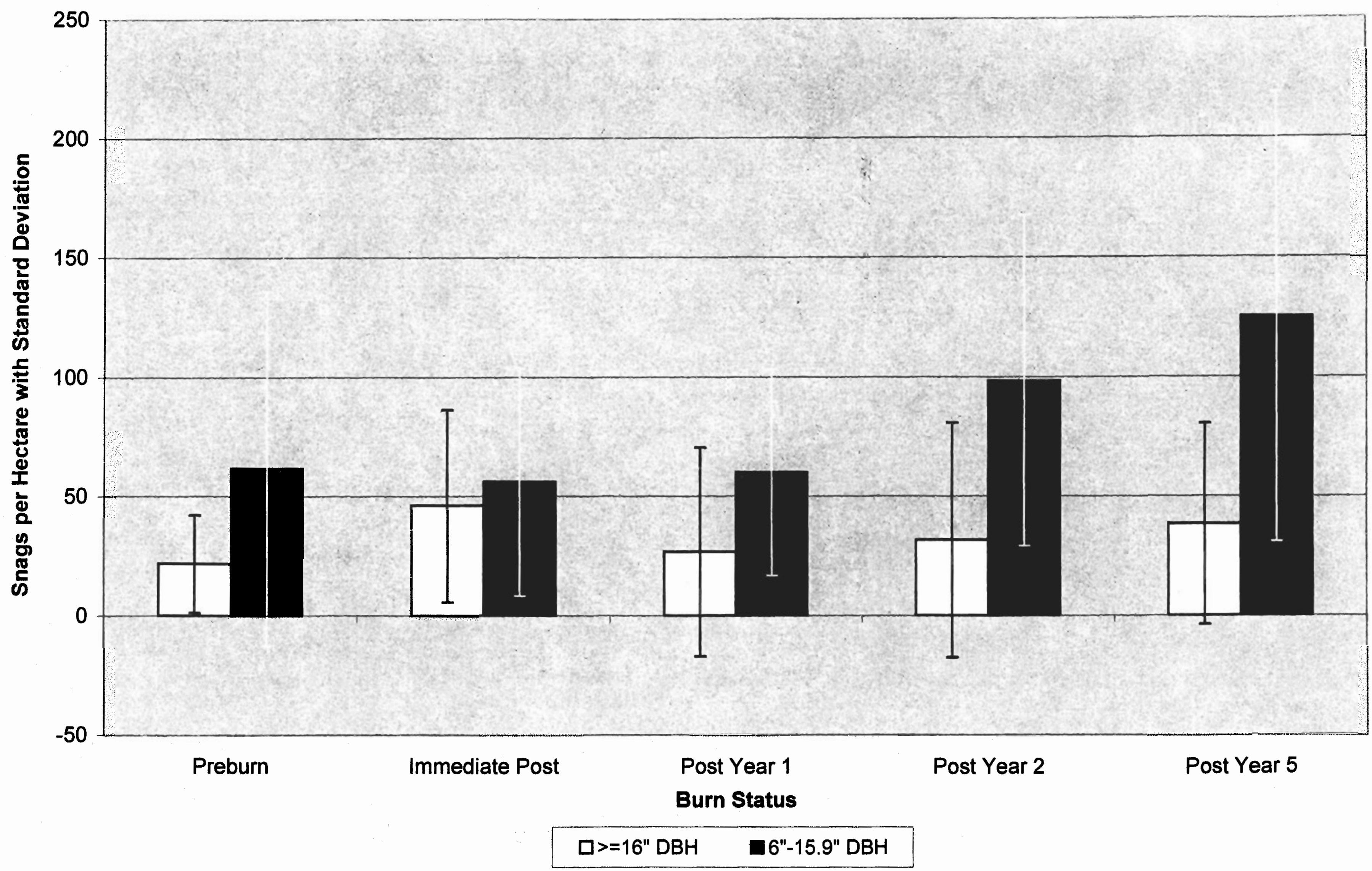


Figure 39. *Abies concolor* Seedling Densities, by plot
December 2003

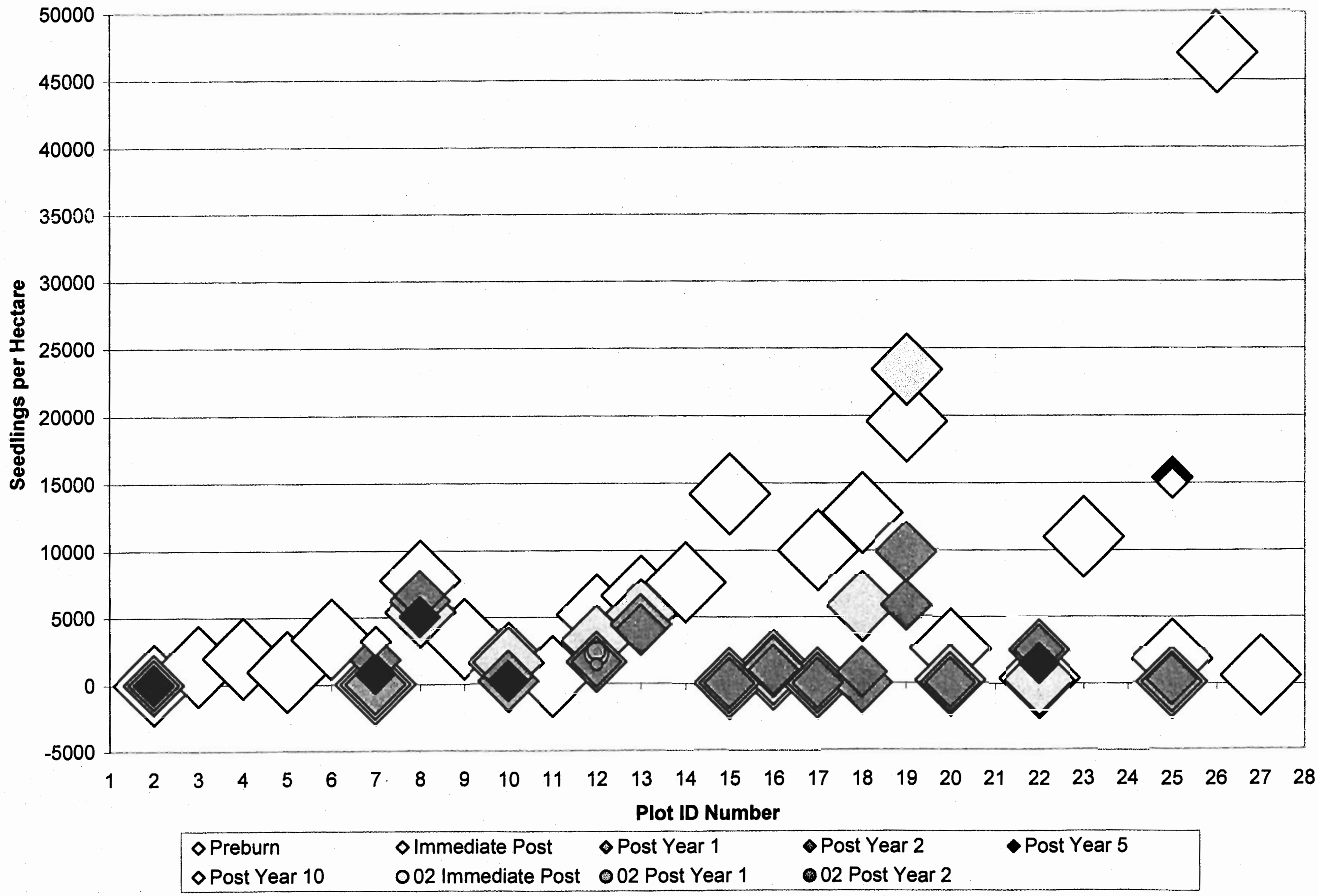


Figure 40. *Pinus ponderosa* Seedling Densities, by plot
December 2003

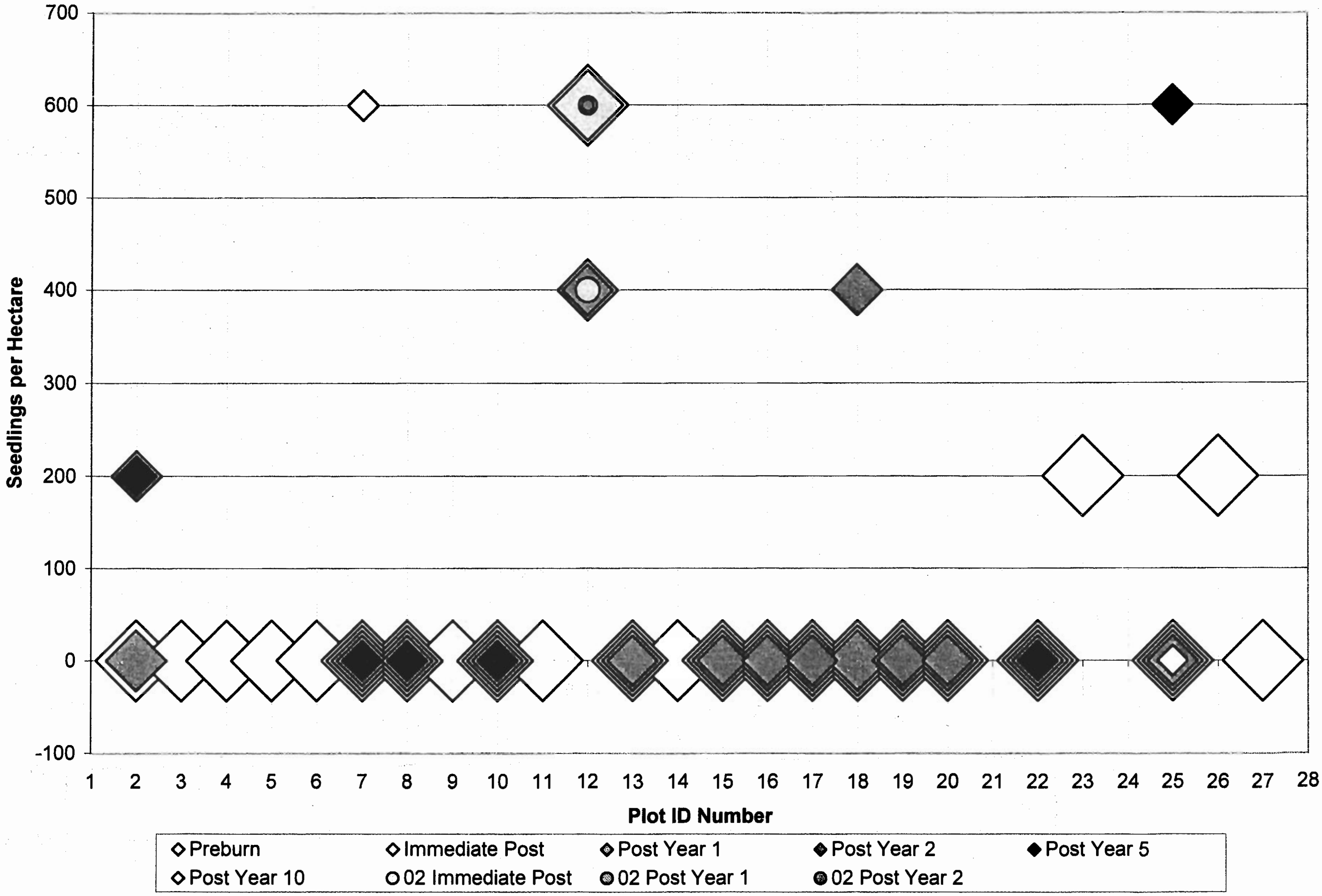
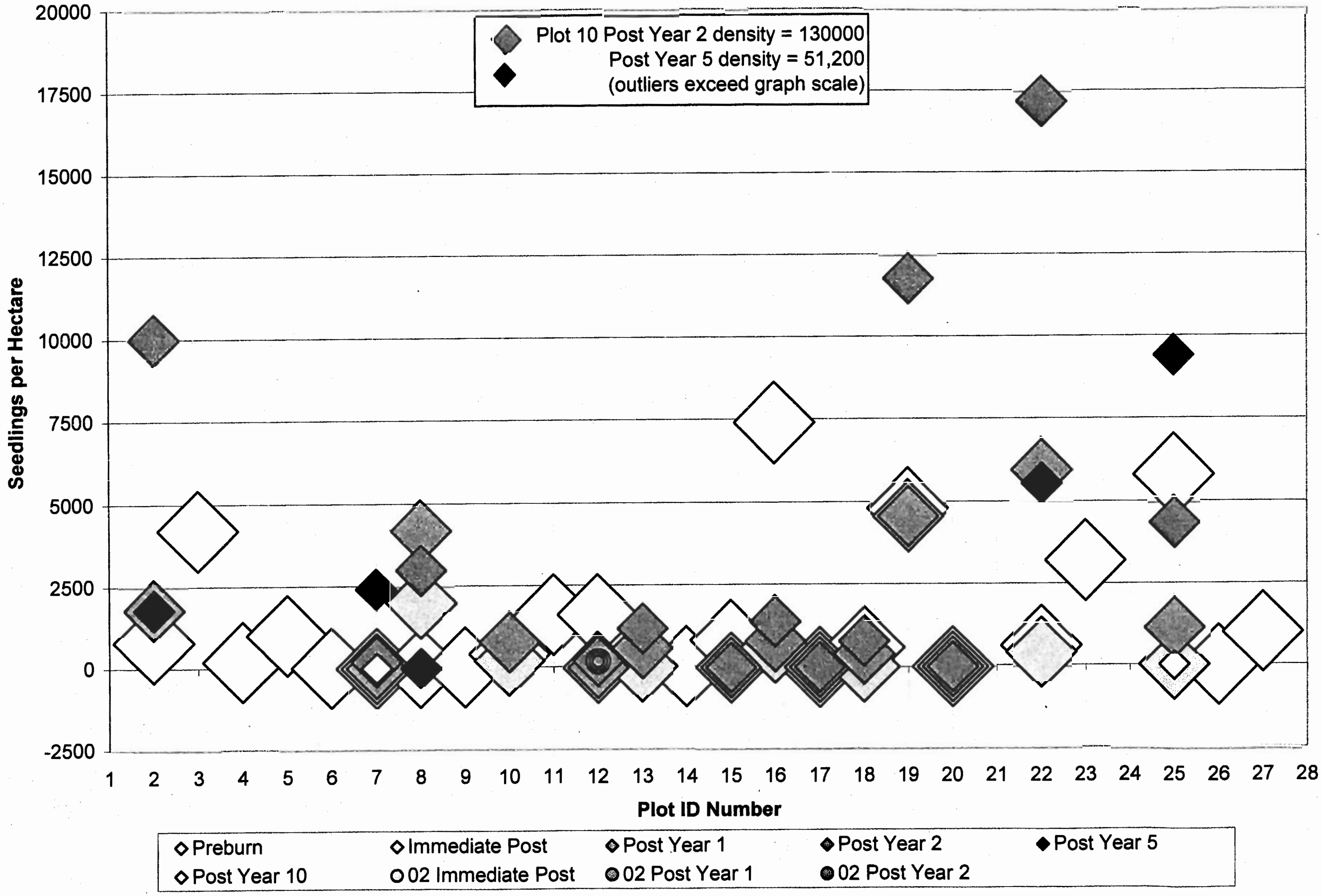


