

**Grand Canyon National Park
Fire Effects Monitoring Program Annual Report
2002 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, 2002 to December 31, 2002. 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 have been no significant changes to the monitoring protocols in the past year, but some may occur in the near future as all monitoring type descriptions and monitoring objectives are revisited. The schedule for plot installations in 2003 is less rigorous than the previous two record-breaking years. We hope that less time spent on scheduled plot remeasurements will 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. Utilizing these parameters, and lumping together spring and fall burning, we can assess 9 of our 12 variables 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 2003 calendar year to ensure this program is on track.

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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 annually and updated as needed.

STAFFING

The same Lead Monitor and Fire Ecologist were on staff for the entire season for the first time since 1999. This consistency in personnel helped maintain established standards and ensure continued high data quality.

Four GS-0404-05 seasonals were hired to work on the Fire Effects Crew for the expected season. However, one regular crewmember reached the end of her season while plot reads remained and efforts to complete CBI plot installations for the 2001 Swamp Ridge Complex had not yet begun. To help complete the planned reads and CBI plots, one additional person was brought on for 3 pay periods as an emergency hire. Table 10 reflects all Fire Effects related positions and the number of pay periods worked, including overtime and hazard pay hours. Table 11 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, air quality sampling, and other activities. Every regular Fire Effects Crewmember went on at least one fire or fire effects detail—in-park or out-of-park—during the 2002 season. See Table 2 for a summary of how crew time was spent during the 2002 calendar year.

TABLE 1. Fire Ecology Staff for 2002 calendar year.

Monitor	Account #	Starting Date	Ending Date	# Pay Periods	OT Hrs	Hazard Hrs
Kara Leonard, GS-9/11	RX Management: (H11)	01/01/02	12/31/02	26		
Li Brannfors, GS-6/7	Fire FX Base: (H12)	01/27/02	12/14/02	23	197	6
Michelle Farnham, GS-5	Fire FX Base: (H12)	04/07/02	11/30/02	17	321	72
Kristin Kolanoski, GS-5	Fire FX Base: (H12)	04/07/02	11/02/02	15	247	33
John Moeny, GS-5	Fire FX Base: (H12)	04/07/02	10/19/02	14	145	173
Michele Young, GS-5	Fire FX Base: (H12)	05/12/02	08/24/02	7.5	2	0
Marcus Martin, GS-5	Fire FX Base: (H12)	08/29/02	10/02/02	3	22	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	Air Quality	Rx Fire Monitoring	Rx Fire Ops	Suppression And Helibase Ops.	Fuel Sampling	Other*
Li Brannfors, GS-6/7	4	13	1	53	7	1	3	1	2	0	15
Michelle Farnham, GS-5	8	19	7	36	3	0	1	3	9	0	14
Kristin Kolanoski, GS-5	6	22	5	27	5	0	1	1	2	1	30
John Moeny, GS-5	9	25	3	27	4	0	0	0	3	0	29
Michele Young, GS-5	11	30	3	25	0	0	0	0	2	0	29
Marcus Martin, GS-5	15	18	10	19	27	0	0	0	0	0	11

*"Other" includes training

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. The PIEN FMH-4 was written in 1993 but needs revision after input from the Natural Resources Branch staff. The GRIN & GRED FMH-4s have not been written but initial data gathered over the last two 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 24 visits were made to PIPO plots during the 2002 field season. Five plots were burned (all for the second time) in the Watson IV prescribed fire. A total of 34 plots exist as of December 2002, 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, two more plots may be installed in 2003 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 (PIP)

Twenty plot visits occurred in North Rim Ponderosa Pine, including 7 new installs. Despite previously reaching minimum plot objectives, additional plots were installed in the remaining areas of unburned ponderosa pine on the North Rim to capture effects of probable future fire use activity. 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. No new installs are planned for 2003.

PONDEROSA PINE WITH WHITE FIR ENCROACHMENT (PIAB)

Thirteen plots were re-read in the PIAB monitoring type during 2002. No installs were made in this monitoring type, and new ones are not scheduled since 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.

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.

ROCKY MOUNTAIN SUBALPINE CONIFER (PIEN)

Five additional PIEN plots were installed during the 2002 field season, giving us 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 2 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), so no new installs are planned in 2003 until we assess our existing data.

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. We installed five more interior GRIN brush plots and one more edge GRED modified forest plot in 2002 before canceling further installations. 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 remains in the Fire Effects Office to be used if it is 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 2003, two plots may be randomly located in the Long Jim III, Horsethief, or RX-300 units, completing the plot network for PIPO. 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 the 7 installations in 2002 have given us 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 a few more PIPN plots in these areas as time permits. 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 12 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. No installs are scheduled for 2003.

- 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 7. Analyzing at 90%/R20 is just out of reach with a requirement of 13 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 no species could be validly monitored with less than 100 plots! This indicates either a need for refinement of the monitoring type, or abandonment of overstory density objectives. No further installs are planned in 2003.
- 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=5 90%/20=9 <i>n=15 Pre</i>	Overstory 80%/20=15 JUOS, 7 PIED 90%/20=27 JUOS, 12 PIED <i>n=15 Pre</i>	n/a
FPIPO1D09	PIPO Overstory 80%/20=14 90%/20=23 <i>n=34 Pre</i>	Total Fuel Load 80%/20=5 90%/20=9 <i>n=34 Pre</i>	PIPO Poles 80%/20=111 90%/20=185 <i>n=32 Pre</i>
FPIP1D09	PIPO Overstory 80%/20=4 90%/20=7 <i>n=29 Pre</i>	Total Fuel Load 80%/20=11 90%/20=18 <i>n=29 Pre</i>	PIPO Poles 80%/20=86 90%/20=145 <i>n=29 Pre</i>
FPIAB1D09	PIPO Overstory 80%/20=12 90%/20=20 <i>n=24 Pre</i>	Total Fuel Load 80%/20=7 90%/20=12 <i>n=24 Pre</i>	ABCO Poles 80%/20=27 90%/20=46 <i>n=24 Pre</i>
FPIEN1D10	Total Fuel Load 80%/20=7 90%/20=13 <i>n=12 Pre</i>	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 2002 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. Twenty-three plots were installed this year, 5 on the South Rim and 18 on the North Rim. Forty-nine visits were made to re-read previously burned plots (Year 1, Year 2, Year 5, and Year 10 post-burn) and 5 visits were made to immediate Post-burn plots. This makes for a total of 77 plot visits in 2002, the heaviest workload ever at Grand Canyon.

TABLE 4. Number of plots installed by monitoring type in 2002 and previously.

Monitoring Type Code	Monitoring Type Name	Rim	Number of Plots Installed in 2002	Total Number of Plots Installed
FPIED1D02	Great Basin Conifer Woodland	S	0	17 ¹
FPIPO1D09	South Rim Ponderosa Pine Forest	S	5	34
FPIP1D09	North Rim Ponderosa Pine Forest	N	7	29
FPIAB1D09	North Rim Ponderosa Pine with White Fir Encroachment	N	0	24
FPIEN1D10	Rocky Mountain Subalpine Conifer Forest	N	5	17 ²
BGRIN1D01	North Rim Meadows--interior	N	5	10 ³
FGRED1D08	North Rim Meadows--edge	N	1	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 2002 AND BEYOND

Fifty-four plots were re-measured in 2002 and 52 such visits are planned for 2003 (Table 5). Workload is expected to lessen through 2004, then pick back up again in 2005 & 2006 (Table 6). In 2003, 52 plot visits are planned, along with 2 installs for a total of 54 plot visits (Table 7). These installs will take place in the remaining unburned ponderosa forests of the South Rim. More installs may occur in 2003. *It is expected that the crew will spend the first four weeks on the South Rim, and the remainder of the season on the North Rim in 2003.*

TABLE 5. Plot re-measurements by plot type for 2003 and 2002.

Plot Type	Total Plots to Re-measure 2003				Total Plots Re-measurement 2002			
	G	B	F	Total	G	B	F	Total
YROX Visits	0	0	40	40	0	0	49	49
POST Visits			(12 P)	(12 P)			(5 P)	(5 P)
Total Visits	0	0	52	52	0	0	54	54

P = Immediate Post-burn Re-measurements

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

Year	Number of Plots					
	2003	2004	2005	2006	2007**	2008**
YROX Visits	40	20	48	52	35	24
POST Visits	(12 P)	(13 P)	(17 P)	(10 P)		
Total Visits	52	33	65	62	35**	24**

**These projections do not predict plots burned after 2006. Plots will undoubtedly be burned during this time but plans are not finalized.

TABLE 7. Projected plot installation.

Plots to be Installed 2003				Projected Total BY 12/03			
G	B	F	Total	G	B	F	Total
0	0	2*	2*	0	10	129	139

* = Installation numbers undecided at time of report

POSTBURN PLOT VISIT SUMMARY

Five plots burned this year at Grand Canyon: 4 in the Watson IV burn unit, and 1 in the Hance burn unit, both on the South Rim (Table 8). All five were burned for the second time.

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, 78 have immediate Post-burn data, and 17 have had immediate Post-burn data gathered again, after a second burn. Although 97 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 95. 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.

Plot Type	Total Plots Burned 2002				Total Plots Burned to Date			
	G	B	F	Total	G	B	F	Total
Initial Burn	0	0	5	5	0	0	80	80
Re-burn			(5 R)	(5 R)			(17 R)	(17 R)
Total Burned	0	0	5	5	0	0	97	97

R = Second-entry reads (re-burns)

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

	G	B	F	Total
Immediate Post-burn	X	X	78 (+17R)	95*
Immediate Non-fire	X	X	X	X
1 Year post-burn	X	X	78 (+12R)	90**
2 Year post-burn	X	X	62 (+13R)	75
5 Year post-burn	X	X	36	36
10 Year post-burn	X	X	3	3

*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).

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														02	09		16*		06							
	03														07	10		17*		08							
	04															11				13							
	05																			14							
	12																			15							
PIPO	01	15	18		19	29	25	26							04	06				02		08				17	
	07		27			30	28	31							05	10				03						20	
			34			33	32								11					09						21	
						36	35								12					13						22	
																				14						24	
																		24									
PIPN									01					05										03	27	06	19
									02					09										04	28	08	20
														12										07	29	13	21
																									10	15	22
																									11	16	25
																									14	17	26
																								23	18		
PIAB										07	06			02	22									03	13	18	
										25				08	23									04	14	19	
														10										05	15	20	
														11										09	16	26	
														12												17	
GRIN														04			01	06									
														10			02	07									
																	03	08									
																	05	09									
GREB														02			01	05									
																	03	06									
PIEN	02			05									01			10	17		08		15						
	04			06									03			11			13								
	12			07												14											
				09																							

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

THE 10-YEAR BURN PLAN

At this time it is estimated that up to 5,310 acres may be burned in calendar year 2003 in the Walhalla, Outlet, and Topeka units. We may install a few new plots on Walhalla in the North Rim Ponderosa Pine monitoring types since this will likely be our last chance to do so within that unit. 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

2002 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. We will continue to base plot installation goals for 2002 on the previously established minimum plot numbers since they are attainable, but further installs in our main monitoring types will curtail sharply after that. Henceforth, minimum plot numbers used in this report will be based solely on pre-burn calculations for consistency.

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

A major change in crew management will occur in 2003. For the first time, a GS-6 seasonal Assistant Lead Monitor will be hired to help coordinate and lead field operations and assist with off-season office duties. In addition, the entire seasonal crew of GS-5s will be duty stationed on the North Rim. With only 10 guaranteed S Rim plot visits and up to 35 N Rim plot visits, this change in duty station from the past 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. With an overhaul of office furnishings in 2002, we now have slightly less storage space, but more usable space, especially for the permanent staff. All plot binders are now 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 has been purchased and will be moved to the North Rim in 2003. A two- and four-drawer filing cabinet were added to augment individual rolling files for each permanent desk setup. Extraneous bookshelves have been replaced with more closed-door storage cabinets, in which crew packs, field equipment, and digital/electronic devices are kept. 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 within the next 1-2 years, 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, an herbarium cabinet and supplies, and storage areas. We have extra storage room up in the fire cache for less frequently used items. The Fire Effects Office was enhanced with new furniture in 2002.

Our "plot board" continues to be invaluable. 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. However, with increasing work on the North Rim and complete transfer of necessary office supplies to the North Rim during the field season, the beloved dry-erase plot board has been left behind on the South Rim each of the last two years. In its stead, a portable version printed on "E" sized paper has been developed to allow continuous tracking of plot activity regardless of where our plot work may take us.

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 seasonal assistant 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 2001, 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 two travel trailers in 2002, one of which was the primary office for all crew activities, and one which provided storage space plus a work area for the Lead Monitor. 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.

Housing was secured on both rims for the crew in 2002. The duty station remained on the South Rim for all but one seasonal, but weekly travel to and from the South Rim was no longer required since everyone had the option to stay on the North Rim during lieu days. This set-up worked extremely well, improving both crew morale and efficiency. However, it was recognized as being expensive, since all South Rim duty stationed personnel continued to receive backcountry per diem travel allowances. For this reason, and with

the aid of a small South Rim workload, all crewmembers except the GS-6 Assistant Lead Monitor and GS-7 Lead Monitor will be duty stationed solely on the North Rim in 2003.

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 2013) 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. Improvements for 2002 included tracking of all second- and third-entry reads, as well as tallying Year 1, Year 2, Year 5, Year 10 reads separately for the first time.

All plot locations continue to be tracked in an updated ArcView GIS database, allowing individual maps to be produced with ArcView 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 were randomized exclusively with ArcView. Consultation with the Fire GIS Specialist allowed advanced refinement of potential plot installation areas. 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 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, new records for annual fire effects accomplishments were set for the second 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, below.

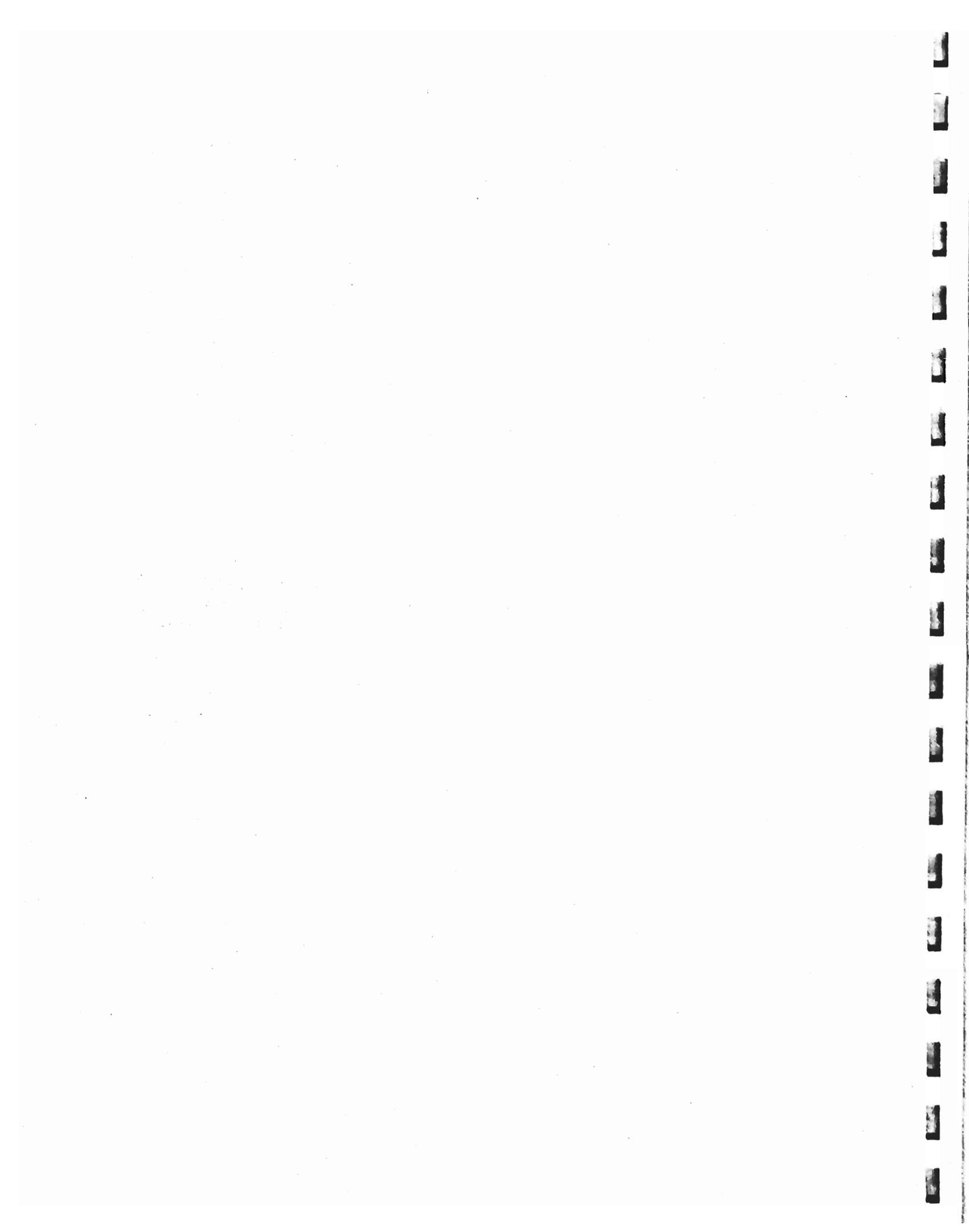


Table 11. Planned GRCA plot installations vs. actual plot installations by year.

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

For all the reasons listed above, a Regional Program Review should be scheduled for 2003. 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.