Figure 41. ***Populus tremuloides*** **Seedling Densities, by plot**
December 2003



SUMMARY OF RESULTS

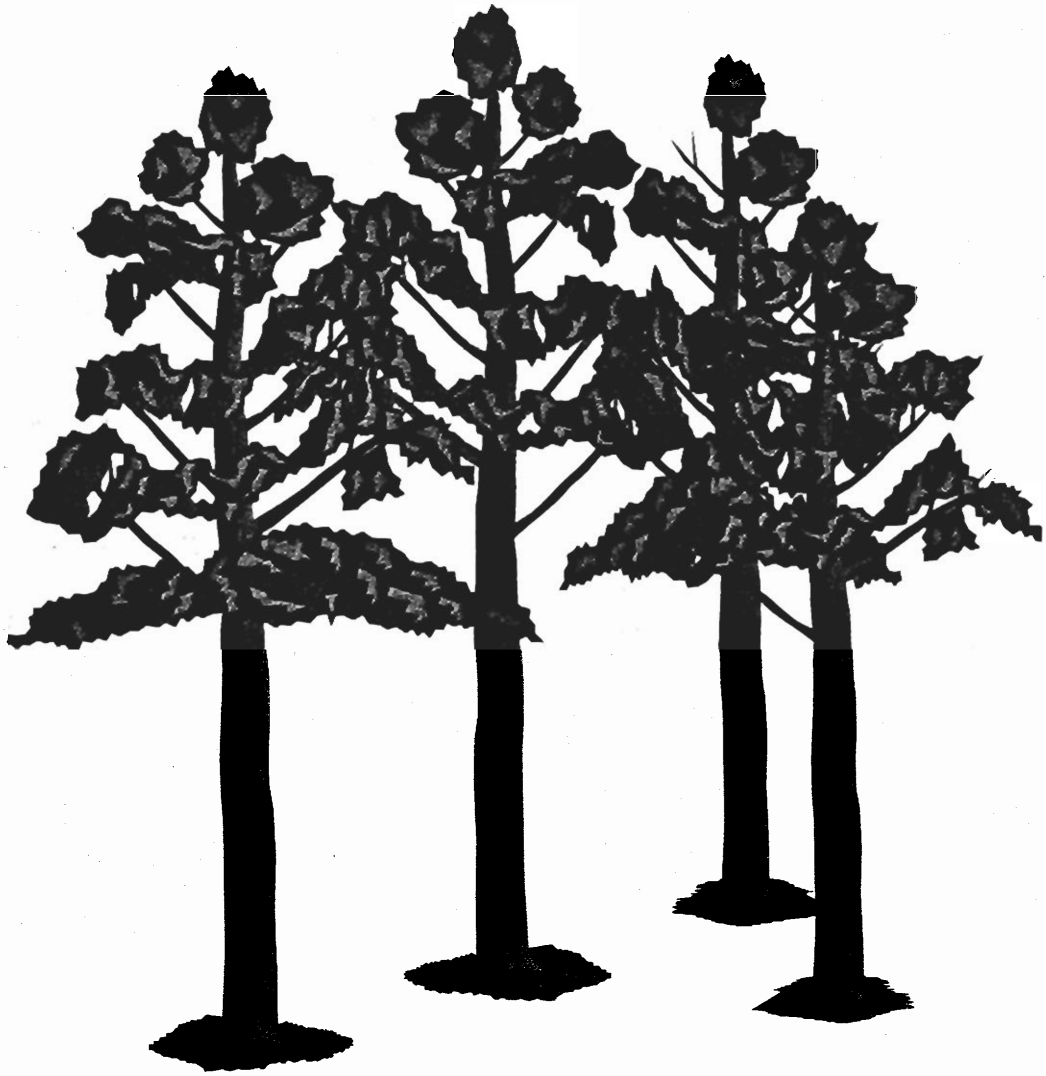
Table 12 shows results for all variables that have specific monitoring objectives identified in FMH-4s. After over 15 years of fire monitoring, nine variables can finally be assessed with our minimum level of statistical confidence, and seven objectives can be accurately measured. This does not mean the plots have not been installed. In most cases, the minimum pre-burn number of plots is there, but the plots may not have burned, or they may have been burned only recently. Therefore, data to assess overstory at five years post-burn are not collected yet. Although we have only met four of our stated burn objectives (total fuel load and overstory density for PIPO & PIED), we are headed in the right direction on fuel loading for both PIPN and PIAB, as well as overstory for PIPN. Another entry in the burn cycle will hopefully reduce fuels to desired levels. With several more years of Year 5 data, PIAB overstory densities may soon be available. Future installs in PIEN will show whether we're on target with that monitoring type. Monitoring pole densities with any confidence seems to be prohibitive for all types except PIAB, so trend analysis may be all we are ever able to show for that variable.

This table illustrates the problems that result from not installing plots on schedule, as well as turnover in management staff resulting in changing burn priorities. If more plots had been installed in past years, five-year data would be available today to assess overstory. Similarly, if we had burned the units on schedule based on the previous Long-Range Project Plan, we would have post-burn data on many more plots. Several plots installed in 2001 & 2002 do not now look like they will be burned within three years and will have to be re-read. The effects of delaying plot installs or burns are not immediately apparent. It may be years after the burn when the data suddenly become important to justify the prescribed fire program, only to find that they are not available for five more years. If prescribed burning becomes a controversial issue in the future, we do not yet have the local data to support this program. This is a serious issue that should be addressed by the GRCA Fire Management staff, the Science Center staff, and the Regional Fire Ecologist.

Table 12. Summary of Results for variables with specific objectives.

Monitoring Type	Variable	Minimum Samples Achieved? Y/N	Objective Achieved? Y/N/Unknown
PIED	Fuel Load	Y	Y
	Overstory (JUOS, PIED)	Y	Y
PIPO	Overstory (PIPO)	Y	Y
	Fuel Load	Y	Y
	Poles (PIPO)	N	Unknown
PIPN	Overstory (PIPO)	Y	N
	Fuel Load	Y	N
	Poles (PIPO)	N	Unknown
PIAB	Overstory (PIPO)	Y	Unknown
	Fuel Load	Y	N
	Poles (ABCO)	N	Unknown
PIEN	Fuel Load	Y	Unknown

Appendix A. FMH-4 Monitoring Type Descriptions



FMH-4 MONITORING TYPE DESCRIPTION SHEET
Grand Canyon National Park

Monitoring Type Code: FPIED1D02

Monitoring Type Name: Great Basin Conifer Woodland

Prepared by: Duhnkrack, Schroeder, Kuenzi, Kaplan in 1991 and 1993

Updated by: Tonja Opperman and Ken Kerr

Date: December 18, 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%

MONITORING VARIABLES IN ORDER OF IMPORTANCE

1. Fuel Loading

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

See FMH-4 Data Analysis Checklist

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 Note: DRC on JUOS trees with multiple stems >2/tree.	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	√	

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: December 18, 1999, Updated 11/24/00

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 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 14-18 overstory trees per acre (35-44 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

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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.

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). A postburn increase in fuel loads is acceptable after the initial prescribed fire treatments.

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. Prescription element ranges and treatment objectives developed using past experience, BEHAVE program, and FOFEM program.

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%

MONITORING VARIABLES IN ORDER OF IMPORTANCE

1. Overstory density
2. Fuel Load
3. Pole density

PRESCRIBED FIRE PROJECT OBJECTIVES—First Entry Burn

Immediately Post-Burn:

1. Reduce total fuel load by at least 30% on average, as measured over the landscape immediately post-burn (fuel reduction efforts will continue until the Desired Future Condition of 0.2-9.3 tons/acre is achieved).
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. Achieve and maintain a five-year post-burn density of 19-25 trees/acre of *Pinus ponderosa* in the 16"+ 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. 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
See FMH-4 Data Analysis Checklist

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	
Note: DRC for multiple-stemmed JUOS >2 stems/tree.	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	√	

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: December 18, 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[2], 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 *Robinia neomexicana*, *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, and areas with >50% canopy cover of Robinia neomexicana.

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

[2] 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.

there were 40-55 trees/acre (99-136 trees/ha) on the Kaibab Plateau during presettlement times. 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. Fuel loads ranged from 0.2 to 9.3 tons/acre (0.5-23 tons/ha) (Covington 1992). An increase in postburn fuel loads is acceptable after the initial prescribed fire treatments.

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. Prescription element ranges and objectives were developed using past experience, BEHAVE program, and FOFEM program.

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%

MONITORING VARIABLES IN ORDER OF IMPORTANCE

1. Overstory density
2. Fuel Load
3. Pole density

PRESCRIBED FIRE PROJECT OBJECTIVES—First Entry Burn

Immediately Post-Burn:

1. Reduce total fuel load by at least 30% on average, as measured over the landscape immediately post-burn (fuel reduction efforts will continue until the Desired Future Condition of 0.2-9.3 tons/acre is achieved).
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. Achieve and maintain a five-year post-burn density of 19-25 trees/acre of *Pinus ponderosa* in the 16"+ 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

See FMH-4 Data Analysis Checklist

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: December 18, 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[3] *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

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[3] 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.

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, but are likely greater than the PIPN forest type to the south. A conservative estimate for desired average fuel load is 0.2 to 20 tons/acre, but this figure should be revised as new information is available. Pole density figures for this forest type are also unknown, but again, are likely to be more dense than the drier forests to the south.