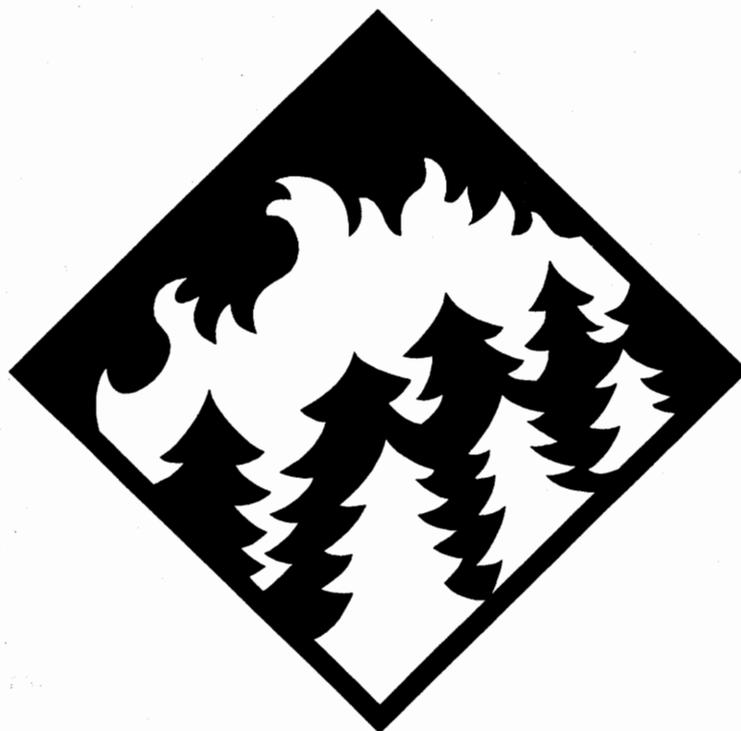
The graphical information presented in this report allows resource managers to more accurately determine whether prescribed fire is meeting objectives. Keep in mind that the objectives set in the FMH-4 Monitoring Type Descriptions are based on the best available science, and they can be revised as new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

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 5 out of 19 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*. In fact, overstory densities slightly increased 5 years after burning and jumped *up* into our desired future condition. This is good since limiting overstory ponderosa mortality is of great import. Additional Year 5 data will be available next year to further assess this variable with greater confidence.

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 7 plots, decreased on 4 plots, and remain unchanged on others from Pre-burn through second-entry post-burn Year 2 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 2002

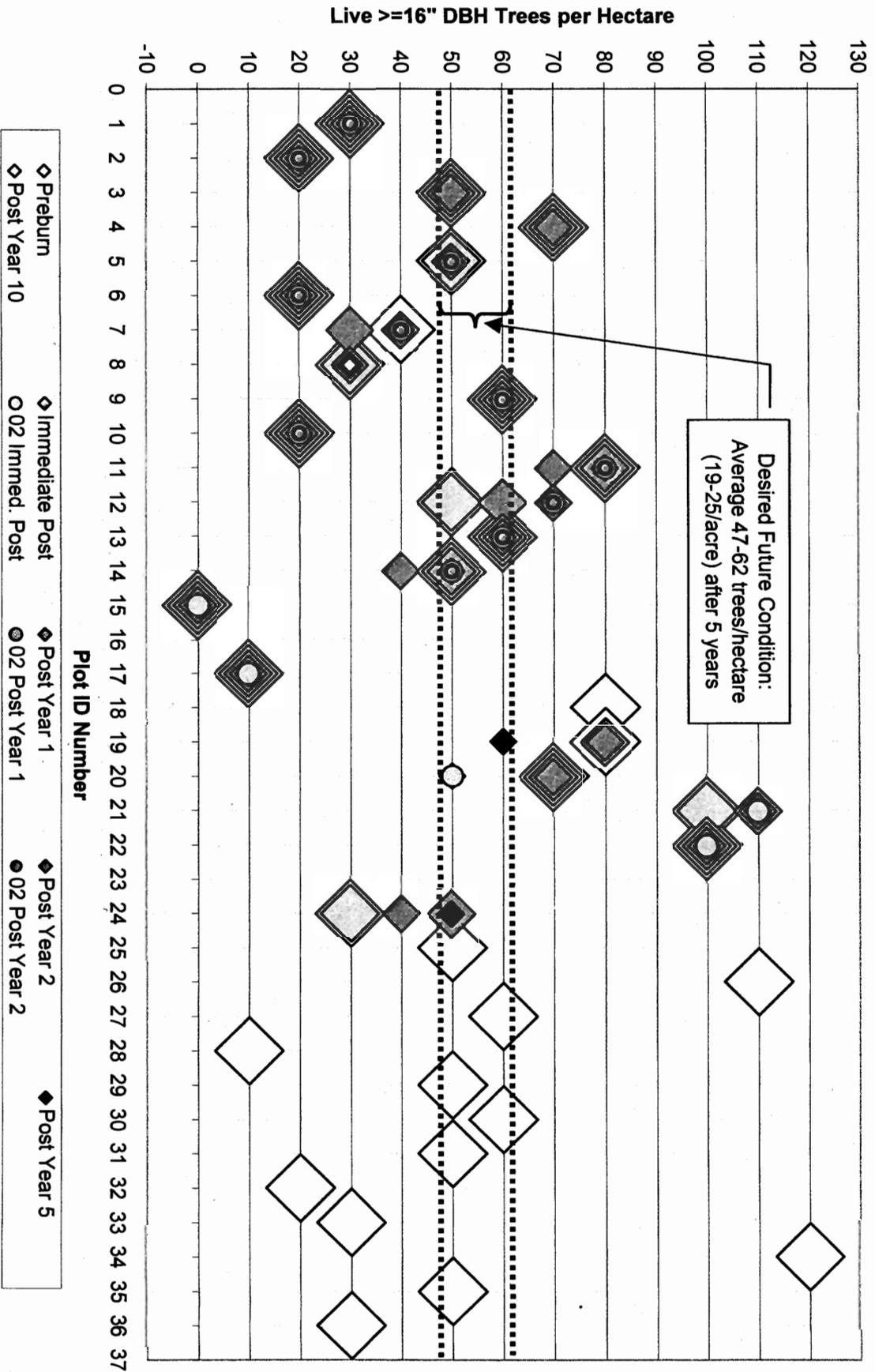


Figure 2. Mean Density of Live 16" DBH and larger *Pinus ponderosa*

December 2002

n = 19 plots, required minimum pre plots = 14

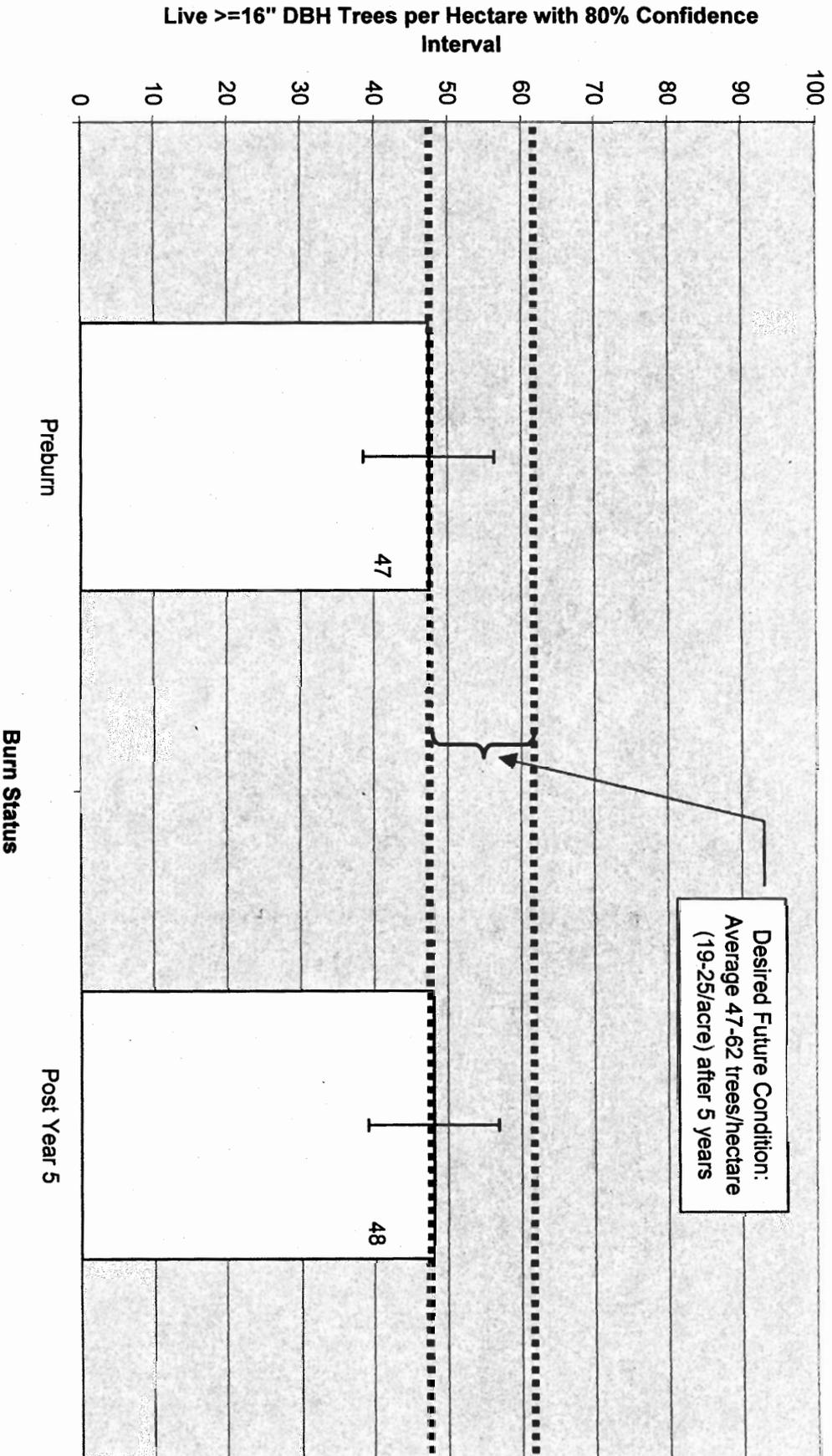


Figure 3. Post-burn Crown Scorch Percent on Live Pinus Ponderosa Overstory Trees, by plot
December 2002

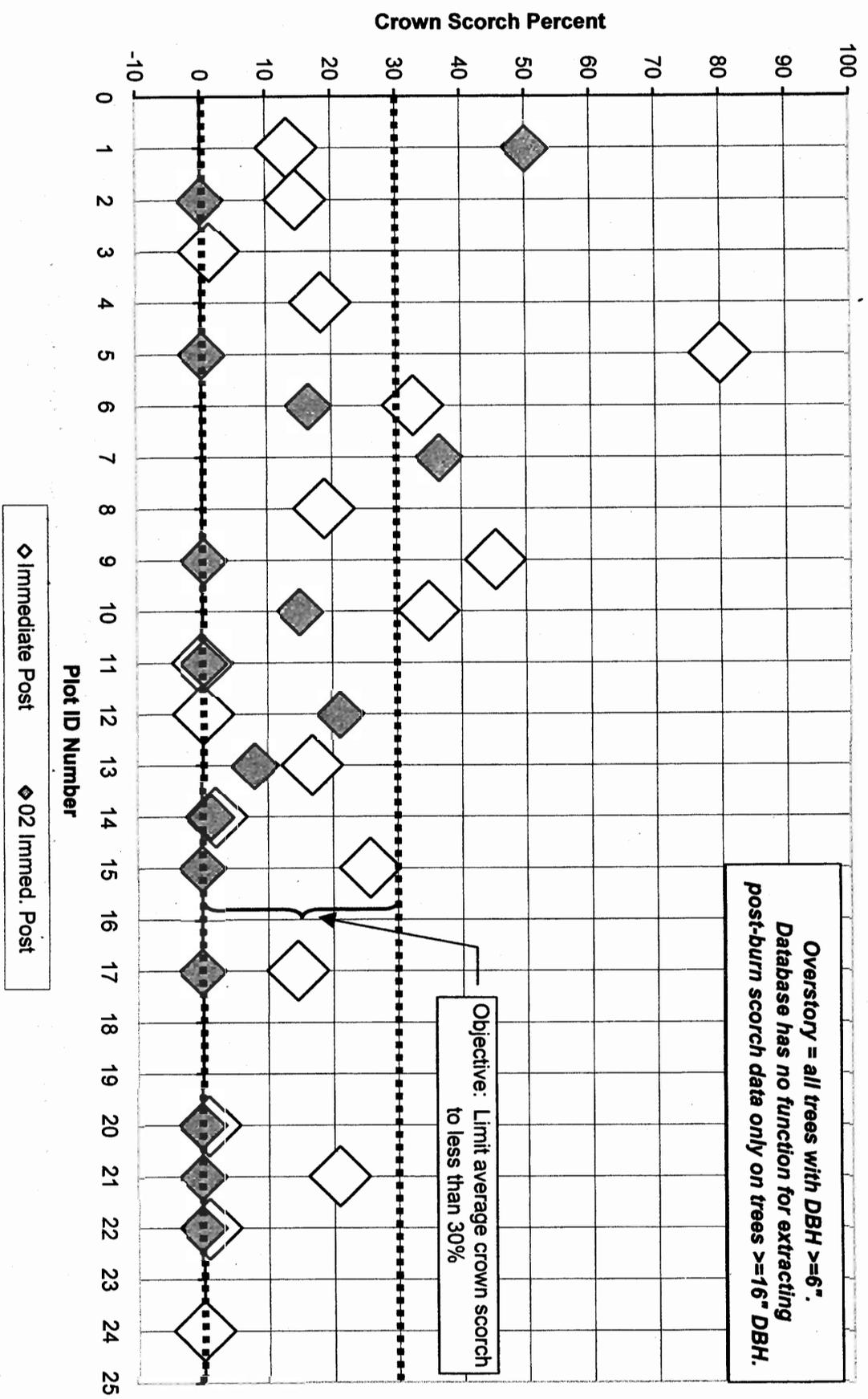


Figure 4. Post-burn Crown Scorch Percent on Live *Pinus ponderosa* Overstory Trees
December 2002

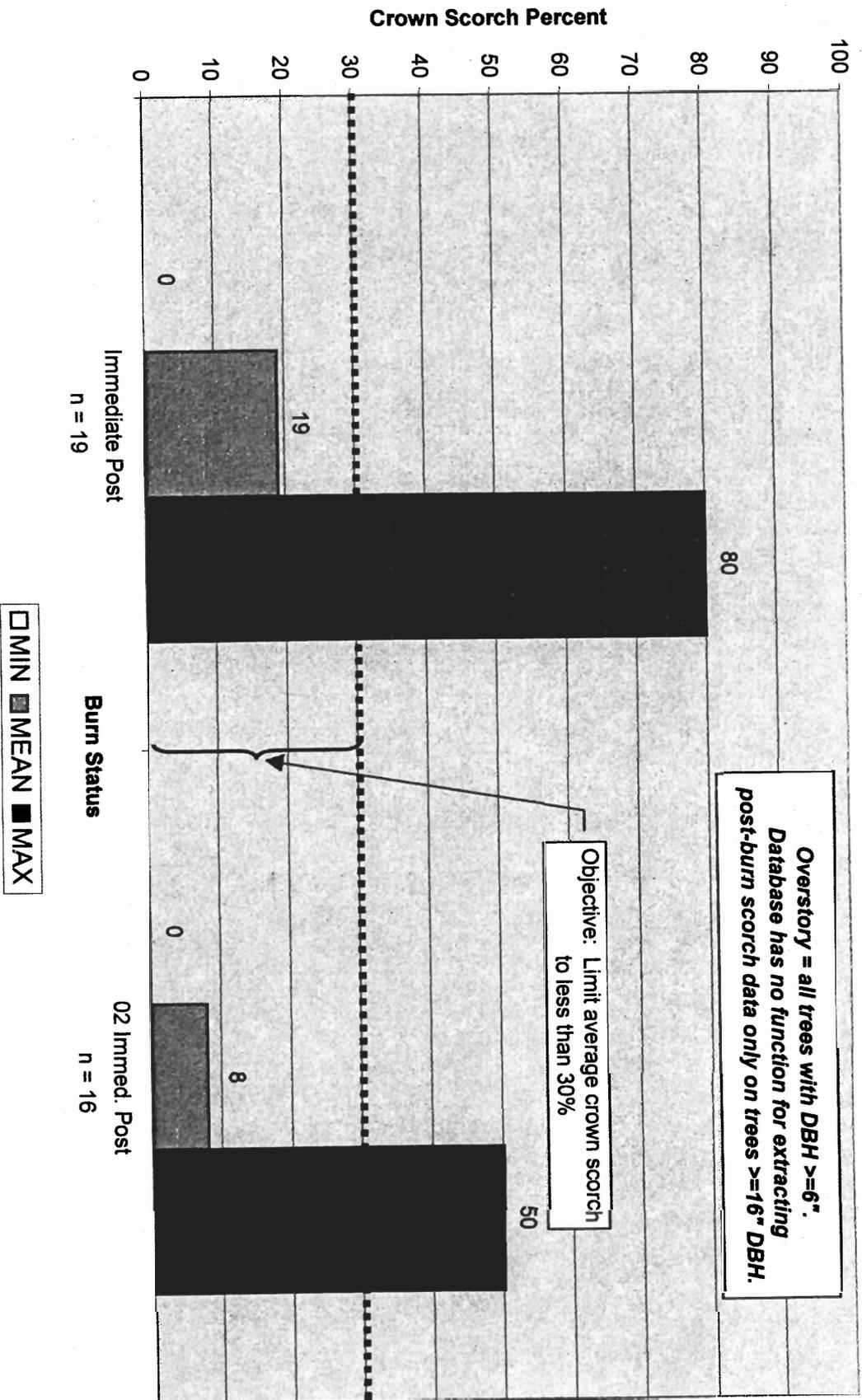
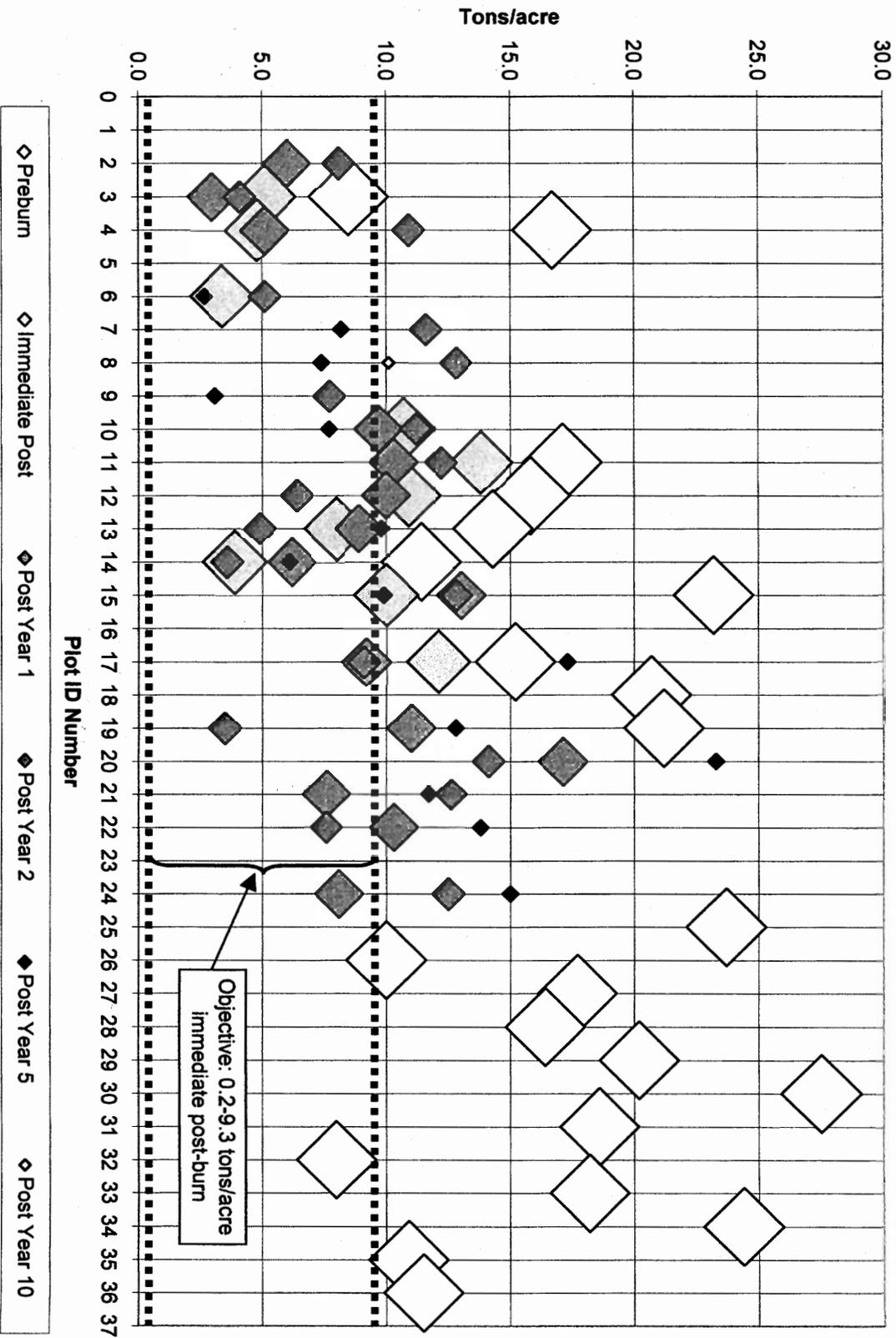