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. Prescription element ranges and objectives were developed using past experience, BEHAVE program, and FOFEM program.

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%

MONITORING VARIABLES IN ORDER OF IMPORTANCE

1. Overstory density
2. Fuel Load
3. Pole density

PRESCRIBED FIRE PROJECT OBJECTIVES—First Entry Burn

Immediately Post-Burn:

1. Reduce total fuel load by at least 30% on average, as measured across the landscape immediately post-burn (fuel reduction efforts will continue until the Desired Future condition of 0.2 to 20 tons/acre (average) is achieved).
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 less than 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. Achieve and maintain a five-year post-burn density of 19-25 trees/acre of *Pinus ponderosa* in the 16"+ 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

See FMH-4 Data Analysis Checklist

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

FMH-4

MONITORING TYPE DESCRIPTION SHEET

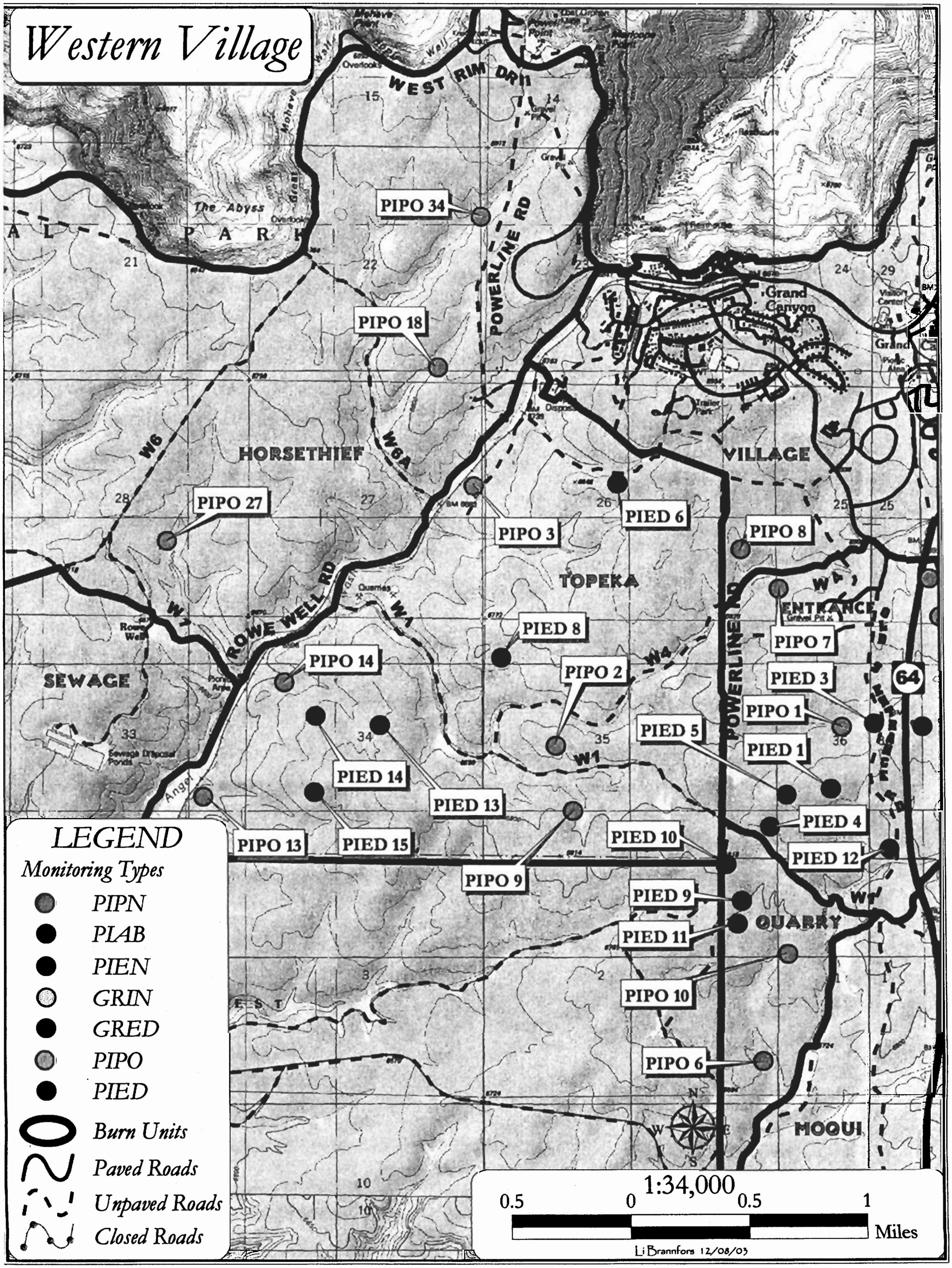
Monitoring Type Code:* F P I E N 1 D 1 0 **Date Described:** 01/25/93
Monitoring Type Name Rocky Mountain Subalpine Conifer Forest
Preparers (RxFS/RxFT): Duhnkrack/Schroeder
Burn Prescription: Prescribed fires will be conducted during summer and fall (May-December) to meet management objectives. Both backing and head fires will be used. Prescription parameters are identified in 1992 GRCA Fire Management Plan and include:

RH 20-60 %
Mid-flame Wind Speed 0-6 mph
10hr Time Lag Fuel Moisture 6-15 %
Rate of Spread .3 - 6.8 ch/hr

Burn Goals: Reduction of hazardous fuel accumulations and restoration of natural fire regimes.
Monitoring Type Variables: Fuel loading & overstory tree density.
Physical Description: Located on the North Rim, this monitoring type ranges from 7,500 to 9,165 feet (2,290 to 2,793 meters) elevation. Slopes range from 0 % to greater than 60 % and favors north and northeast aspects at the lower elevations, yet occurs on all aspects at higher elevations. Soils are relatively deep of loamy texture which are derived from Kaibab limestone material.
Biological Description: Vegetative associations 121.3111, 121.3171, and 121.3172 have been idenitified by Warren et al. (1982) adapted from the system of Brown, Lowe, and Pase (1979). *Picea engelmannii, Populus tremuloides and Abies concolor combine to form the main forest canopy. Abies lasiocarpa, Pinus ponderosa* and *Pseudotsuga menziesii* may be present, but to a much lesser degree. The understory is variable, composed of scattered stands of conifer and deciduous pole-sized and seedlings, deciduous shrubs, and evergreen shrubs. Ground cover is also variable to sparse, composed of grasses, sedges, and herbs. Fallen dead timber and deep litter are common on the forest floor.
Rejection Criteria: Initial random areas within 20 meters of large rock outcrops, boundary fences, anamalous vegetation patches, roads, trails, utility corridors, slash piles, or open bare ground. Areas with fuel loading less than 15 tons/acre. Areas within 10 meters of ecotones or transitional vegetative influences including areas void of *Picea engelmannii, Populus tremuloides* and *Abies concolor*. Areas with >50% *Pinus ponderosa* or *Populus tremuloides*. Areas within 10 meters of significant cultural resource features including prehistoric, protohistoric, and historic sites.

* Assign unique 9 character code as described below:
_ Plot Type (F=forest, B=brush, G=grass)
_ _ _ _ _ Dominant Species Alpha Code (see Appendix C of FMH)
_ Burn Period Phenology (phenological stage of key plants affected by and/or carrying the fire):
G=green-up (period of active plant growth)

Appendix B: Maps of FMH Plot Locations



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WEST RIM DR
POWERLINE RD
ROWE WELL RD
POWERLINE RD
HORSETHIEF
VILLAGE
TOPEKA
ENTRANCE
SEWAGE
QUARRY
MOQUI
Grand Canyon
W6
W6A
W7
W4
W1
64
PIPO 34
PIPO 18
PIPO 27
PIPO 3
PIED 6
PIPO 8
PIED 8
PIPO 7
PIPO 14
PIPO 2
PIED 3
PIPO 1
PIED 5
PIED 1
PIED 14
PIED 13
PIED 4
PIPO 13
PIED 15
PIED 10
PIED 12
PIPO 9
PIED 9
PIED 11
PIPO 10
PIPO 6
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
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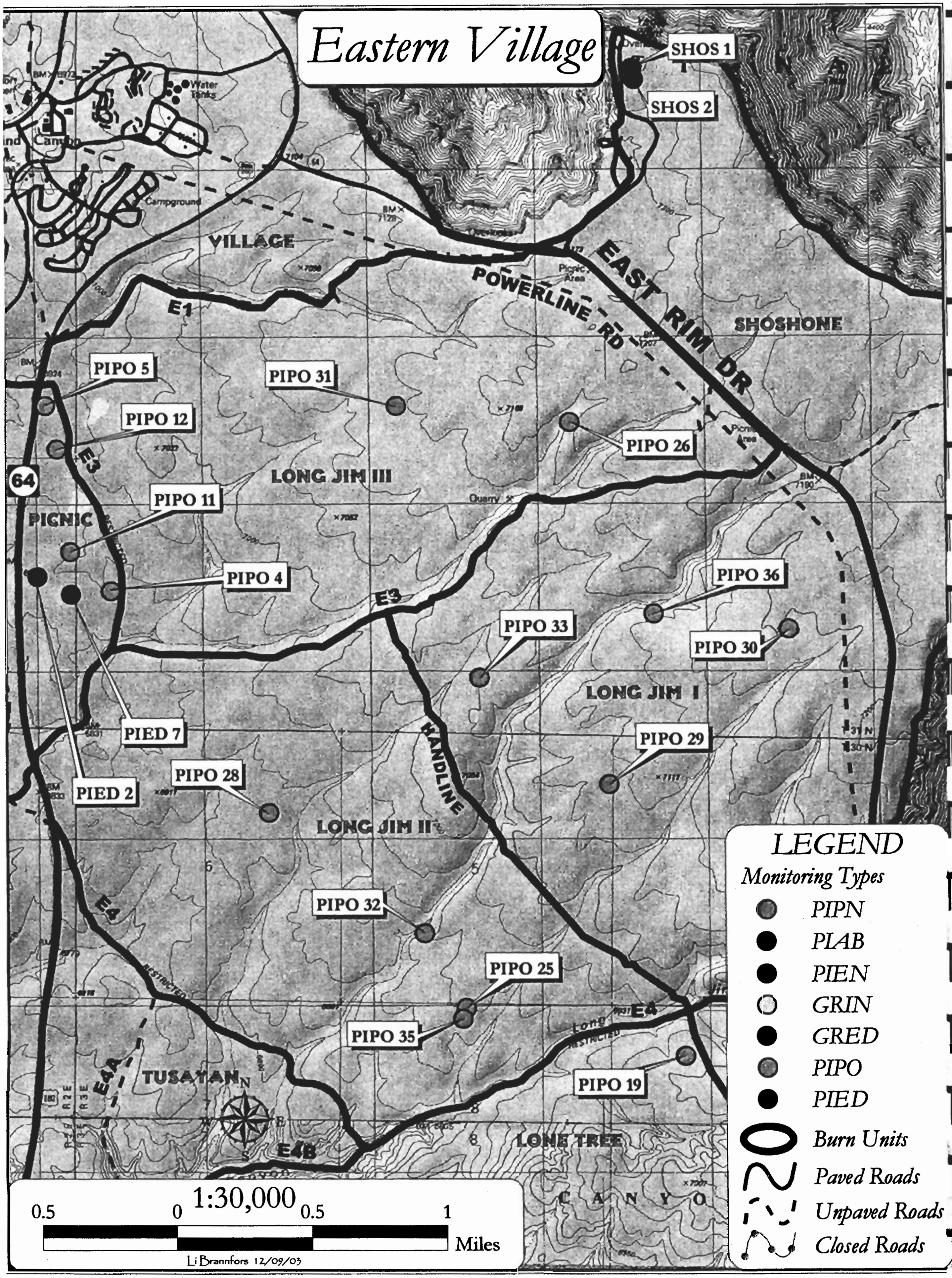
0
0.5
1
Miles
Li Brannfors 12/08/03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SHOS 2
VILLAGE
EAST RIM DR
POWERLINE RD
SHOSHONE
E1
PIPO 5
PIPO 31
PIPO 12
PIPO 26
64
E3
LONG JIM III
PIPO 11
PICNIC
PIPO 4
PIPO 36
E3
PIPO 33
PIPO 30
LONG JIM I
PIED 7
HANDLINE
PIPO 29
PIPO 28
PIED 2
LONG JIM II
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
PIPO 32
E4
PIPO 25
E4
PIPO 35
PIPO 19
E4A
TUSAYAN
E4B
LONE TREE
CANYO
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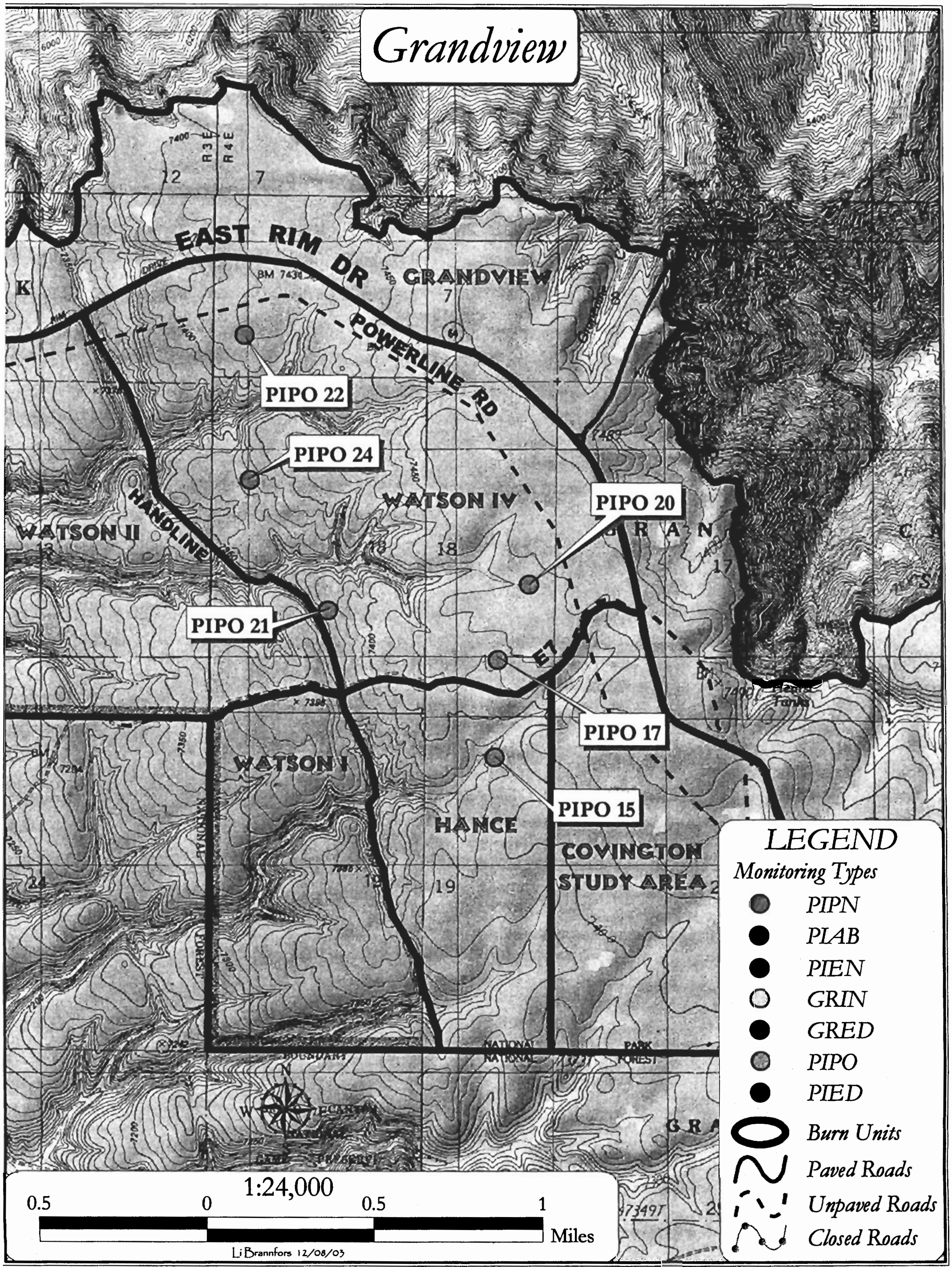
0.5
1
Miles
Li Brannfors 12/09/03