Figure 5. Total Fuel Load by Plot
December 2002
100-foot fuel transects



South Rim Ponderosa Pine (PPO)

Figure 6. Total Mean Fuel Load
 December 2002
 100-foot fuel transects
 n = 8, required *minimum pre* plots = 5

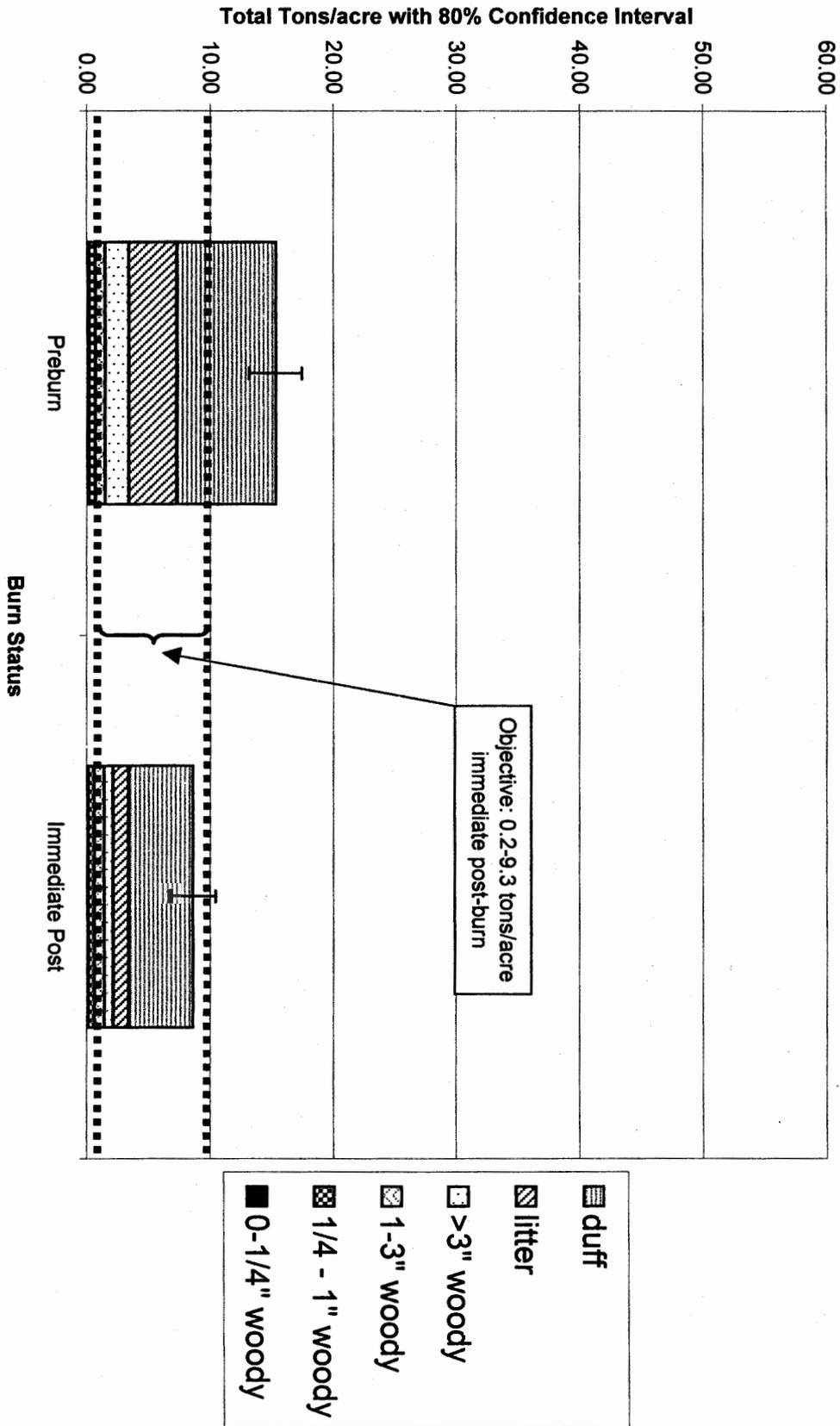


Figure 7. *Pinus ponderosa* Pole Densities, by plot.
December 2002

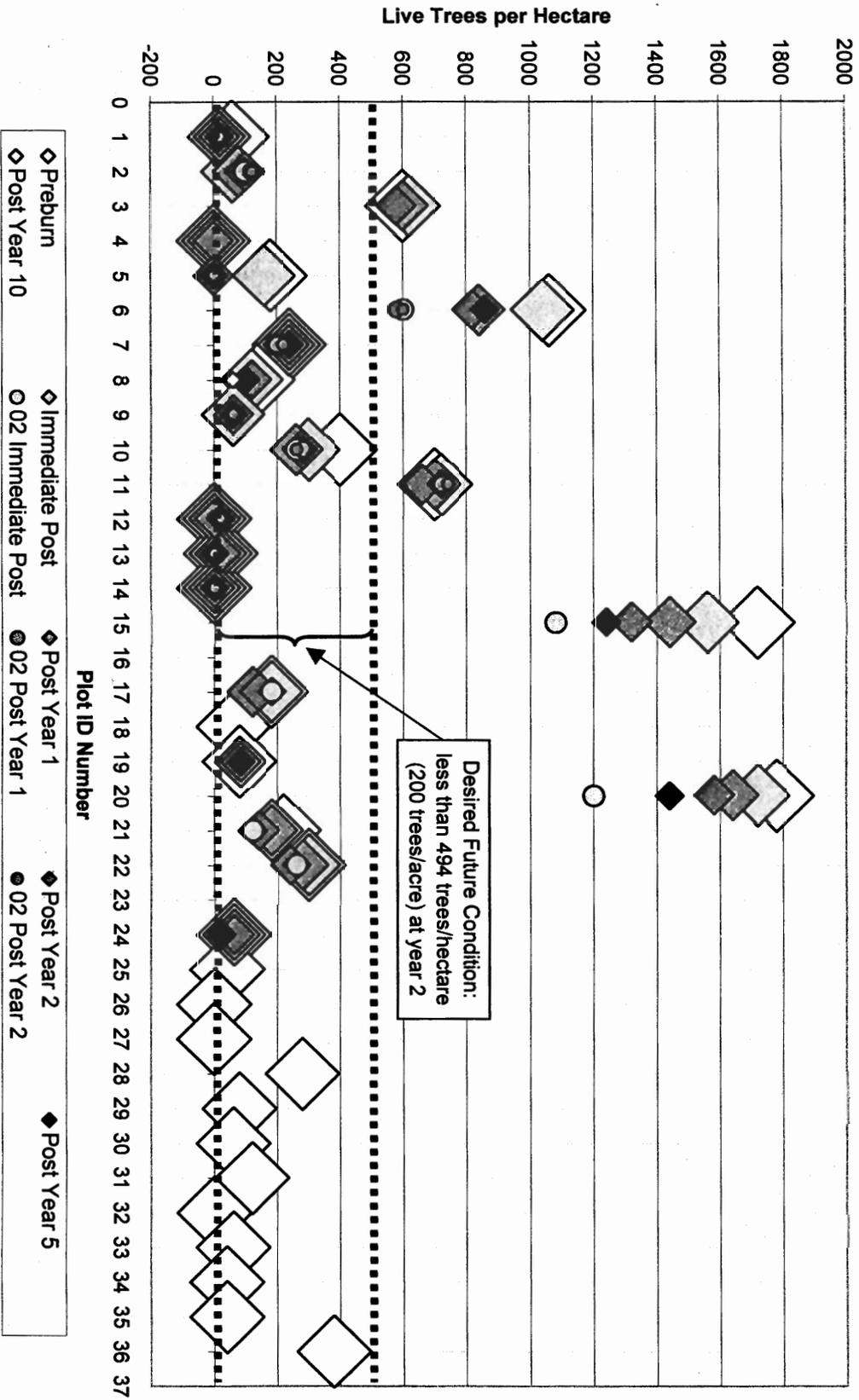


Figure 8. Mean *Pinus ponderosa* Pole Density

December 2002

n = 19 plots, required *minimum pre* plots = 111

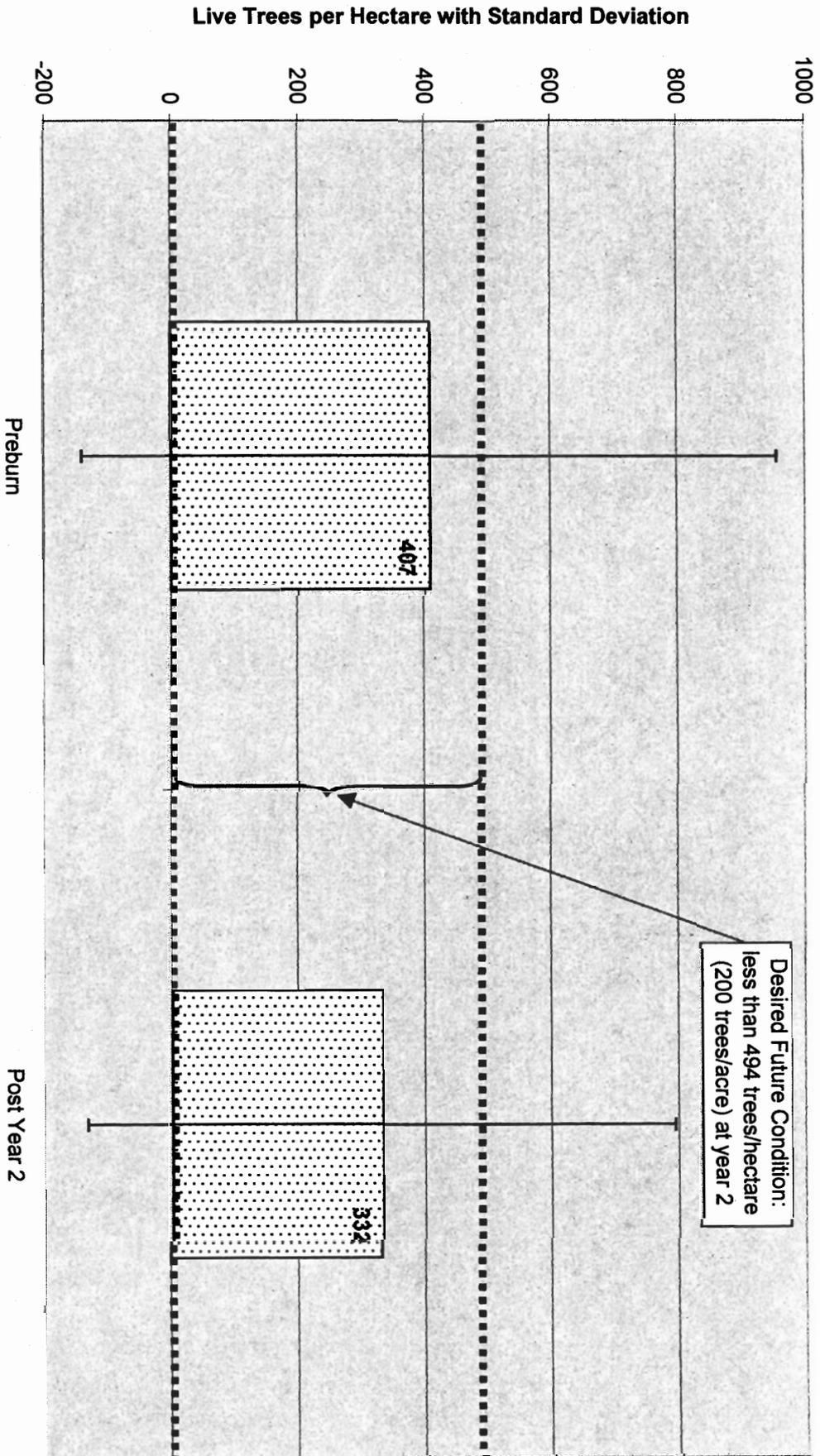


Figure 9. 6 - 15.9" DBH Snag Densities, by plot
December 2002

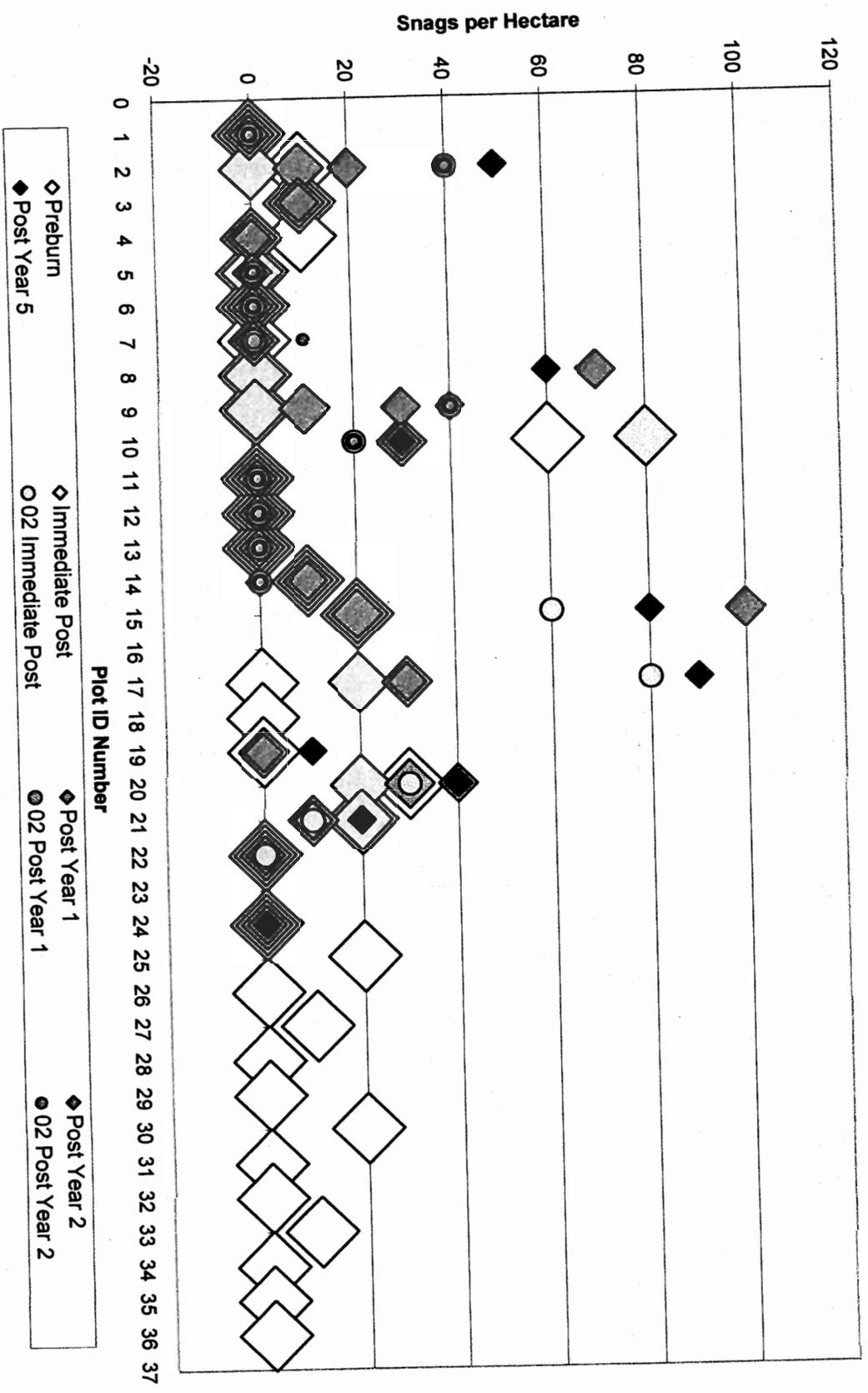


Figure 10. 16" DBH and larger Snag Densities, by plot
December 2002

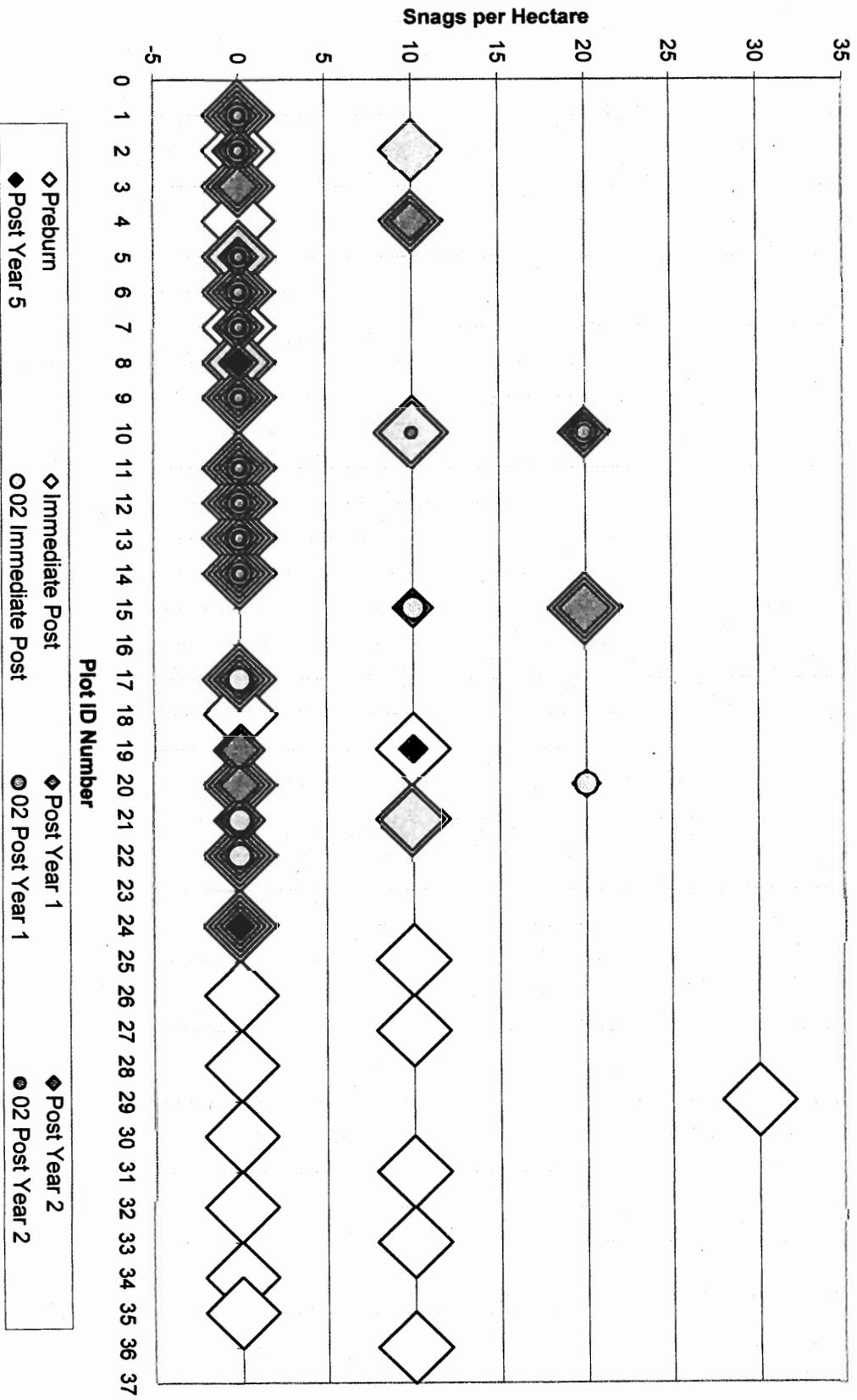


Figure 11. Mean Snag Density, by size class

December 2002

n = 19 plots; required minimum pre plots = 123 (>=16"), 159 (6-15.9")

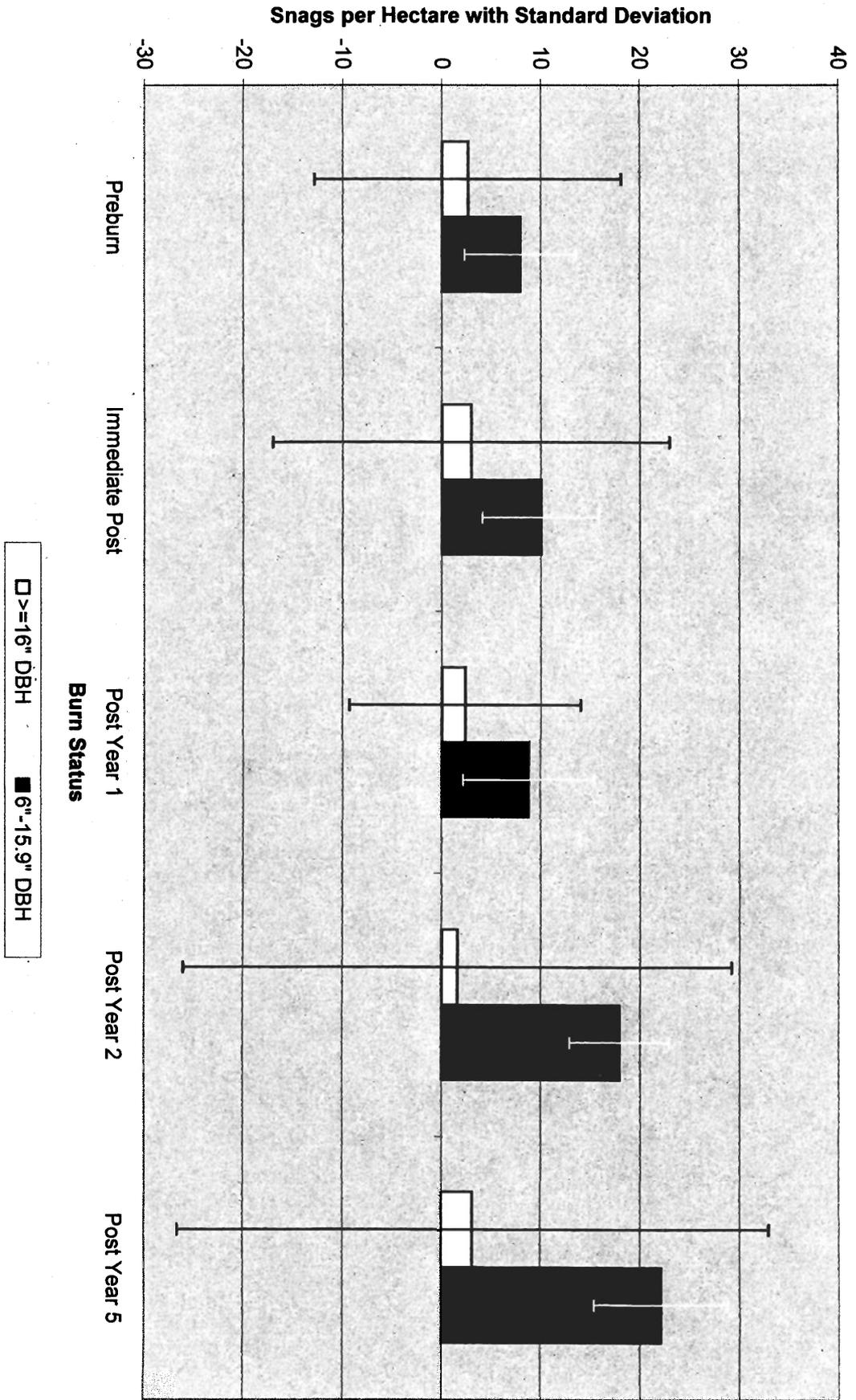


Figure 12. *Pinus ponderosa* Seedling Densities, by plot
December 2002

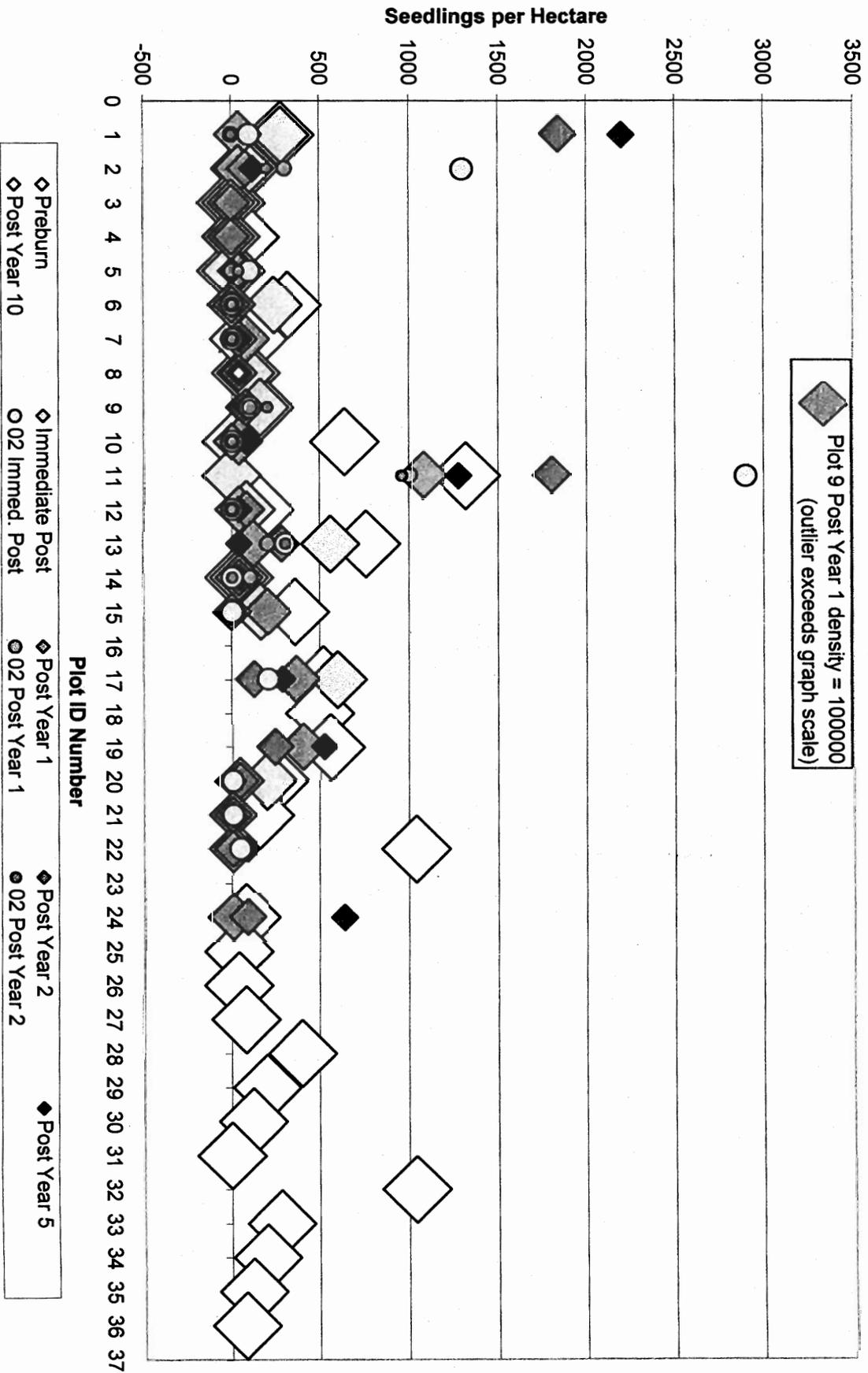
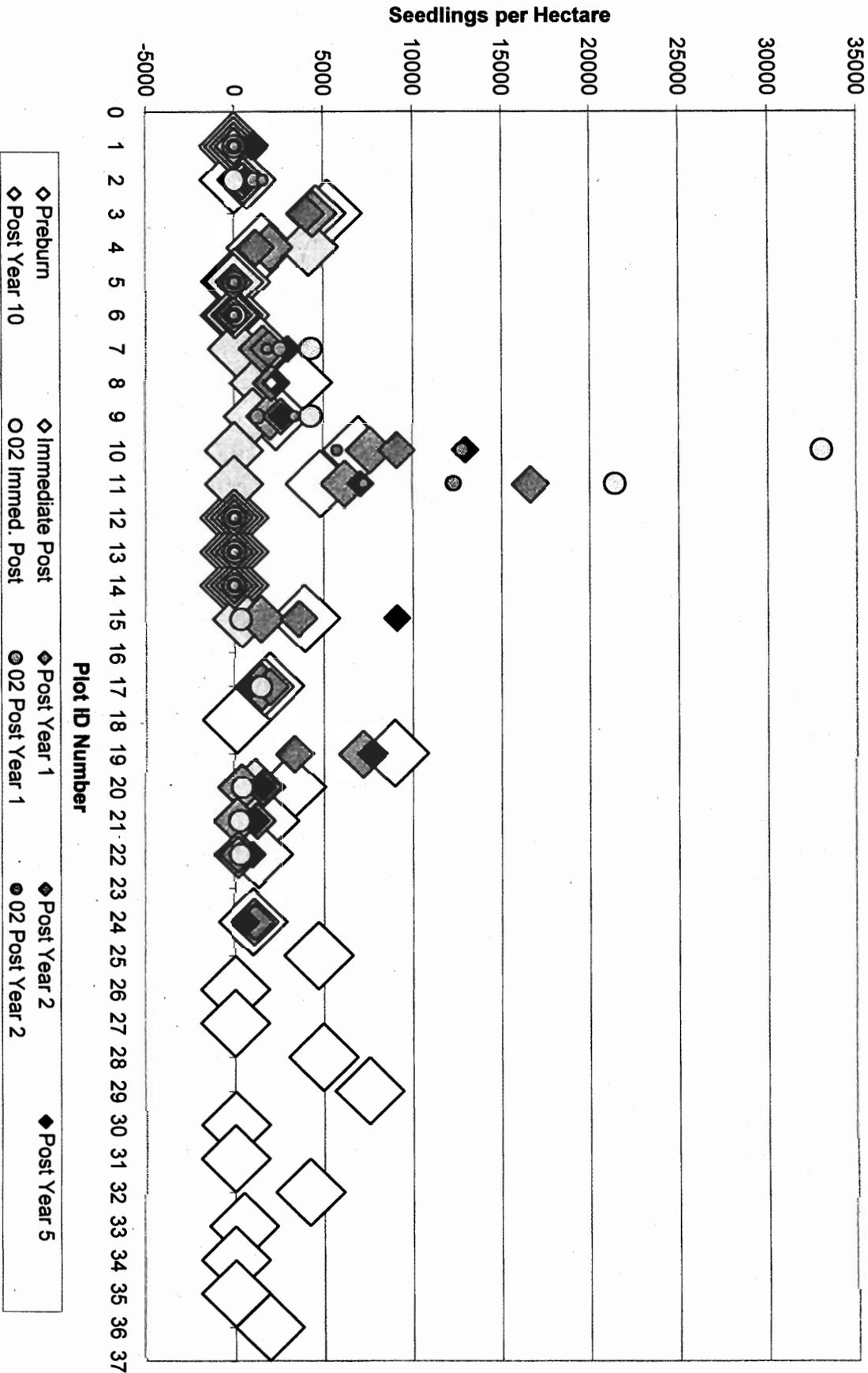


Figure 13. *Quercus gambelii* Seedling Densities, by plot
December 2002



PIP RESULTS AND DISCUSSION

OVERSTORY DENSITY

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: Figure 14 illustrates a very slight decrease in large *Pinus ponderosa* across the entire plot network. There are only 2 plots with Year 5 data—both showing a change in density between 2 and 5 years post-burn. One shows a positive change, and one a negative change. These 2 plots--PIP 1 and 2--were both burned in the Northwest III prescribed burn in 1993. The entire body of post-burn data includes 6 plots with a declining trend, 2 with an increasing trend, and 12 are unchanged. There is no bar graph for this variable because there are only 2 plots with Year 5 data.

Was objective met? It is unknown at this time, since there are not enough Year 5 data.

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 15 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. Figure 16 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.

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 17 shows a lot of change on individual plots, with fuel loads almost always decreasing. Figure 18 shows that duff, litter, and 1000-hour fuels (>3" woody) are decreased the most after the first-entry burn. 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 19 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 20 shows mean densities to be 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 21 shows small snag density changes across the plot network. Response to fire ranges from the dramatic increase on plot 1 to the noticeable decrease on plot 3, although overall change is slight. Figure 22 illustrates decreases in large snag densities on 3 plots, increases on 3, and no changes on 14 between pre-burn conditions and the most recent post-burn data. Plots 1 and 2 were both burned in the Northwest III prescribed burn in 1993. There is no bar graph because there are only 2 plots with Year 5 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.

SEEDLING DENSITY

Objective: Track seedling densities over time.