Grandview
EAST RIM DR
GRANDVIEW
POWERLINE RD
HANDLINE
WATSON II
WATSON IV
WATSON I
HANCE
COVINGTON
STUDY AREA
PIPO 22
PIPO 24
PIPO 20
PIPO 21
PIPO 17
PIPO 15
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
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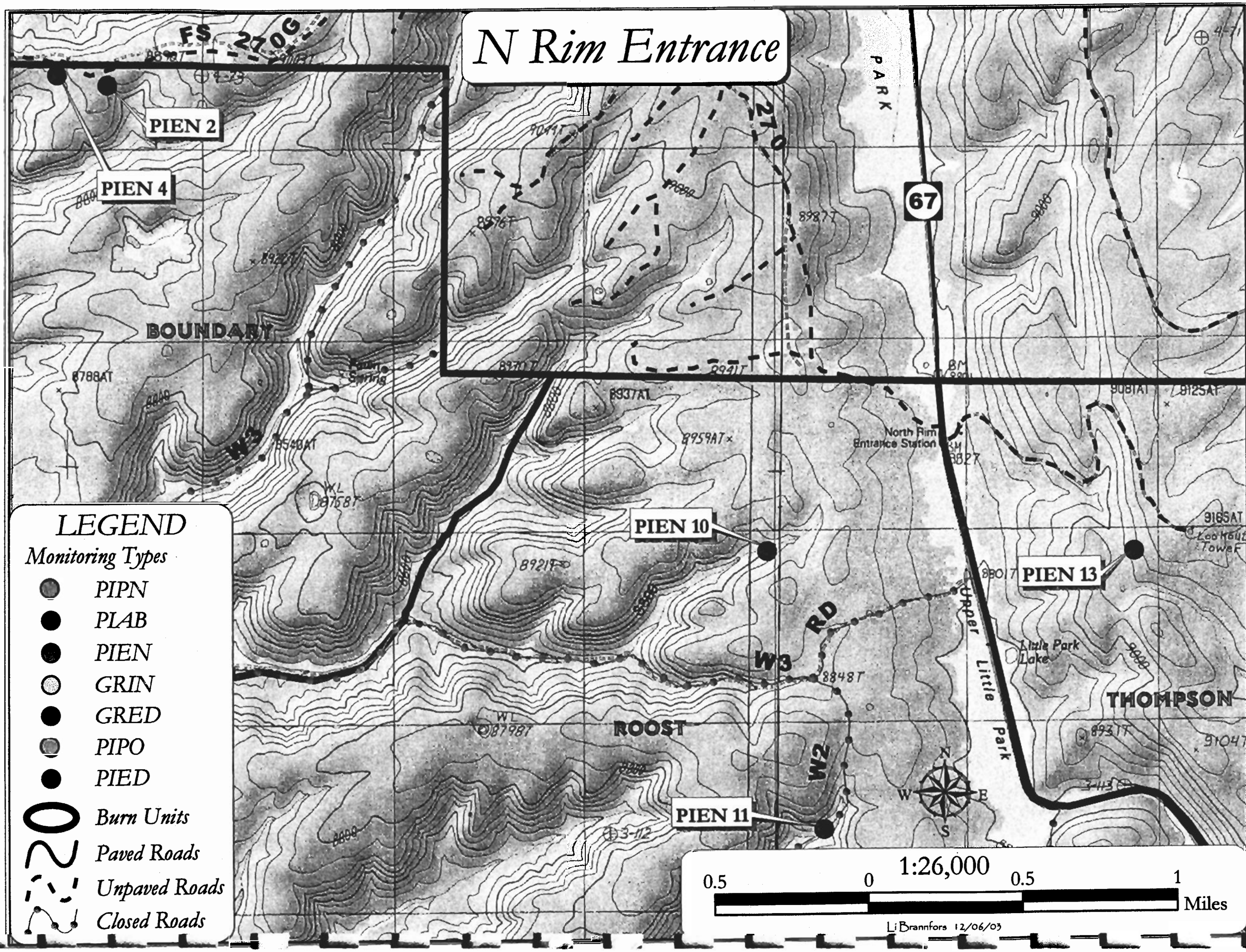
0
0.5
1
Miles
Li Brannfors 12/08/03