Results: Figure 23 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 24 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 25 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 2002

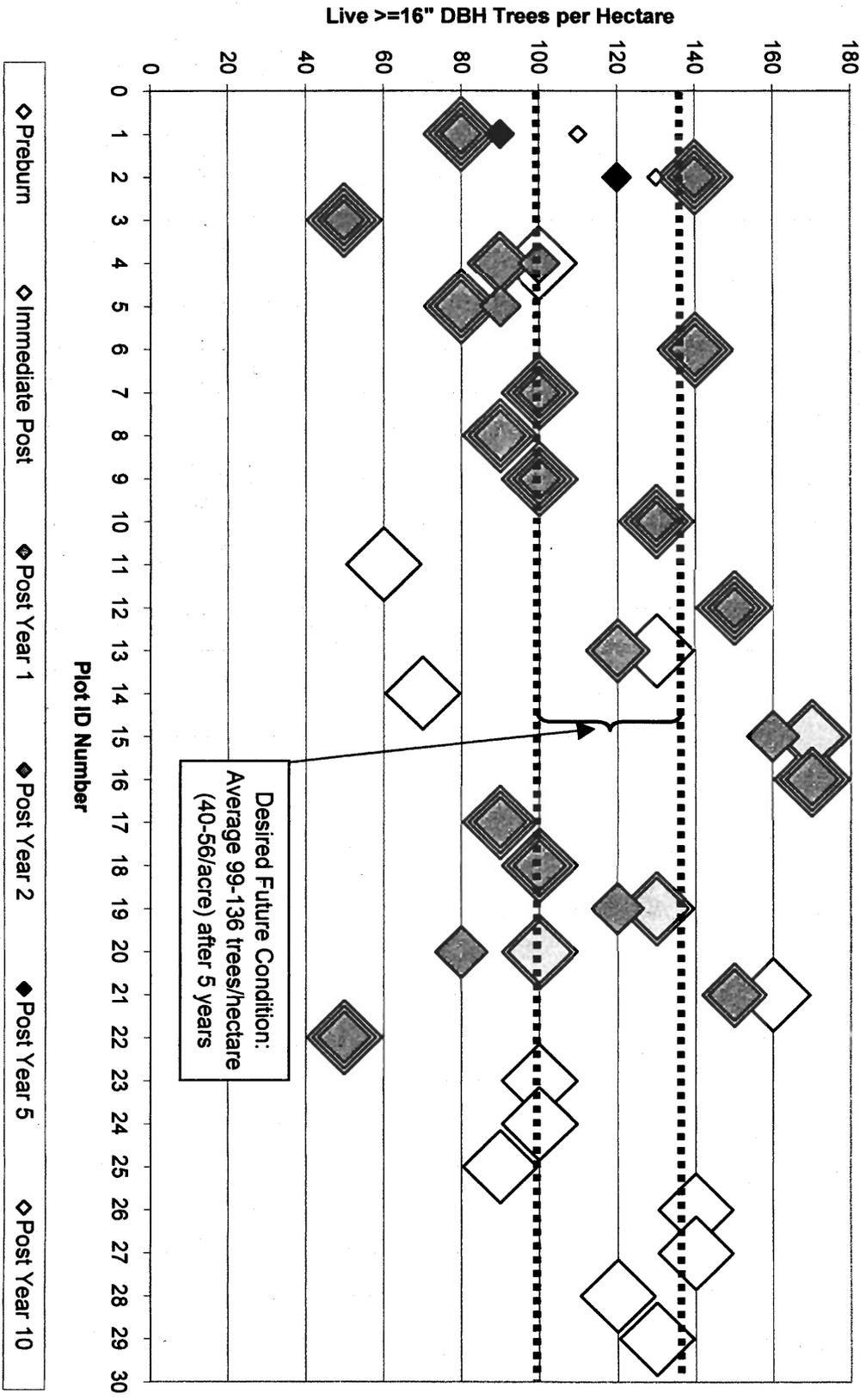
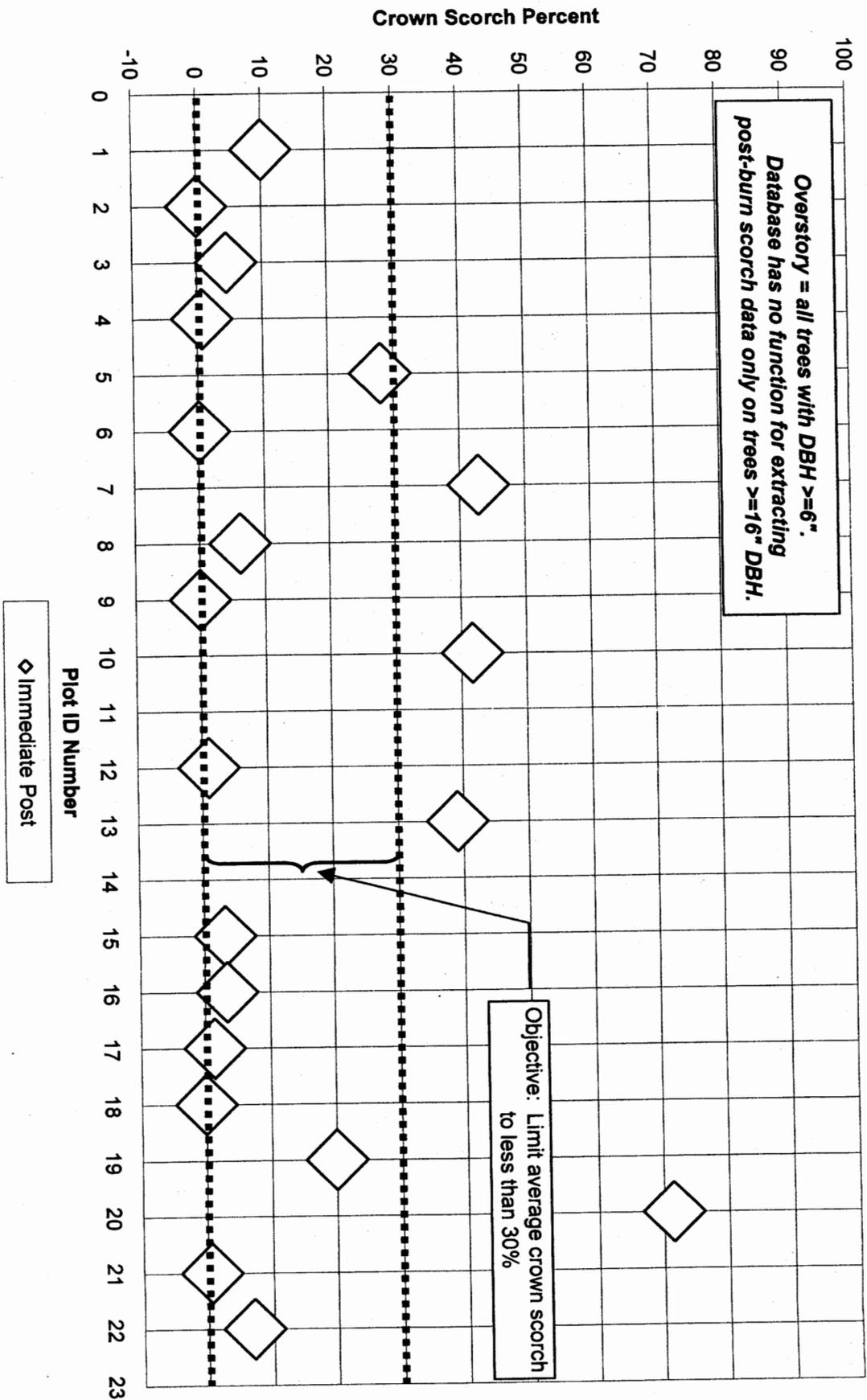


Figure 15. Post-burn Crown Scorch Percent on Live *Pinus Ponderosa* Overstory Trees, by plot
December 2002



North Rim Ponderosa Pine (PIPN)

Figure 16. Post-burn Crown Scorch Percent on Live *Pinus ponderosa* Overstory Trees

December 2002

n = 20

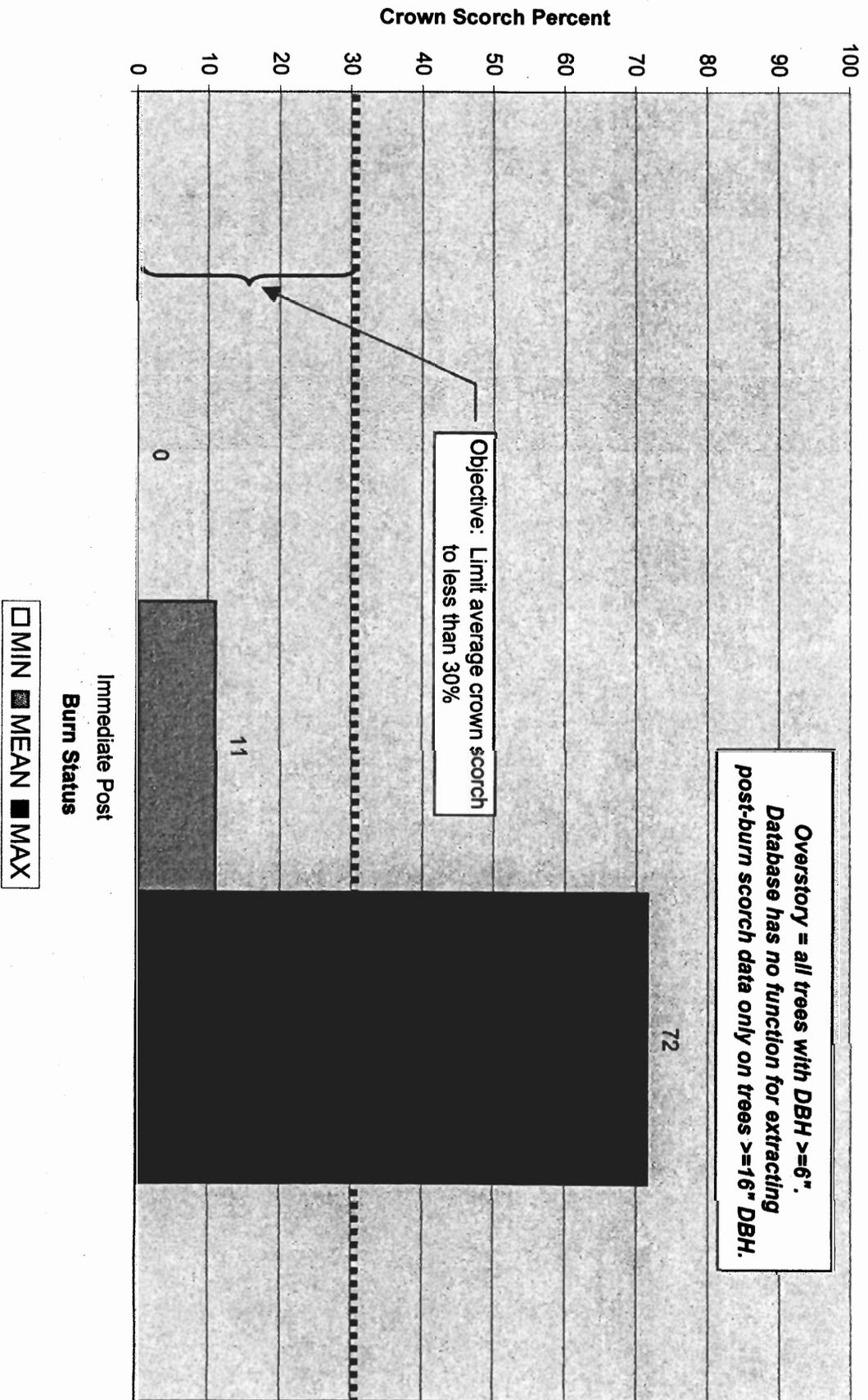


Figure 17. Total Fuel Load, by plot
December 2002
50-foot fuel transects

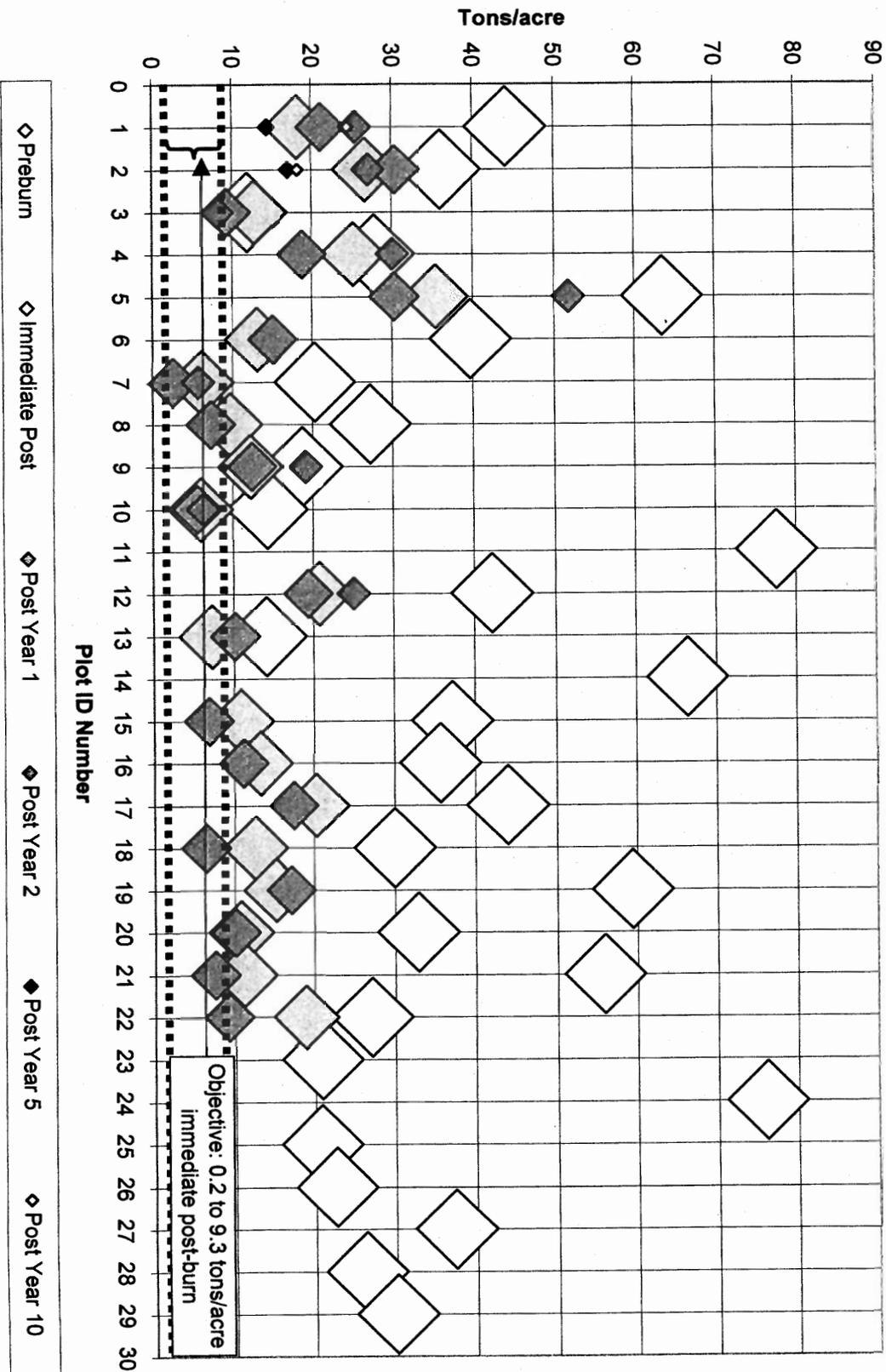


Figure 18. Total Mean Fuel Load
 December 2002
 50-foot fuels transects
 n=20, minimum required plots = 11