N Rim Entrance
PARK
67
270
FS 270G
PIEN 2
PIEN 4
BOUNDARY
PIEN 10
PIEN 13
PIEN 11
North Rim Entrance Station
Upper Little Park
RD
W3
W2
ROOST
THOMPSON
Little Park Lake
Lookout Tower
LEGEND
Monitoring Types
PIPN
PLAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
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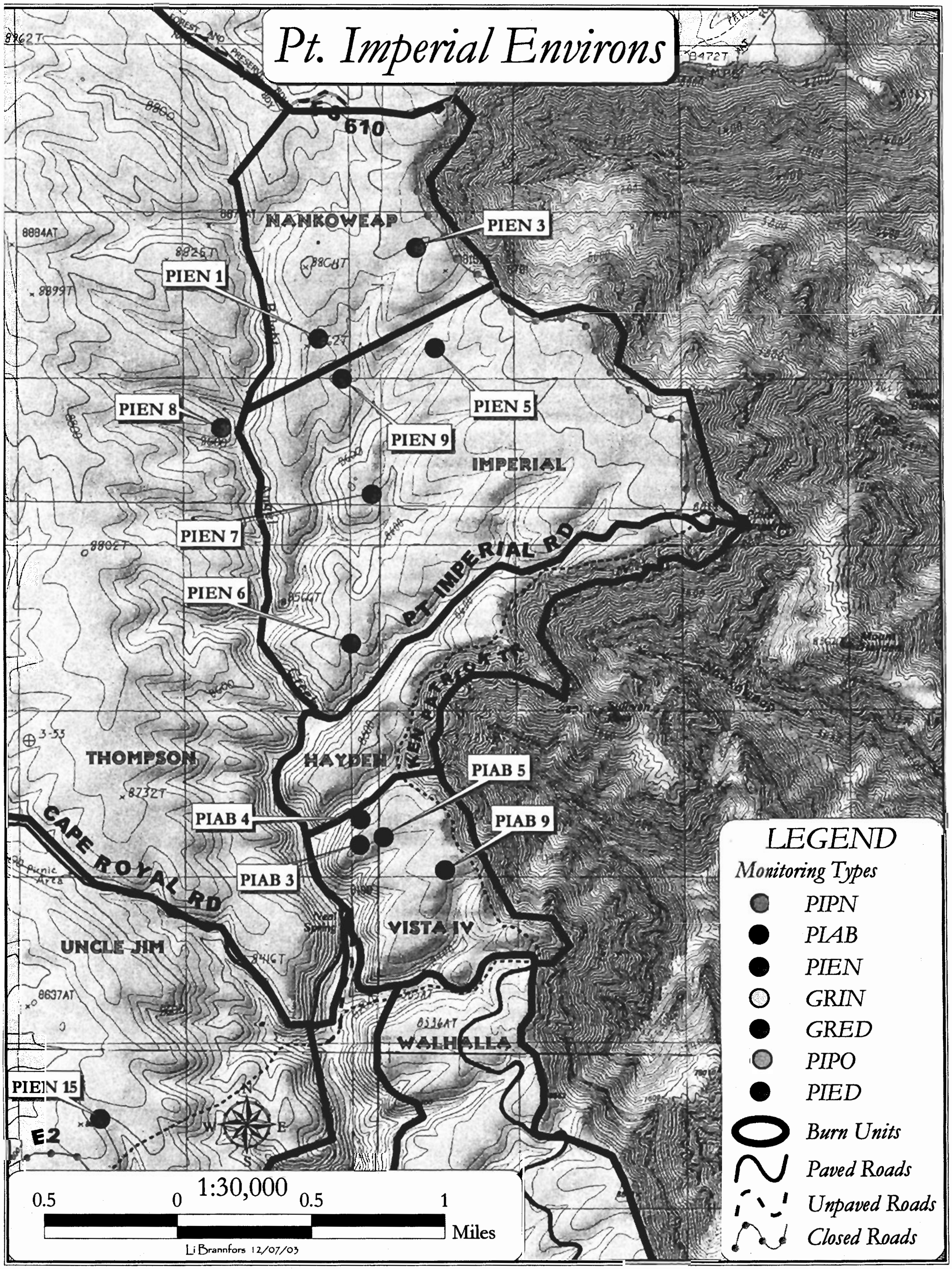
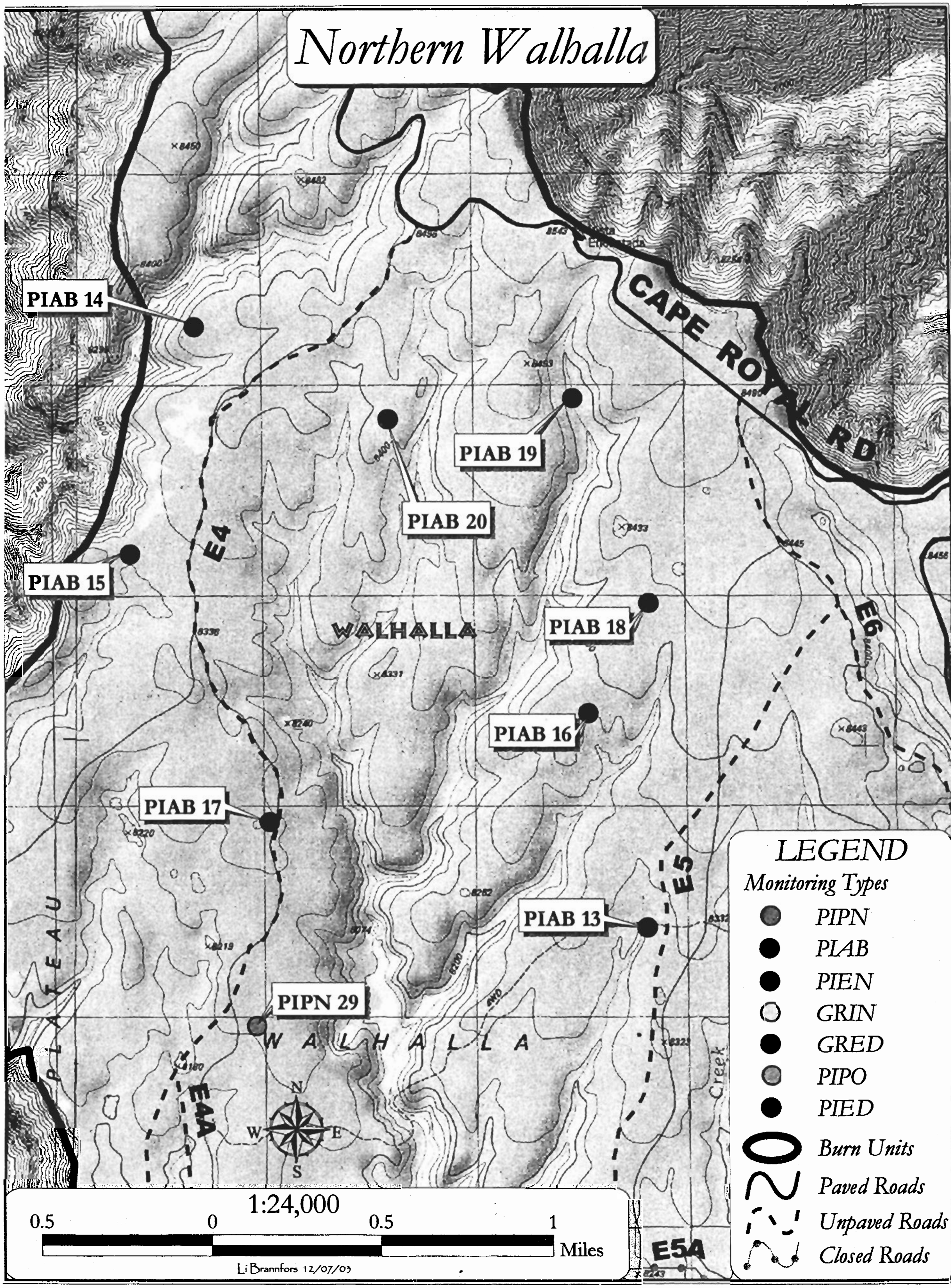
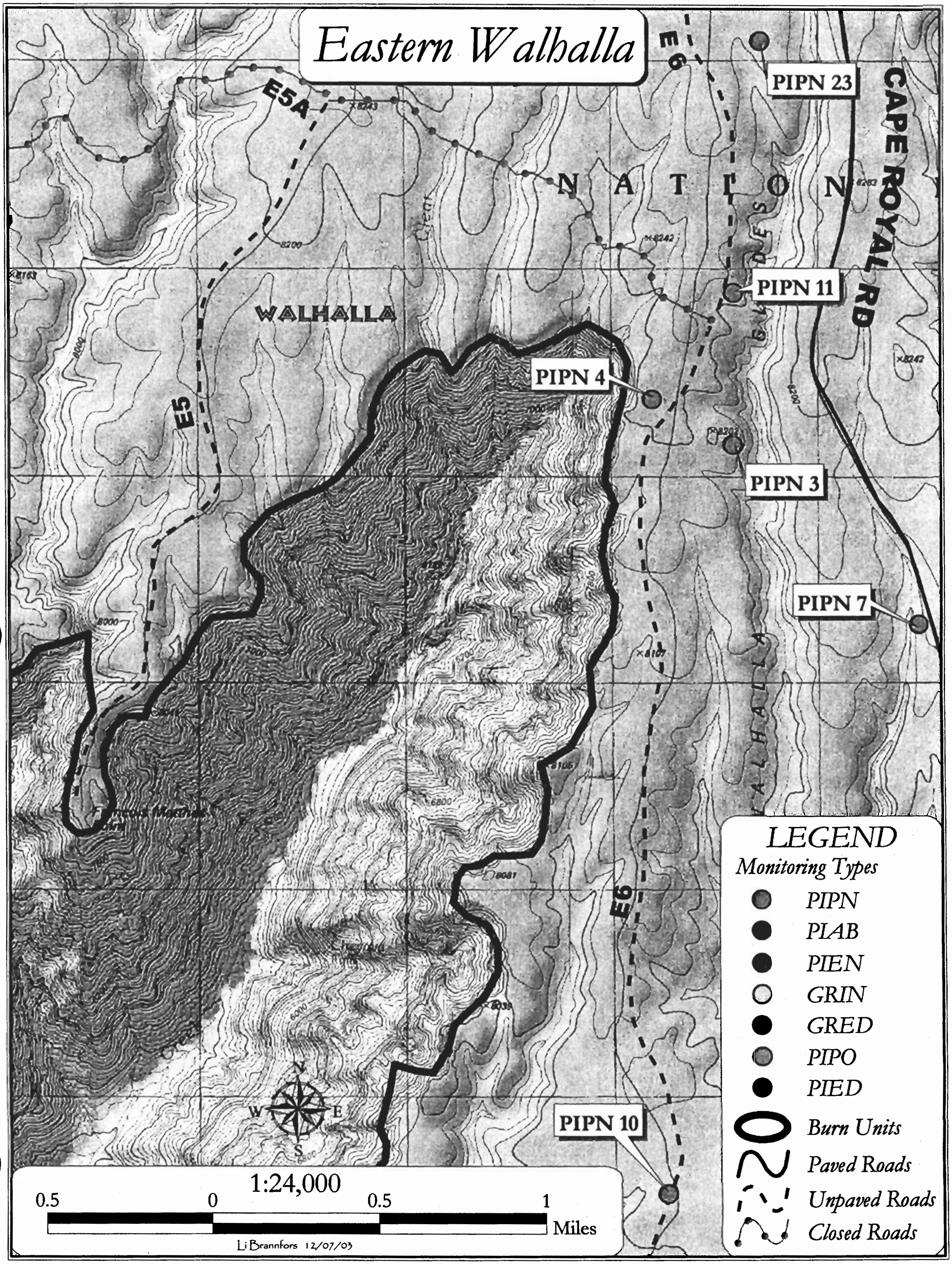
0
0.5
1
Miles
Li Brannfors 12/06/03



Pt. Imperial Environs
610
NANKOWEAP
PIEN 3
PIEN 1
PIEN 8
PIEN 5
PIEN 9
IMPERIAL
PIEN 7
PT. IMPERIAL RD
PIEN 6
KEN PATRICK TR
THOMPSON
HAYDEN
PIAB 5
PIAB 4
PIAB 9
PIAB 3
CAPE ROYAL RD
UNCLE JIM
VISTA IV
WALHALLA
PIEN 15
E2
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
1:30,000
0.5
0
0.5
1
Miles
Li Brannfors 12/07/03



Northern Walhalla
CAPE ROYAL RD
PIAB 14
PIAB 19
PIAB 20
PIAB 15
PIAB 18
WALHALLA
PIAB 16
PIAB 17
PIAB 13
PIPN 29
W A L H A L L A
PLATEAU
E4
E4A
E5
E5A
E6
Creek
N
W
E
S
1:24,000
0.5
0
0.5
1
Miles
Li Brannfors 12/07/03
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads


Eastern Walhalla
E5A
E6
E5
PIPN 23
PIPN 11
PIPN 4
PIPN 3
PIPN 7
PIPN 10
CAPE ROYAL RD
WALHALLA
N A T I O N
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
1:24,000
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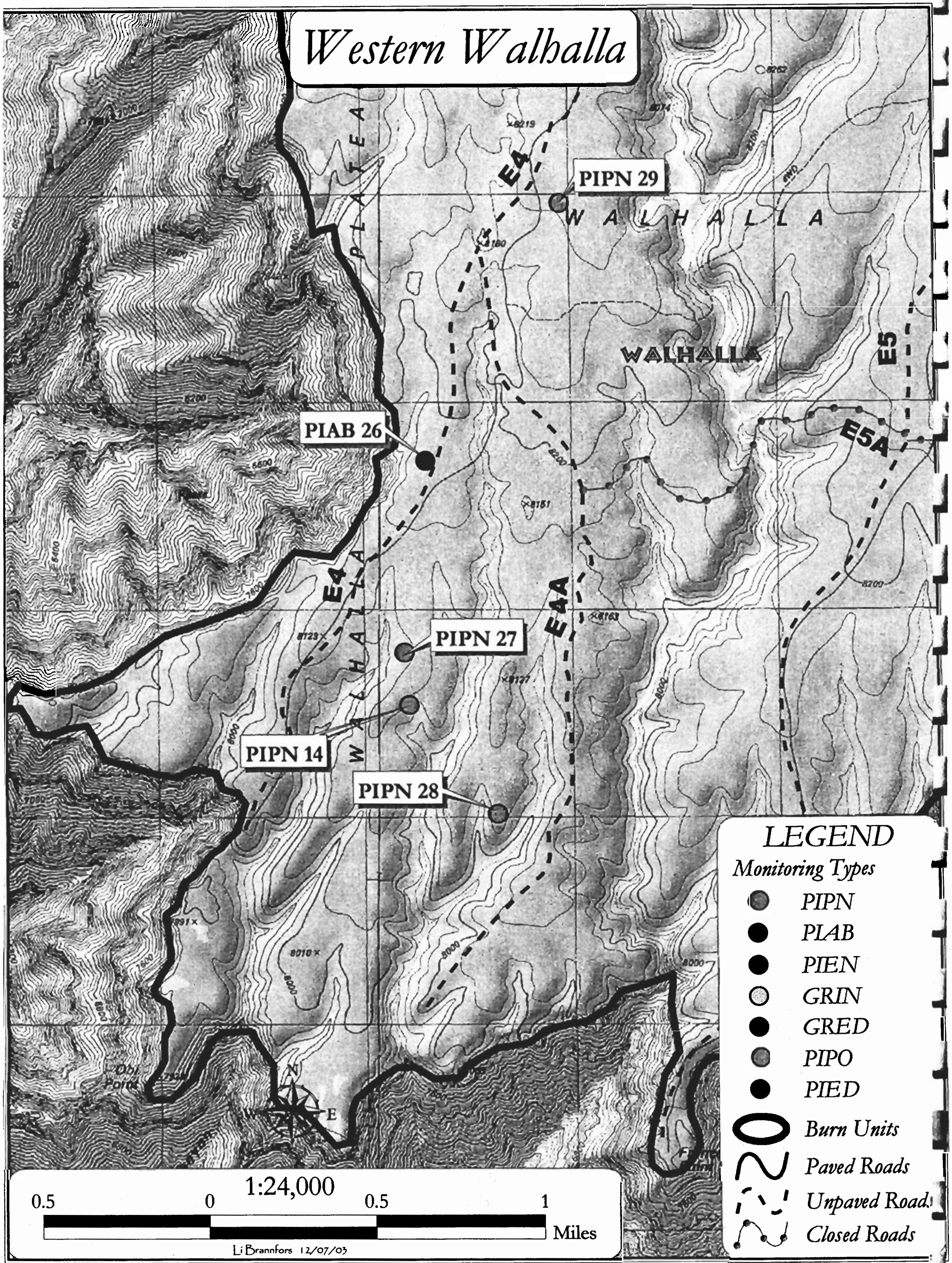
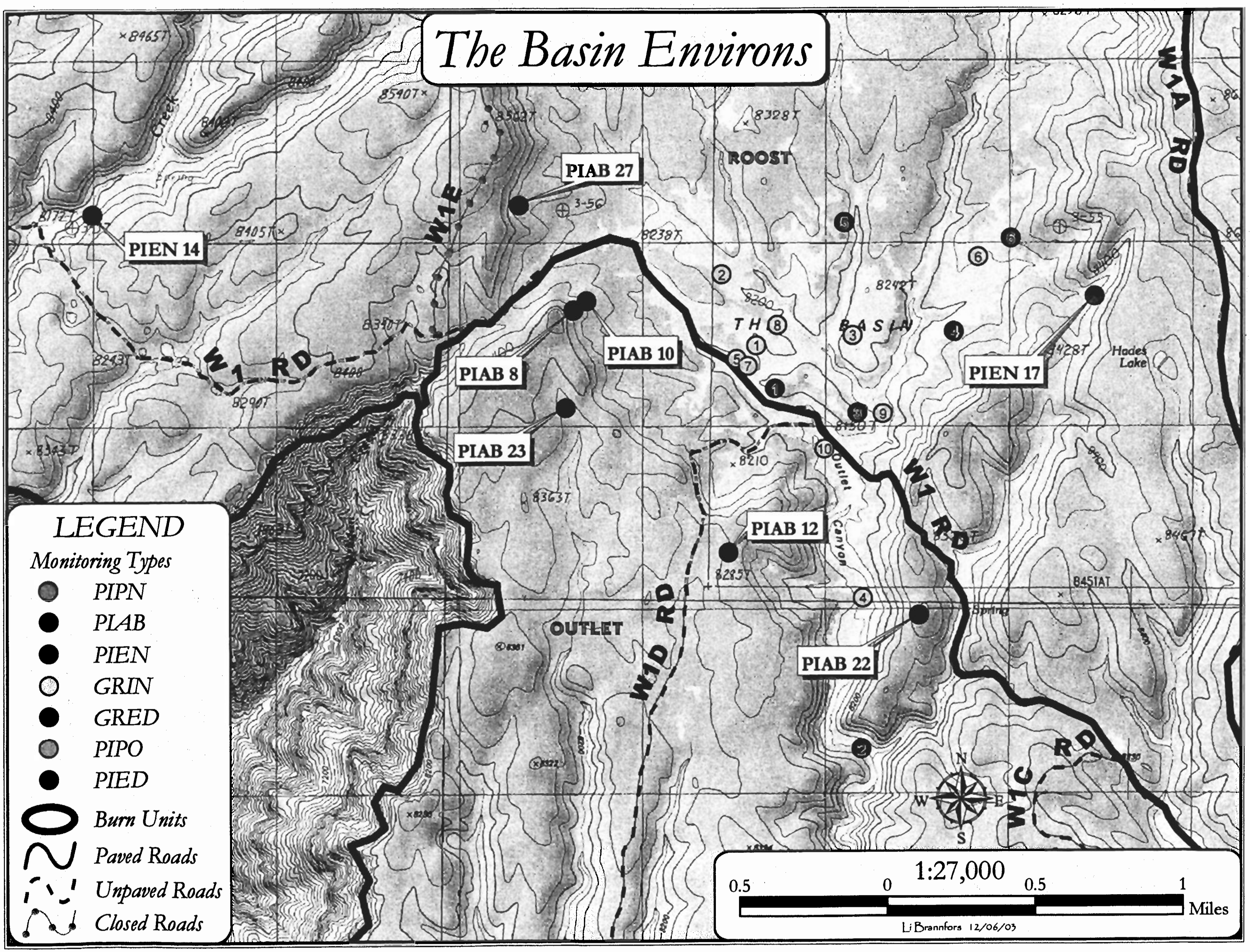
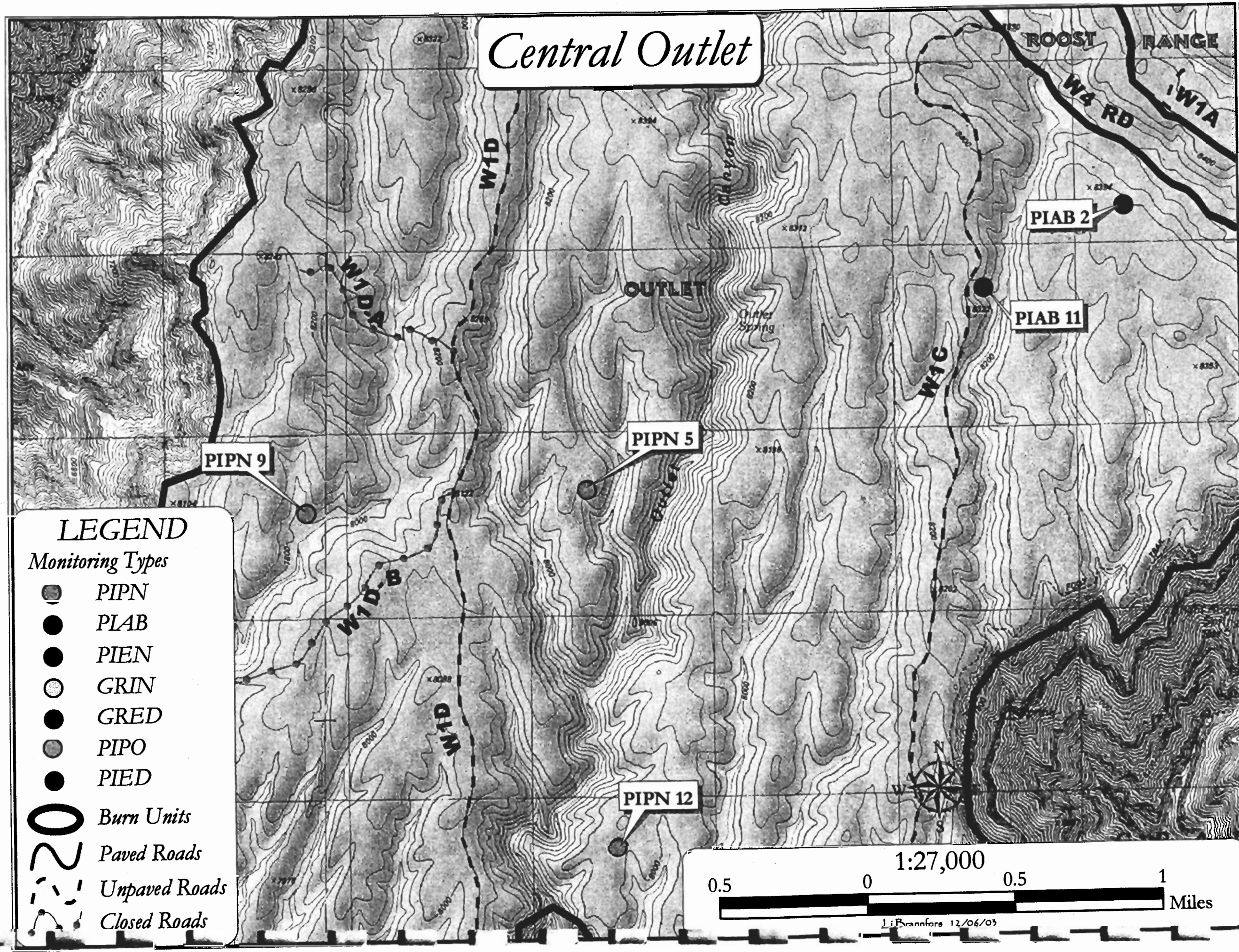
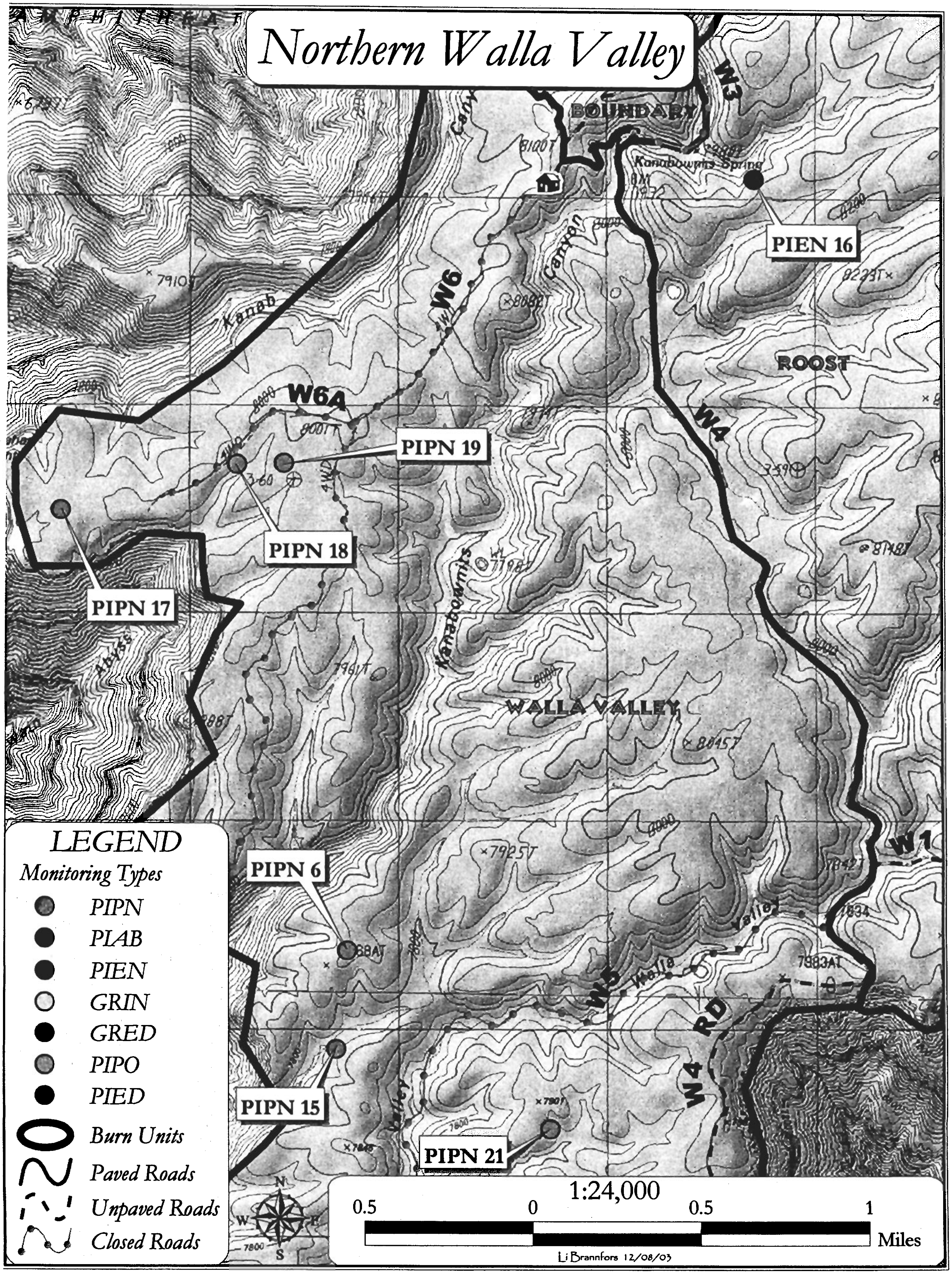
1
Miles
N
W
E
S
Li Brannfors 12/07/03