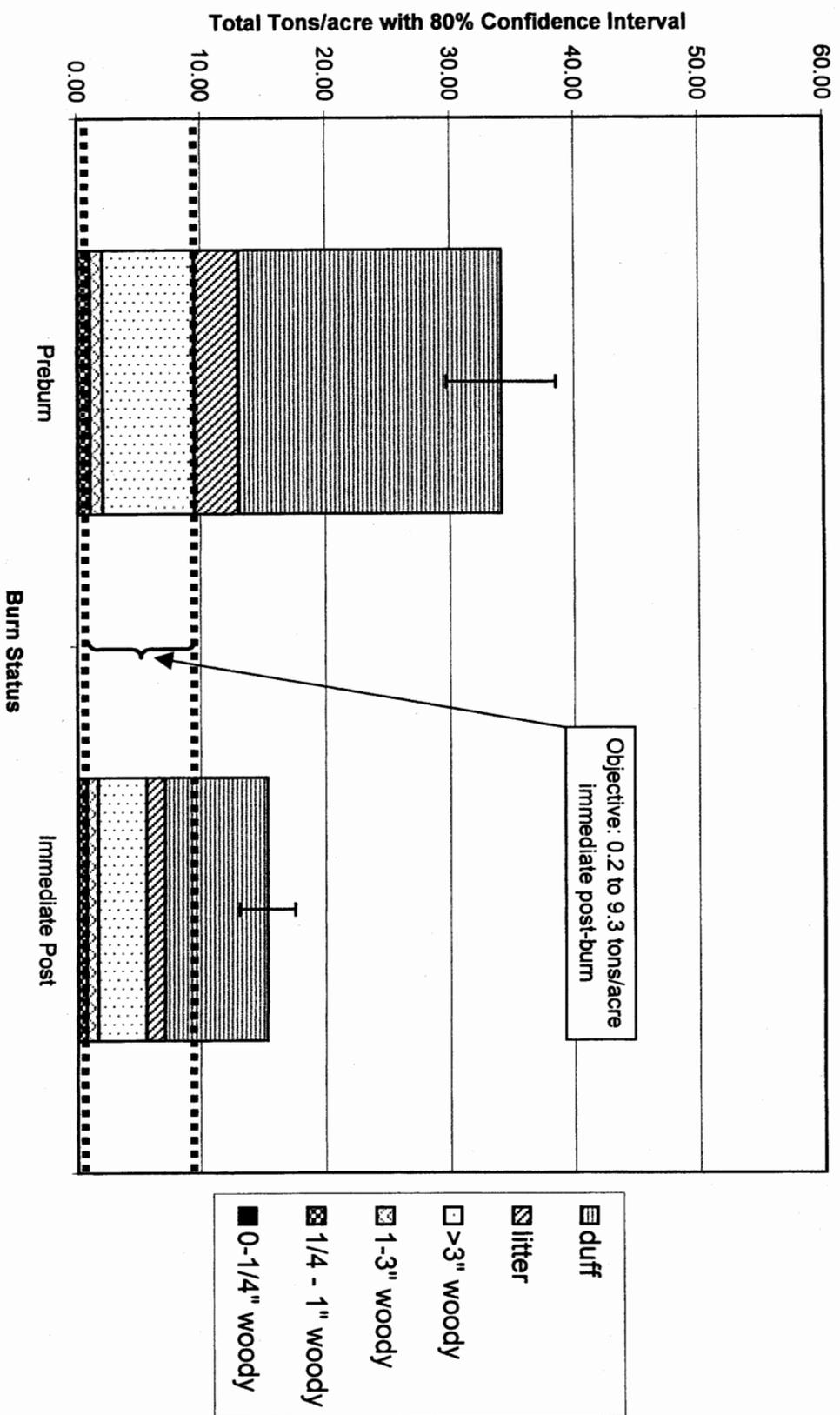


Figure 19. *Pinus ponderosa* Pole Densities, by plot
December 2002

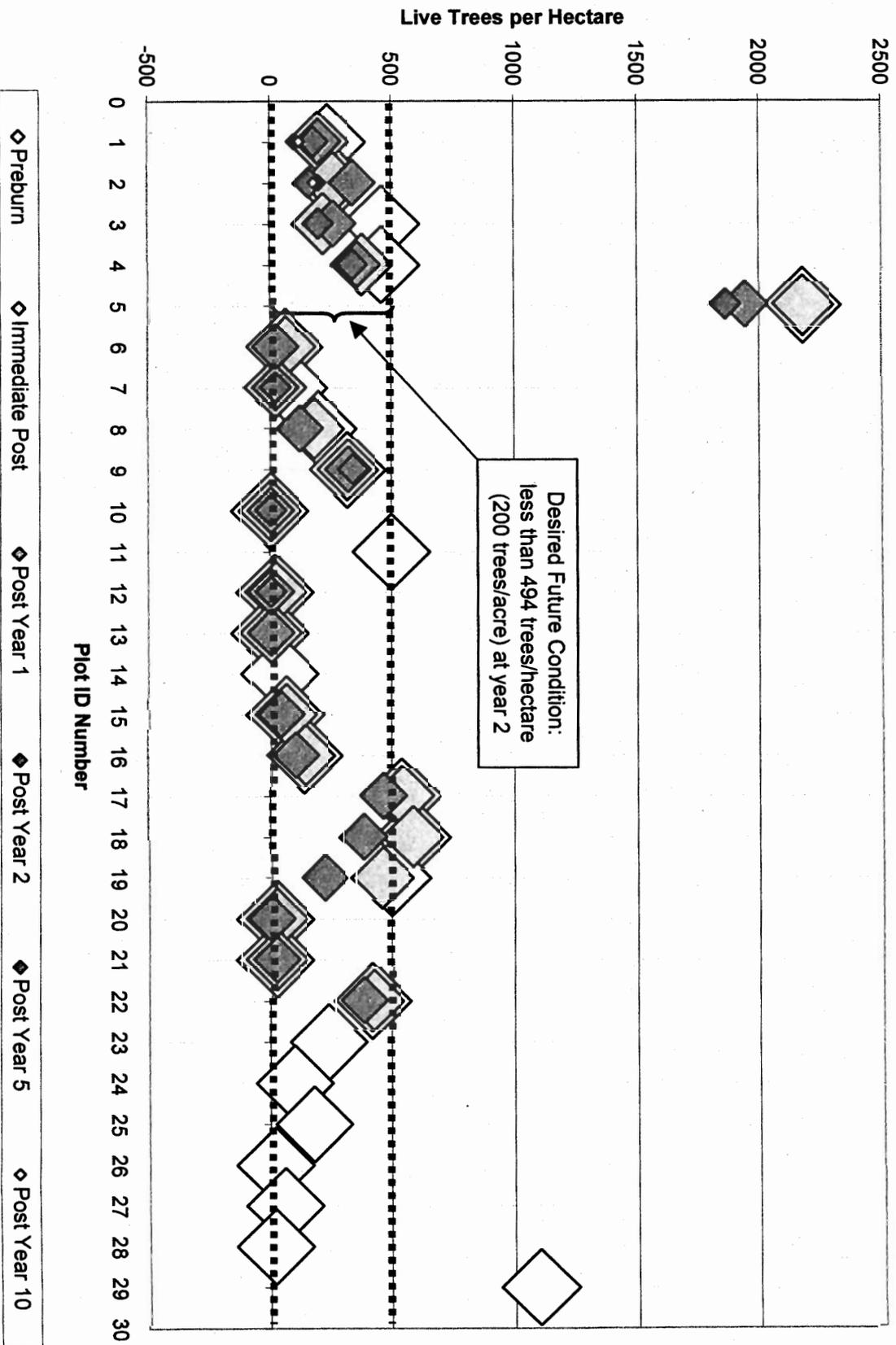
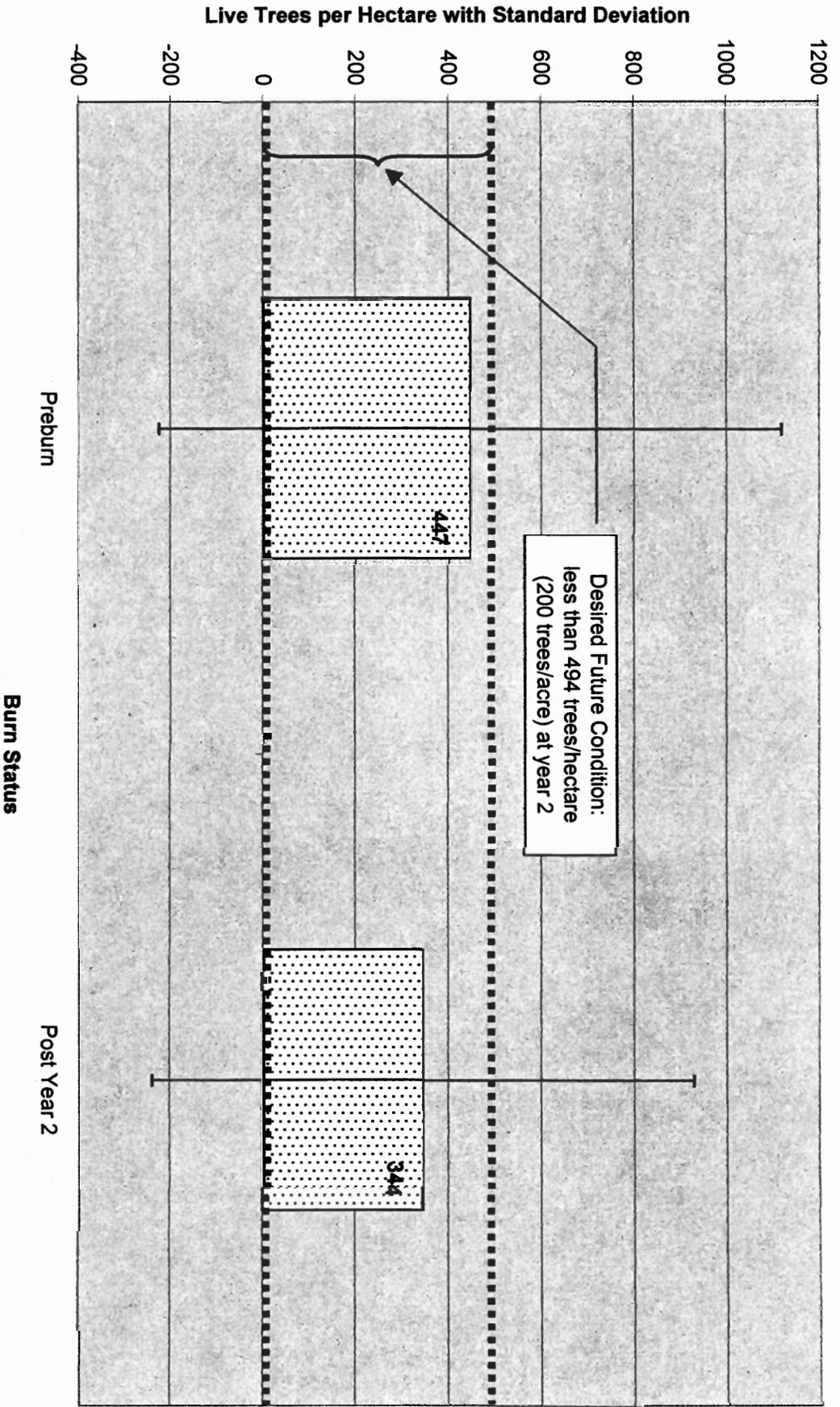


Figure 20. Mean *Pinus ponderosa* Pole Density

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n = 9 plots, required minimum pre plots = 86



North Rim Ponderosa Pine (PIPN)

Figure 21. 6 - 15.9" DBH Snag Densities, by plot
December 2002

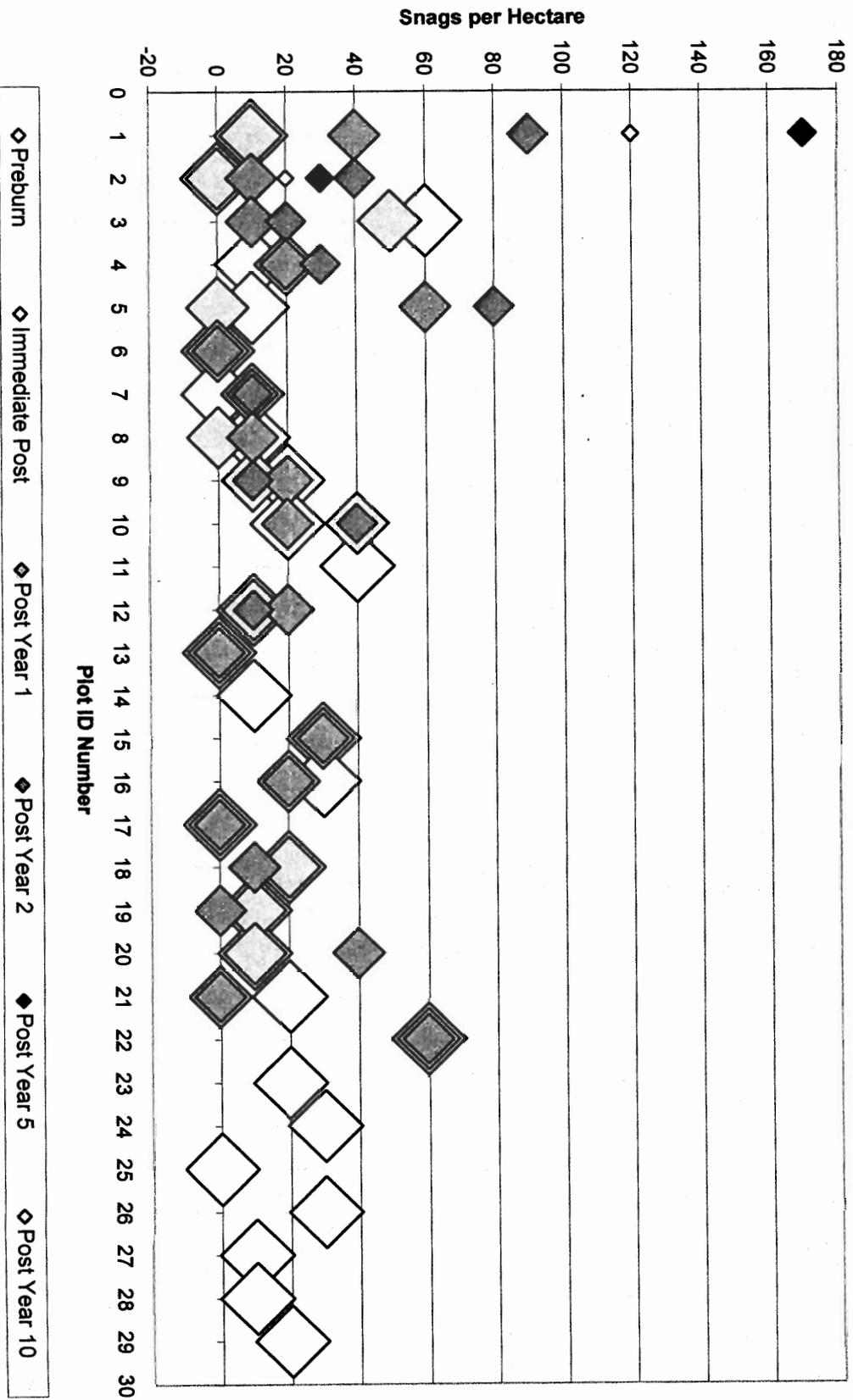


Figure 22. 16" DBH and larger Snag Densities, by plot
December 2002

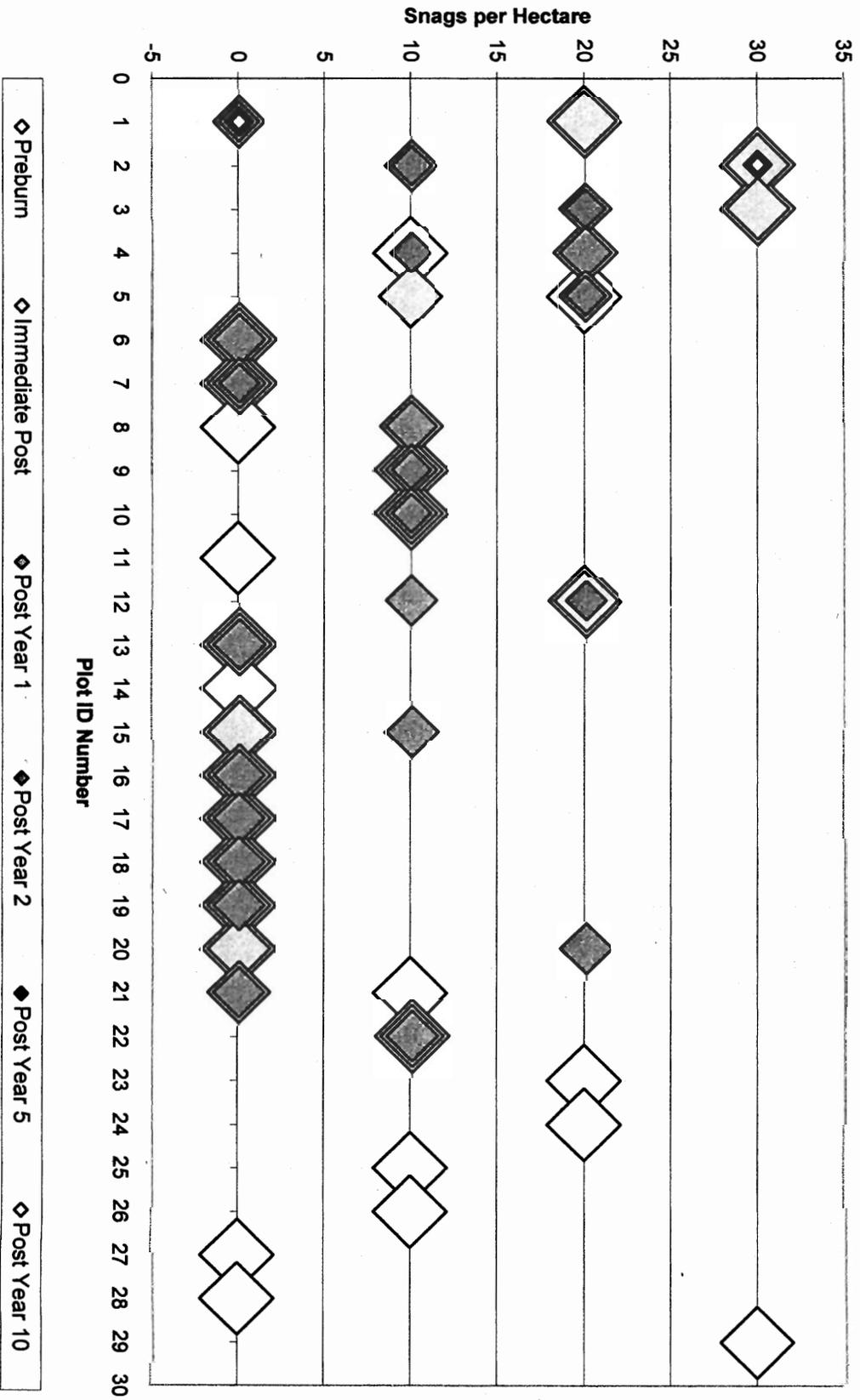


Figure 23. *Abies concolor* Seedling Densities, by plot
December 2002

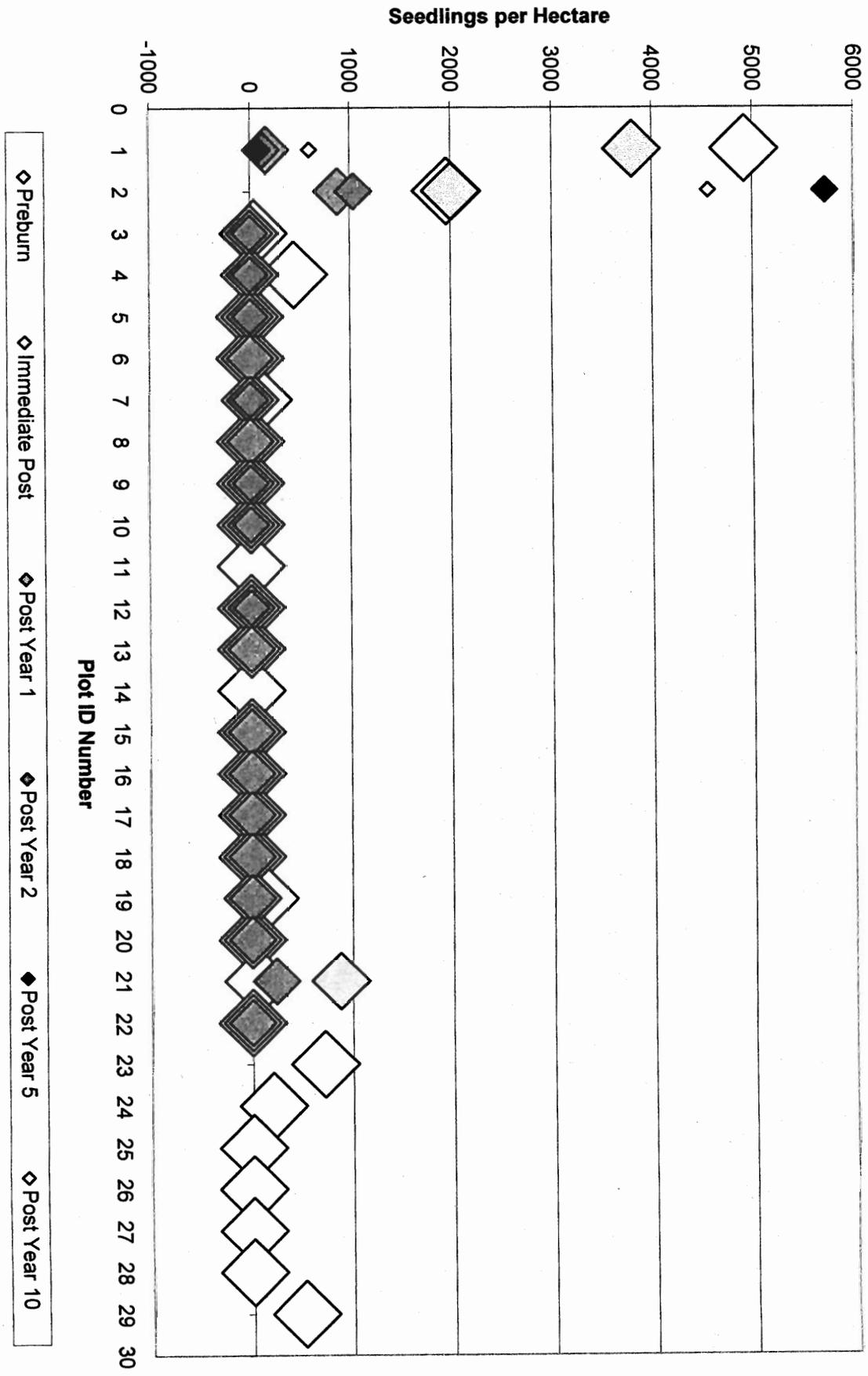


Figure 24. *Pinus ponderosa* Seedling Densities, by plot
December 2002

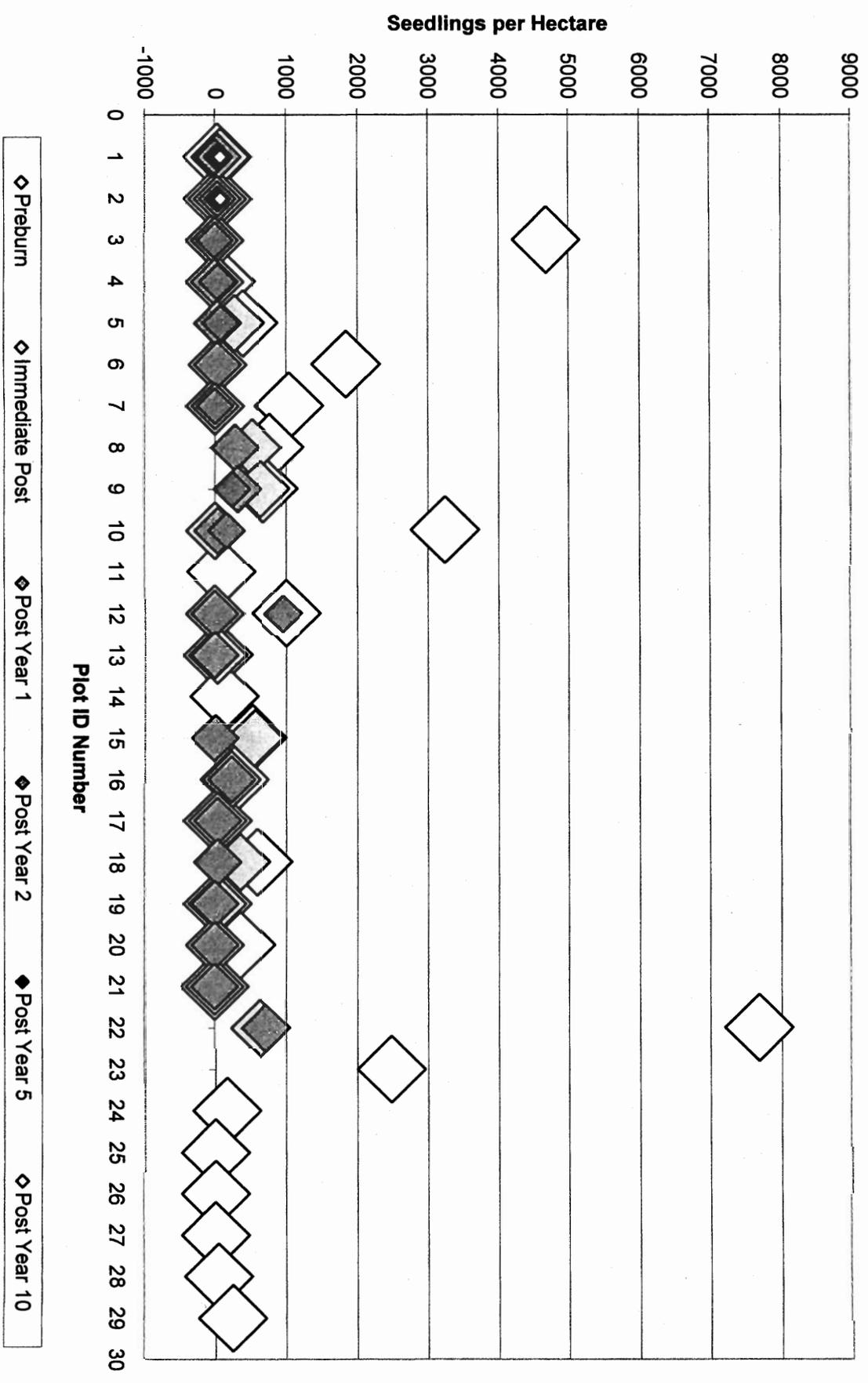
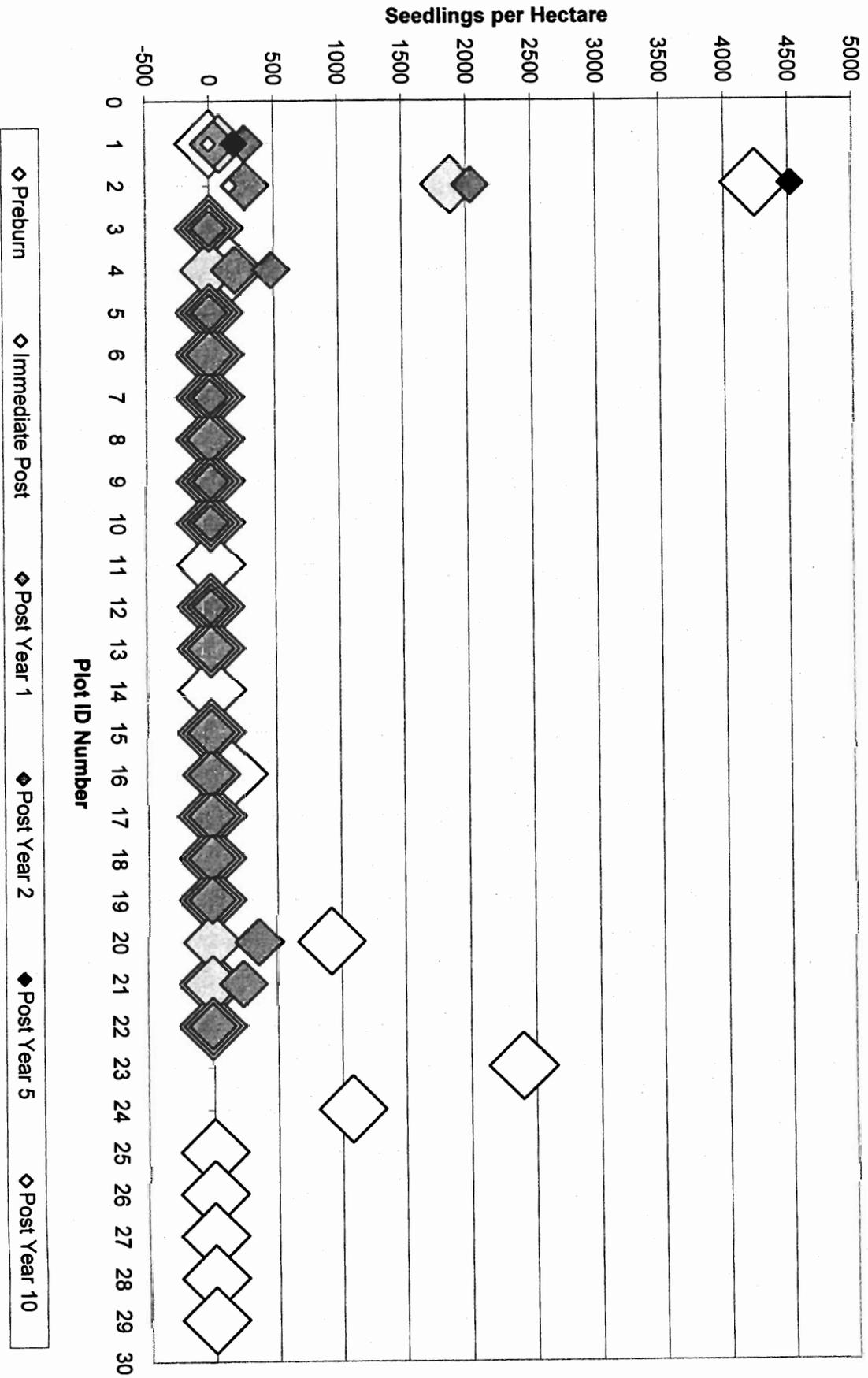


Figure 25. *Populus tremuloides* Seedling Densities, by plot
December 2002



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 26 shows *Pinus ponderosa* live overstory densities for all plots. Most plots show little change over time, with densities decreasing on plots 7, 8, 10, and 19 and increasing on plots 12, 16, and 17. There is no bar graph for this variable because there are only 3 plots with Year 5 data.

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 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 27 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 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 28 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 29 shows the range of pre-burn fuel loads that exist in this monitoring type. Most plots show a decrease in total fuel load. Figure 30 shows total mean fuel load pre-burn and post-burn. 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 yet, 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 31 illustrates the range of *Abies concolor* pole densities—approaching 1800 per hectare on one plot while zero on others. Figure 32 shows mean *Abies concolor* pole densities decreased from 309 to 166 trees/ha on 7 plots, but error bars are wide.

Was objective met? Unknown because minimum sample size is not achieved, but trends are 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 33 shows that small snag densities mostly increase over time after fire. Large snag densities in Figure 34 also generally decrease with time.

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 35 shows *Abies concolor* seedling densities across the monitoring network—trends by plot vary, with a general decrease post-burn. Figure 36 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 37 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 26. Live 16" DBH and larger Pinus ponderosa density, by plot
December 2002

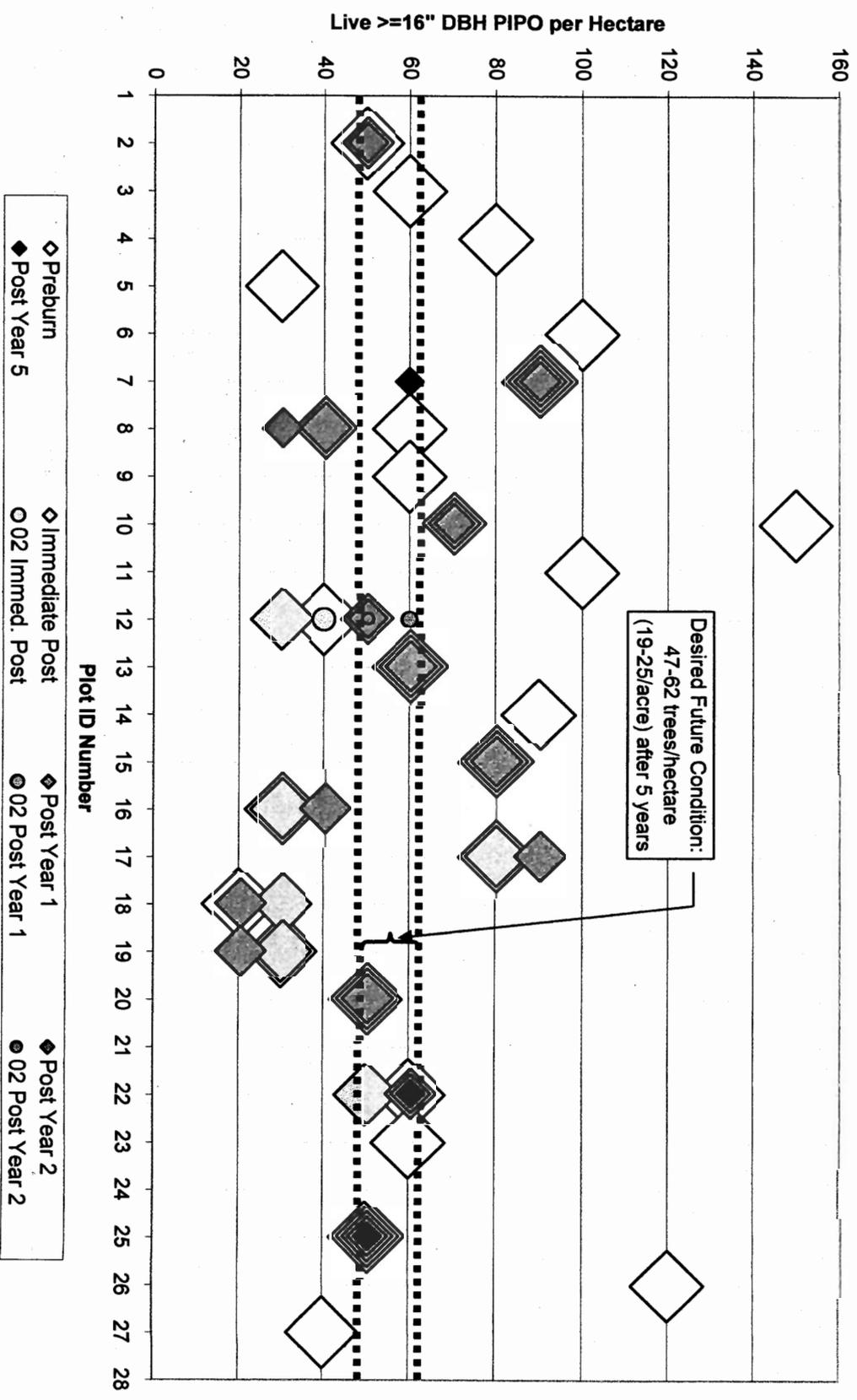


Figure 27. Post-burn Crown Scorch Percent on Live *Pinus Ponderosa* Overstory Trees, by plot
December 2002

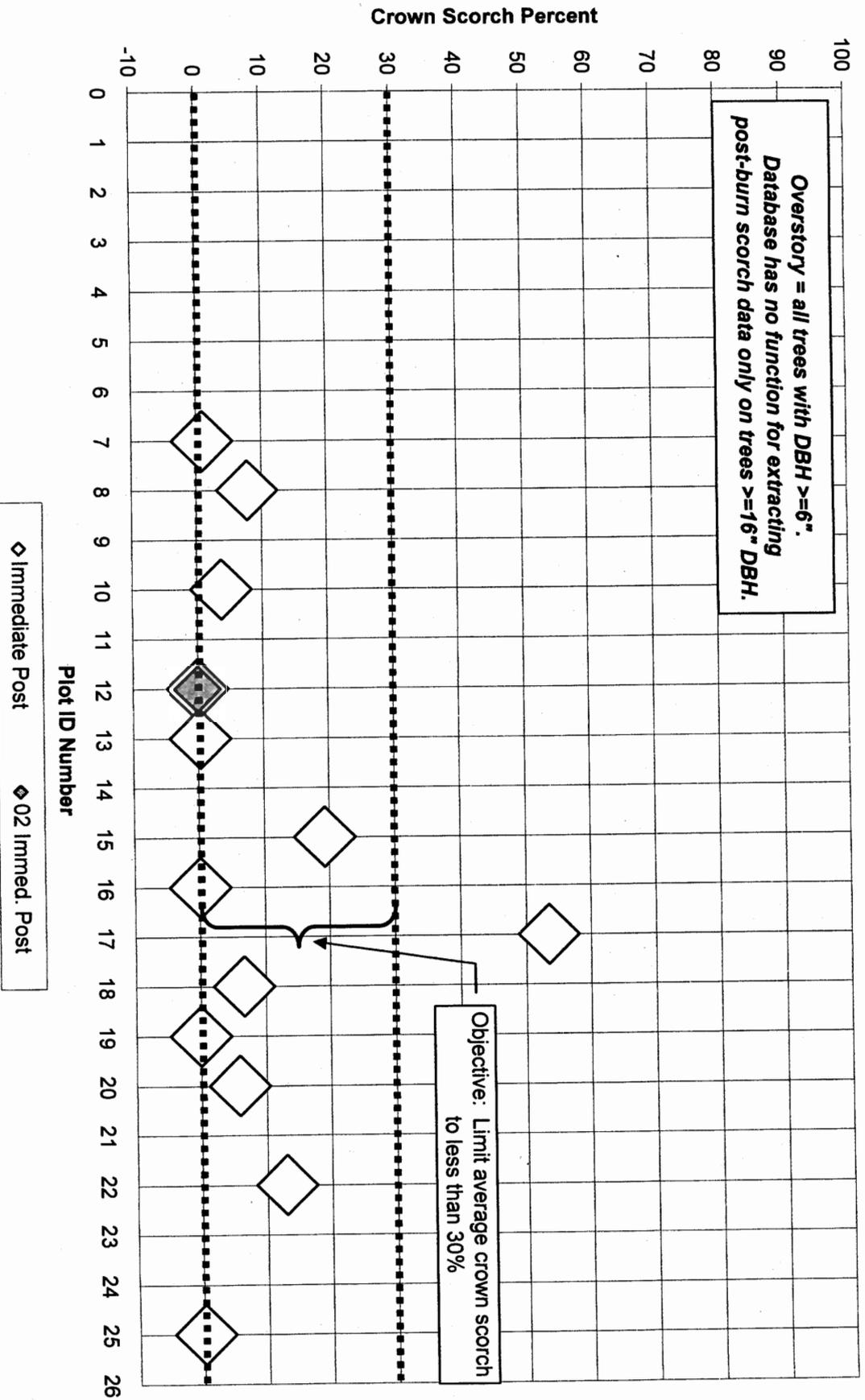


Figure 28. Post-burn Crown Scorch Percent on Live *Pinus ponderosa* Overstory Trees
December 2002