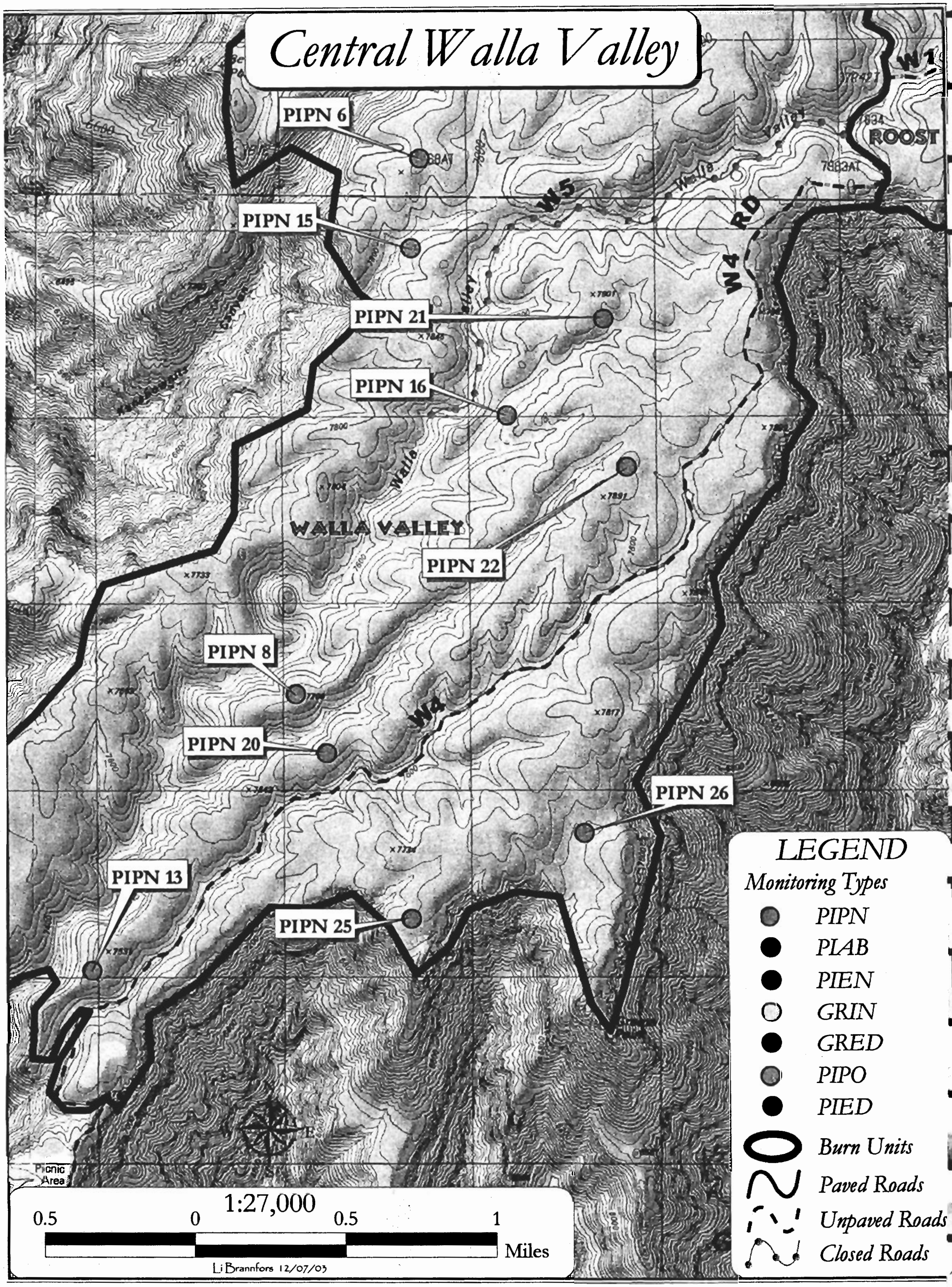
Western Walhalla
PIPN 29
WALHALLA
PLATEAU
WALHALLA
E4
E5
E5A
E4A
PIAB 26
PIPN 27
PIPN 14
PIPN 28
WALHALLA
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
1:24,000
0.5
0
0.5
1
Miles
Li Brannfors 12/07/03
N
E


The Basin Environs
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
1:27,000
0.5
0
0.5
1
Miles
Li Brannfors 12/06/03
PIEN 14
PIAB 27
PIAB 8
PIAB 10
PIAB 23
PIAB 12
PIAB 22
PIEN 17
W1 RD
W1E
W1A RD
W1D RD
W1C RD
ROOST
OUTLET
THE BASIN
Outlet Canyon
Hades Lake
Creek
Spring

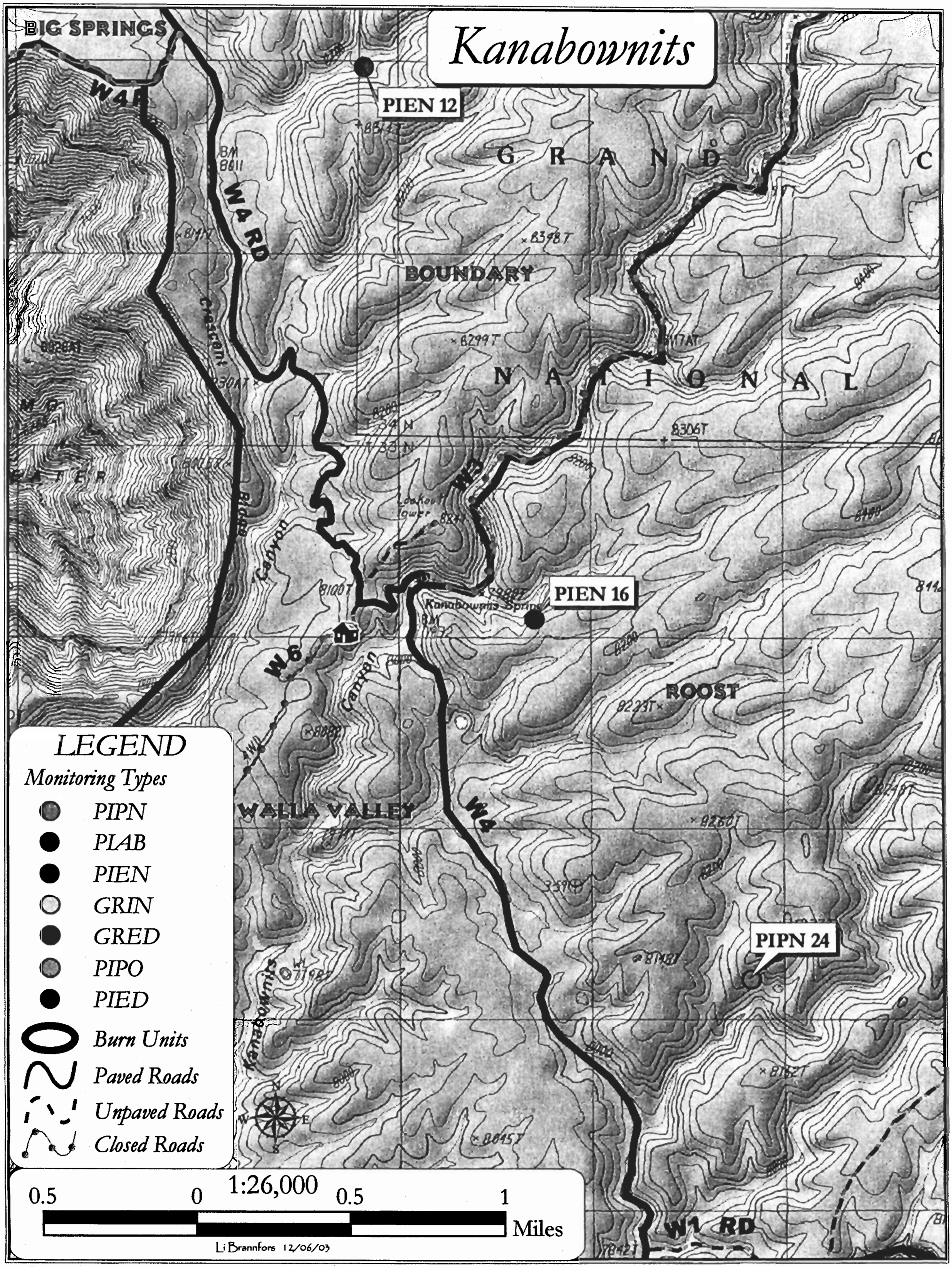

Central Outlet
ROOST
RANGE
W4 RD
W1A
W1C
W1D
W1D-A
W1D-B
OUTLET
Canyon
Outlet Spring
Outlet
PIAB 2
PIAB 11
PIPN 5
PIPN 9
PIPN 12
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
1:27,000
0.5
0
0.5
1
Miles
L.Brannfors 12/06/03

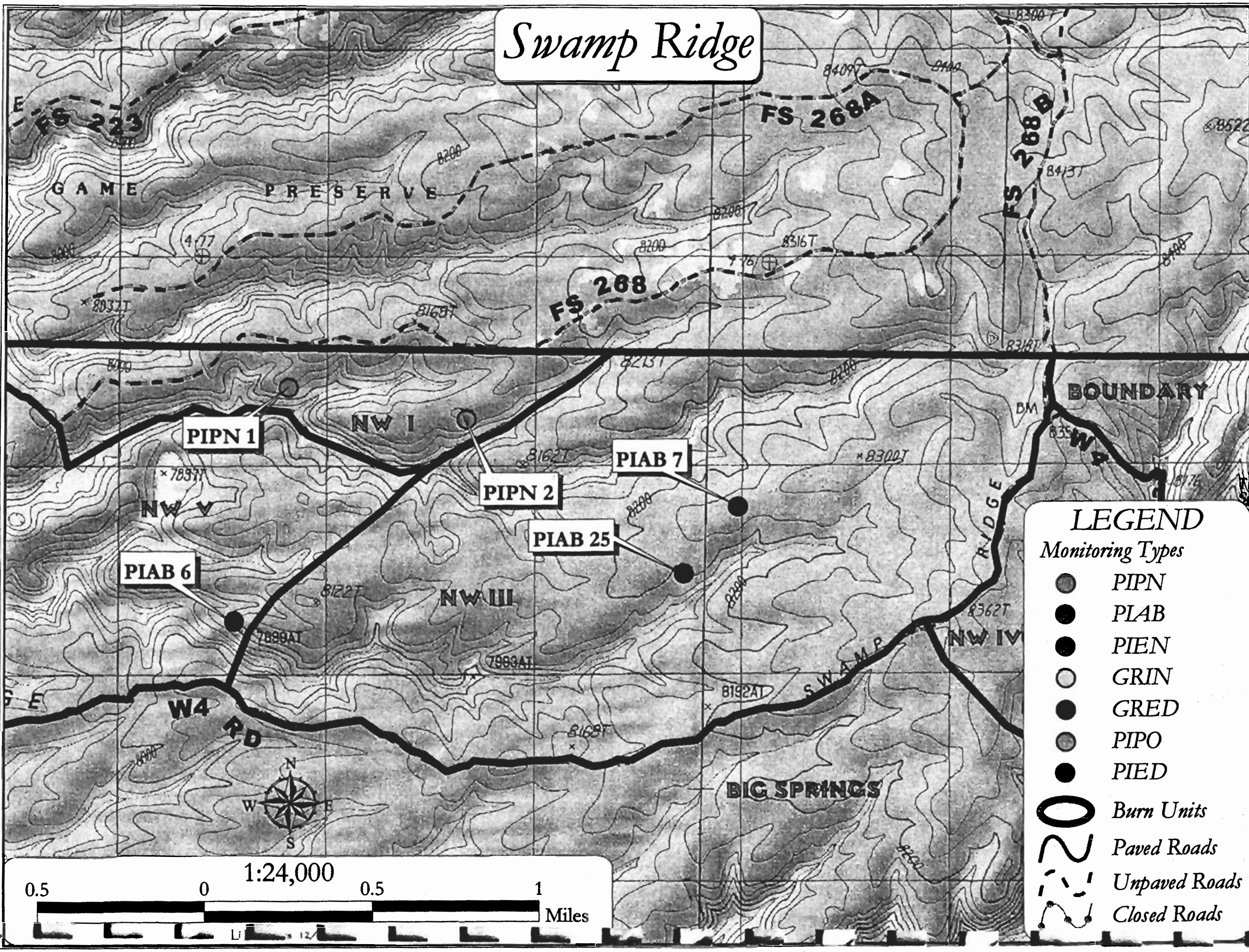


Northern Walla Valley
BOUNDARY
Kanabownits Spring
PIEN 16
W3
W6
W6A
W4
W5
W1
W4 RD
Kanab
Canyon
Kanabownits
ROOST
WALLA VALLEY
Walla Valley
PIPN 19
PIPN 18
PIPN 17
PIPN 6
PIPN 15
PIPN 21
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
1:24,000
0.5
0
0.5
1
Miles
Li Brannfors 12/08/03



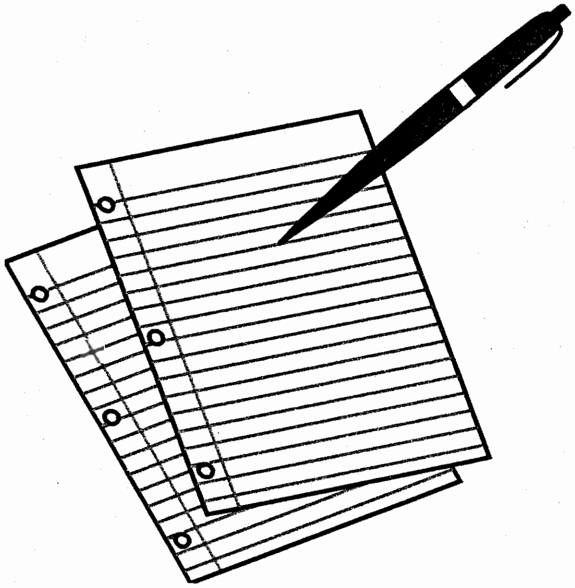
Central Walla Valley
PIPN 6
PIPN 15
PIPN 21
PIPN 16
PIPN 22
PIPN 8
PIPN 20
PIPN 26
PIPN 13
PIPN 25
WALLA VALLEY
W5
W4 RD
W4
W1
ROOST
Picnic Area
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
1:27,000
0.5
0
0.5
1
Miles
Li Brannfors 12/07/03


Kanabownits
BIG SPRINGS
PIEN 12
GRAND C
BOUNDARY
NATIONAL
W4 RD
W4
W3
W6
PIEN 16
Kanabownits Spring
Lookout Tower
ROOST
WALLA VALLEY
PIPN 24
W1 RD
LEGEND
Monitoring Types
PIPN
PLAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
1:26,000
0.5
0
0.5
1
Miles
Li Brannfors 12/06/03



Swamp Ridge
FS 223
GAME PRESERVE
FS 268A
FS 268
FS 268 B
BOUNDARY
W4
RIDGE
SWAMP
W4 RD
BIG SPRINGS
NW I
NW II
NW IV
NW V
PIPN 1
PIPN 2
PIAB 7
PIAB 25
PIAB 6
LEGEND
Monitoring Types
PIPN
PIAB
PIEN
GRIN
GRED
PIPO
PIED
Burn Units
Paved Roads
Unpaved Roads
Closed Roads
1:24,000
0.5
0
0.5
1
Miles

Appendix C: 10-Year Burn Plan



2/2/2004

WUI or HF	Fiscal Year	Project Name	Activity Type	Treat Type	Proposed FMU	Fire Regime	Treat Number	Condition Class	Compliance	Target Acres	Notes
WUI	FY04	Topeka	Treatment	Fire	PP	I	3	I	FMP	2124	ok
HF	FY04	Walhalla- Manz. Pt.	Treatment	Fire	PP	I	1,2	III	FMP	3200	ok
HF	FY04	Outlet- Widfross	Treatment	Fire	PP	I	1,2	III	FMP	1000	ok
HF	FY04	Long Jim III	Treatment	Fire	PP	I	1	II, III	FMP	1618	ok
WUI	FY04	Thompson Fuels Red	Treatment	Manual	SF	IV	1	I		30	Be prepared to Contract if IHC not available
WUI	FY04	Srim Fuels Red.	Treatment	Manual	PJ		1		FMP	30	Be prepared to Contract (Powerline)
										7942	

HF	FY05	Horsethief	Treatment	Fire	PP	I	2	I	FMP	460	
HF	FY05	Grapevine	Treatment	Fire	PP	I	2	II	FMP	864	ok
HF	FY05	RX-300	Treatment	Fire	PP	I	1	II, III	FMP	391	ok
HF	FY05	Shoshone	Treatment	Fire	PP	I	2	I	FMP	650	ok
HF	FY05	Walhalla- C. Final	Treatment	Fire	PP	I	2	I	FMP	2279	ok
HF	FY05	NW-1,3,5	Treatment	Fire	PP	I	1,2	II, III	FMP	2796	Does not include NW IV(Big FU) or Swamp Ridge
WUI	FY05	Srim Fuels Red.	Treatment	Manual	PJ		1			30	Power Line/ Historic District
WUI	FY05	Nrim Fuels Reduction	Treatment	Manual	SF		1	III	FMP	30	Bright Angel / Thompson
										7500	

WUI	FY06	Long Jim I	Treatment	Fire	PP	I	1	III		1776	ok
WUI	FY06	Picnic	Treatment	Fire	PP	I	2	I	FMP	221	ok
WUI	FY06	Entrance	Treatment	Fire	PP	I	2	I	FMP	690	ok
WUI	FY06	Quary	Treatment	Fire	PP	I	2	I	FMP	322	ok
HF	FY06	Walhalla- C. Royal	Treatment	Fire	PP	I	2	I	FMP	2780	ok
HF	FY06	Outlet	Treatment	Fire	PP	I	2	I	FMP	1000	North Boundary -W1 Road
HF	FY06	Uncle Jim	Treatment	Fire	MF	II	1	III	FMP	2475	The 1/2 that did not burn in the outlet fire
WUI	FY06	Srim WUI Fuels Red.	Treatment	Manual	PJ	I	1	III		30	Pinon Park, Trailer Village
HF	FY06	Nrim Fuels Reduction	Treatment	Manual	SF	IV	1	III	FMP	30	Thompson North Boundary
										9324	

HF	FY07	Sewage	Treatment	Fire	PJ	I	1	II	FMP	1200	
WUI	FY07	Tusayan	Treatment	Fire	PP	I	2	II	FMP	584	ok
WUI	FY07	Moqui	Treatment	Fire	PP	I	2	I, II	FMP	744	ok
HF	FY07	Walhalla- Neck	Treatment	Fire	MF	I	1	I, II,III	FMP	1000	Will tie into Uncle Jim unit in BA canyon - Burn PACS?
HF	FY07	Long Jim II	Treatment	Fire	PP	I	1	I, II	FMP	1656	ok
HF	FY07	Roost - sw of poplar			MF		1		FMP	1800	ok - do before walla valley(FY 08)
HF	FY07	Srim WUI Fuels Red.	Treatment	Manual	PJ	I	1	III	FMP	50	Trailer Village/East rim drive pine thickets
HF	FY07	Nrim Fuels Reduction	Treatment	Manual	SF	IV	1	III	FMP	50	Thompson North Boundary
										7084	

WUI or HF	Fiscal Year	Project Name	Activity Type	Treat Type	Proposed FMU	Fire Regime	Treat Number	Condition Class	Compliance	Target Acres	Notes
HF	FY08	Lonetree	Treatment	Fire	PP	I	2	I	FMP	928	ok
HF	FY08	Grandview	Treatment	Fire	PP	I	2	I, II	FMP	1874	ok
HF	FY08	Walhalla - Mathes Pt.	Treatment	Fire	PP	I	2,3	II	FMP	1500	ok
HF	FY08	Outlet	Treatment	Fire	PP	I	2	I		2000	Inbetween W1C and W1D
HF	FY08	Walla Valley	Treatment	Fire	PP	II	2	II		2700	I want to burn all of Walla Valley at once or have no South Boundary = Smoke Issues
WUI	FY08	Srim WUI Fuels Red.	Treatment	Manual		I	1	III		50	????
HF	FY08	Nriim Fuels Reduction	Treatment	Manual	SF	IV	1	II		50	Thompson/Boundary
										9102	
HF	FY09	Bugglen	Treatment	Fire	PP	I	1	II, III		328	ok Must work with FS to use roads or cut line
HF	FY09	Walla Valley	Treatment	Fire	PP	I	2	II		3500	Need to find alternative if burn all of WV in 08
HF	FY09	Hearst	Treatment	Fire	PP		1			800	ok
HF	FY09	Thompson - N boundary	Treatment	Fire	SF	IV	1	II		2000	Need North winds = Smoke Issues
WUI	FY09	Srim WUI Fuels Red.	Treatment	Manual		I	1	III		50	?????
HF	FY09	Nrim Fuels Reduction	Treatment	Manual		IV	1	II		50	????
										6728	
WUI	FY10	Long Jim III	Treatment	Fire	PP	I	2	II		1618	ok
WUI	FY10	Sewage	Treatment	Fire	PP	I	1	II		1300	
HF	FY10	Outlet	Treatment	Fire	PP	I	2	II		2000	West of W1D
HF	FY10	Thompson - Interior	Treatment	Fire	SF	IV	1	II		1000	ok - Smoke Issues with no S boundary
HF	FY10	Hance	Treatment	Fire	PP	I	3	I		2838	ok
HF	FY10	Watson	Treatment	Fire	PP	I	3	I		338	
WUI	FY10	Srim WUI Fuels Red.	Treatment	Manual		I	1	III		50	?????
HF	FY10	Nrim Fuels Reduction	Treatment	Manual		IV	1	II		50	?????
										9194	
WUI	FY11	Horsethief	Treatment	Fire	PP	I	3	I		500	
HF	FY11	Grapevine	Treatment	Fire	PP	I	3	I		864	ok
HF	FY11	RX-300	Treatment	Fire	PP	I	2	I		391	ok
HF	FY11	Shoshone	Treatment	Fire	PP	I	3	I		1090	ok
HF	FY11	Walhalla - vista	Treatment	Fire	PP	I	2	II		3200	no southern boundary or recut old vista line
HF	FY11	Outlet	Treatment	Fire	PP	I	2	II		1000	
HF	FY11	Boundary	Treatment	Fire	MF	IV	1	II		1000	Thoughts include BS Canon / Along HWY 67
WUI	FY11	Srim WUI Fuels Red.	Treatment	Manual		I	1	III		50	????
HF	FY11	Nrim Fuels Reduction	Treatment	Manual		IV	1	II		50	????
										8145	

WUI or HF	Fiscal Year	Project Name	Activity Type	Treat Type	Proposed FMU	Fire Regime	Treat Number	Condition Class	Compliance	Target Acres	Notes
WUI	FY12	Long Jim I	Treatment	Fire	PP	I	2	II		1618	ok
WUI	FY12	Picnic	Treatment	Fire	PP	I	3	I		221	ok
WUI	FY12	Entrance	Treatment	Fire	PP	I	3	I		690	ok
WUI	FY12	Quary	Treatment	Fire	PP	I	3	I		322	ok
HF	FY12	Walhalla- Manz Point	Treatment	Fire	PP	I	2,3	I		3200	ok
HF	FY12	Outlet- Widfross	Treatment	Fire	PP	I	2	I		1000	ok
WUI	FY12	Srim WUI Fuels Red.	Treatment	Manual		I	1	III		50	?????
HF	FY12	Nrim Fuels Reduction	Treatment	Manual		IV	1	II		50	?????
										7151	

WUI or HF	Fiscal Year	Project Name	Activity Type	Treat Type	Proposed FMU	Fire Regime	Treat Number	Condition Class	Compliance	Target Acres	Notes
WUI	FY13	Long Jim II	Treatment	Fire	PP	1	2			1656	
WUI	FY13	Topeka	Treatment	Fire	PP	1	4	1		2124	Weve talked about random numbers for entry
WUI	FY13	Uncle Jim	Treatment	Fire	MF	II	2			1500	1/2 of Uncle Jim
WUI	FY13	Srim WUI Fuels Red.	Treatment	Manual		I	1			50	??????
HF	FY13	Nrim Fuels Reduction	Treatment	Manual		IV	1			50	??????
										5380	

Definitions: I Fire Management Unit
Fire Regime
Treatment Number
Condition Class

Areas to be used for Contingencies : Range-2340
Thompson after FY09
Roost - South of W1 Road or along HWY 180