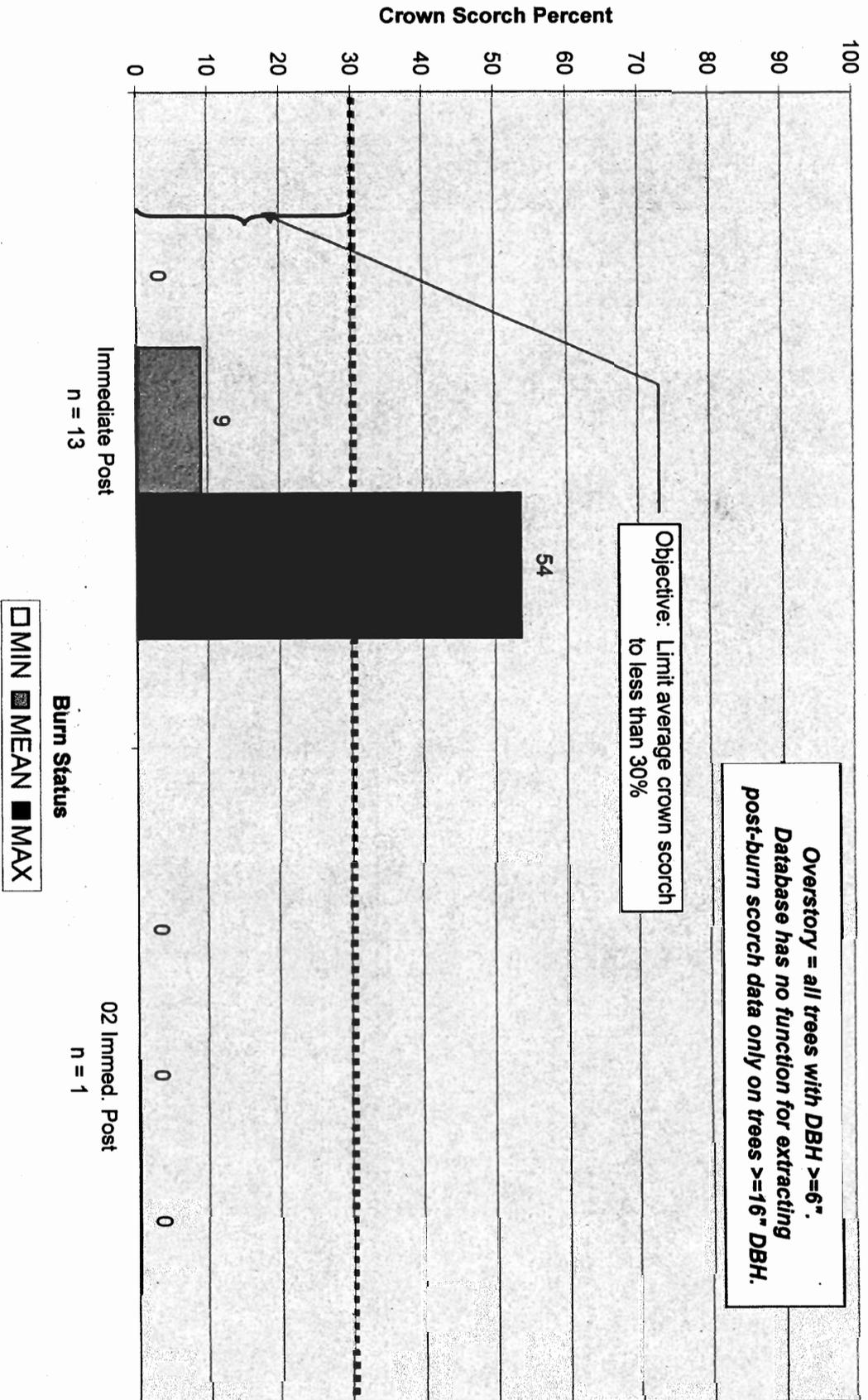


Figure 29. Total Fuel Load, by plot
 December 2002
 50-foot fuel transects

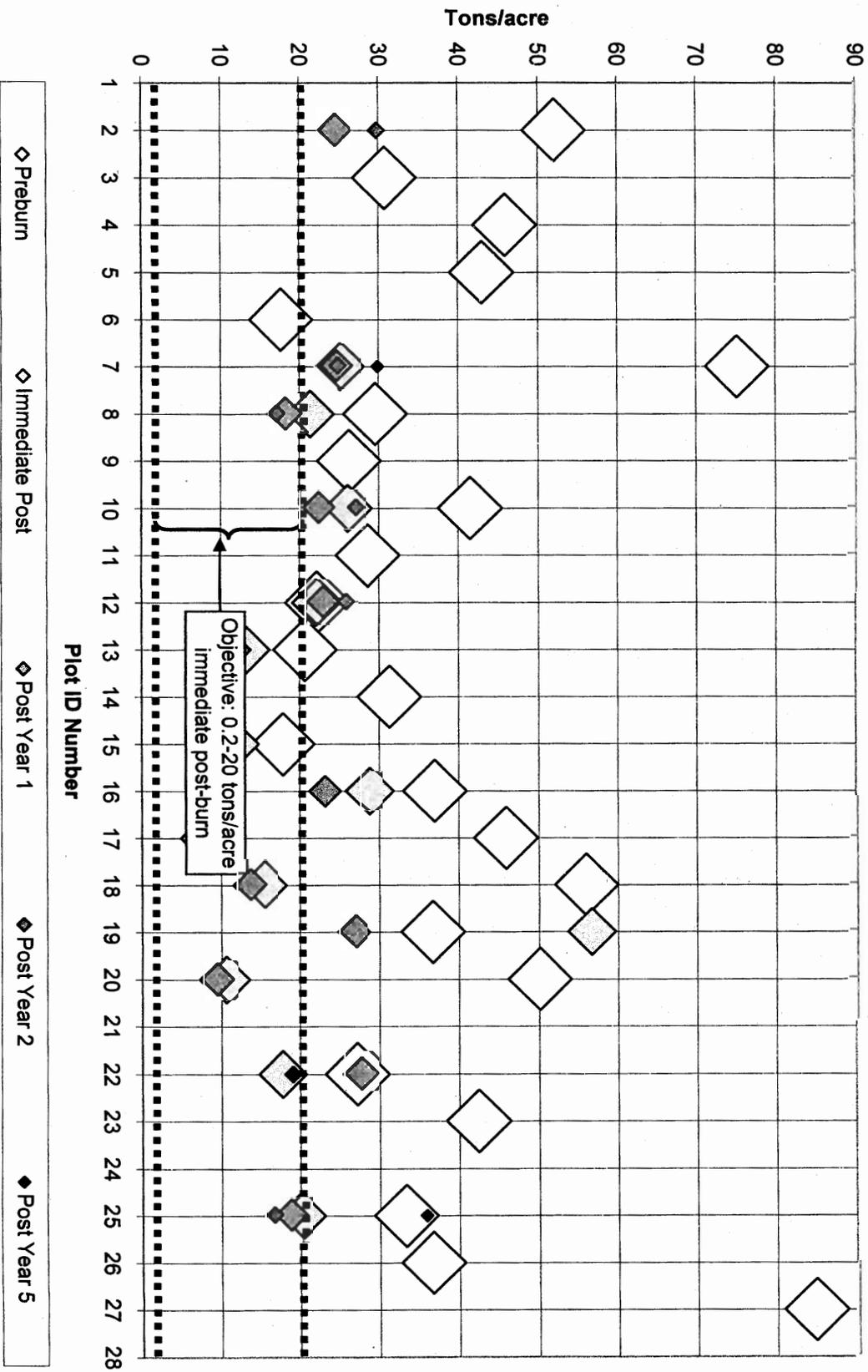


Figure 30. Total Mean Fuel Load
 December 2002
 50-foot fuels transects
 n = 13, minimum required plots = 7

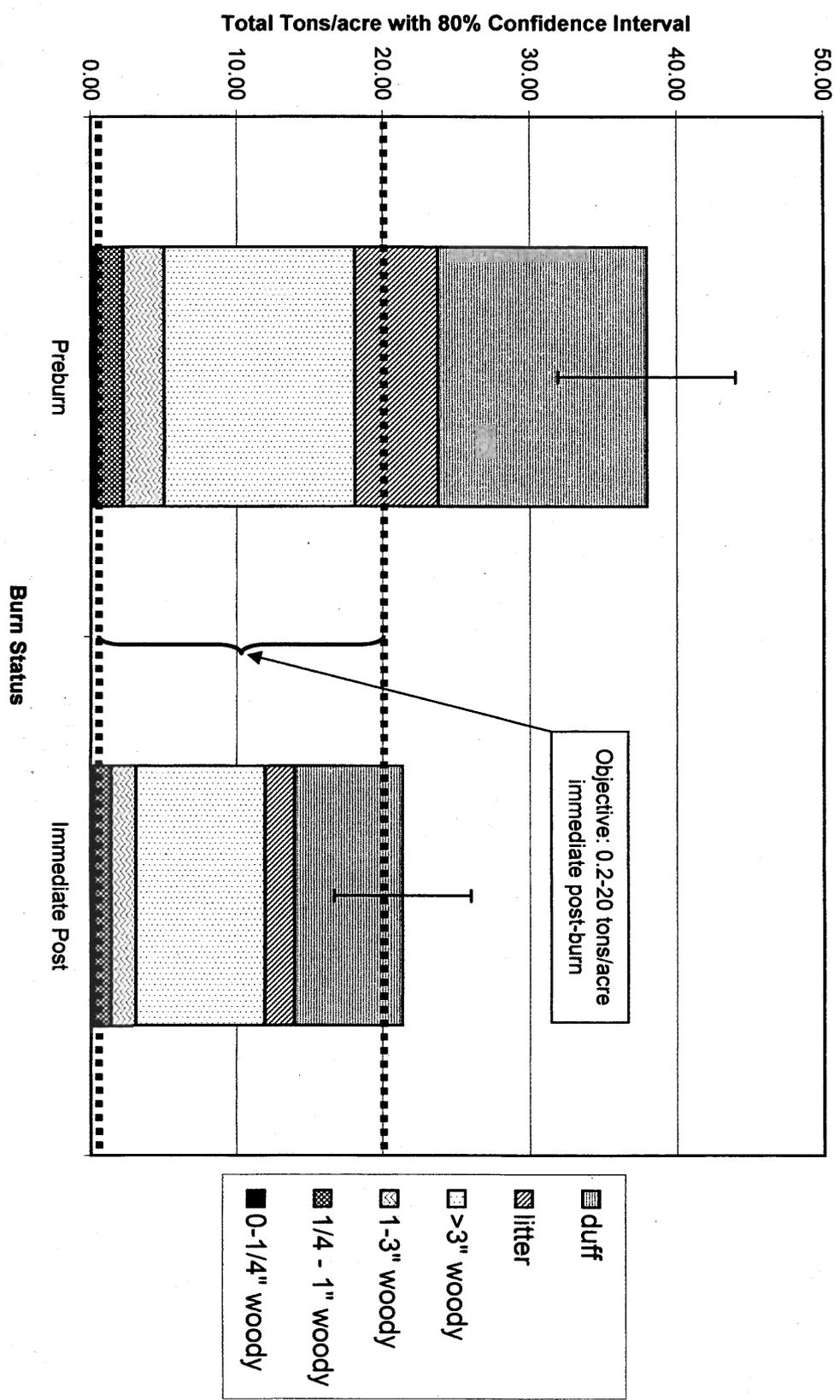


Figure 31. *Abies concolor* Pole Densities, by plot
December 2002

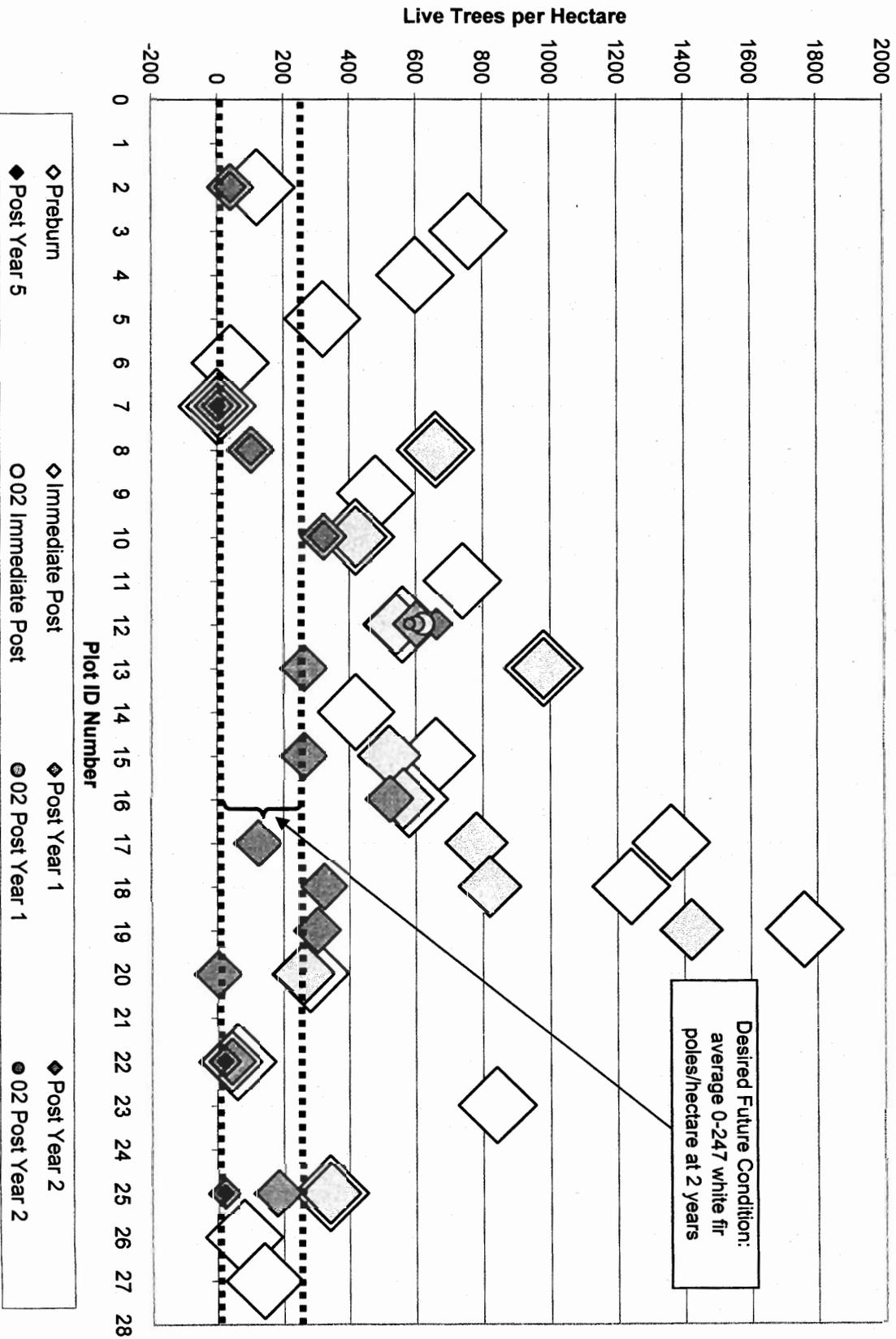


Figure 32. Mean *Abies concolor* Pole Density

December 2002

n = 7, required minimum pre plots = 27

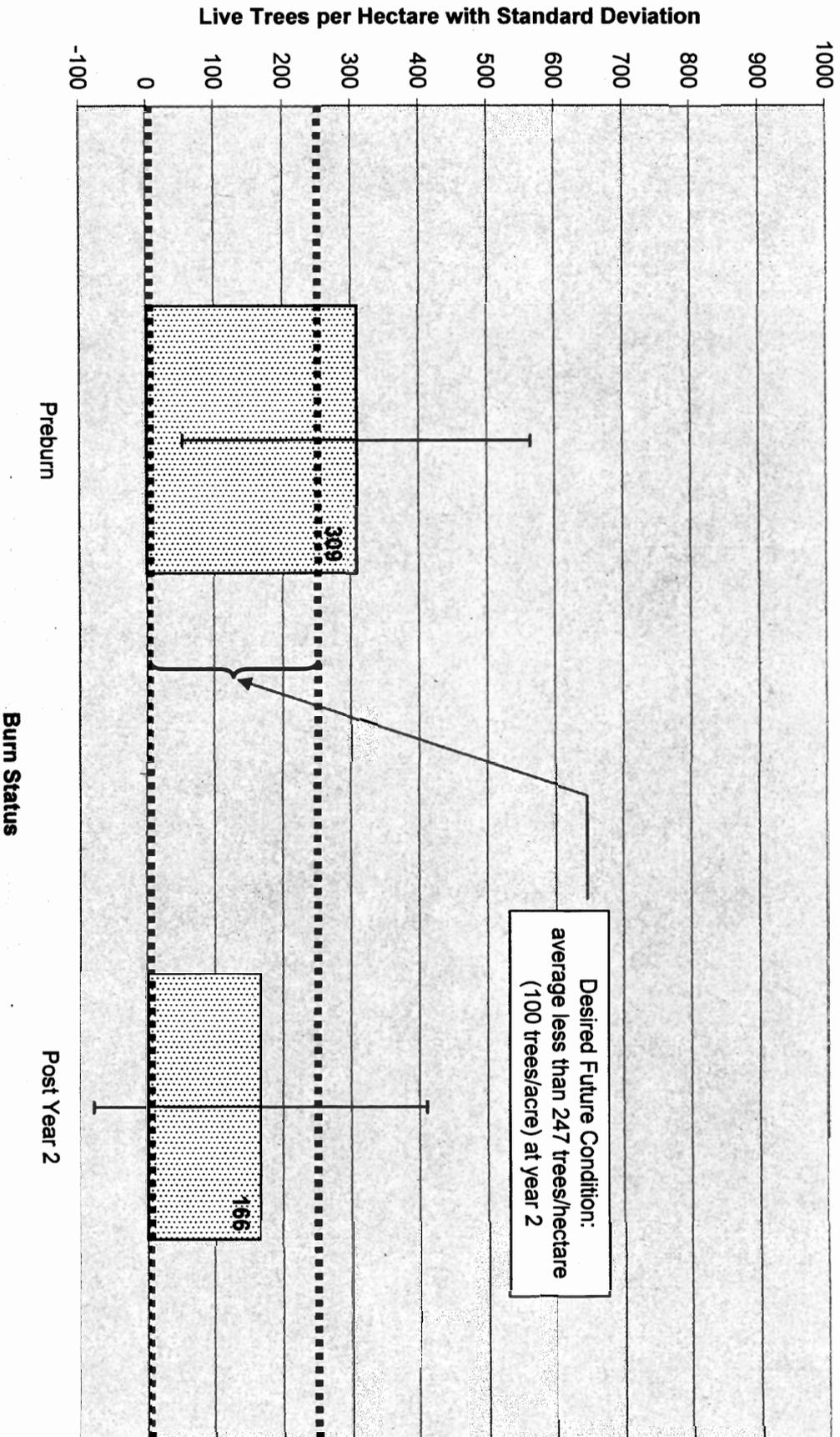
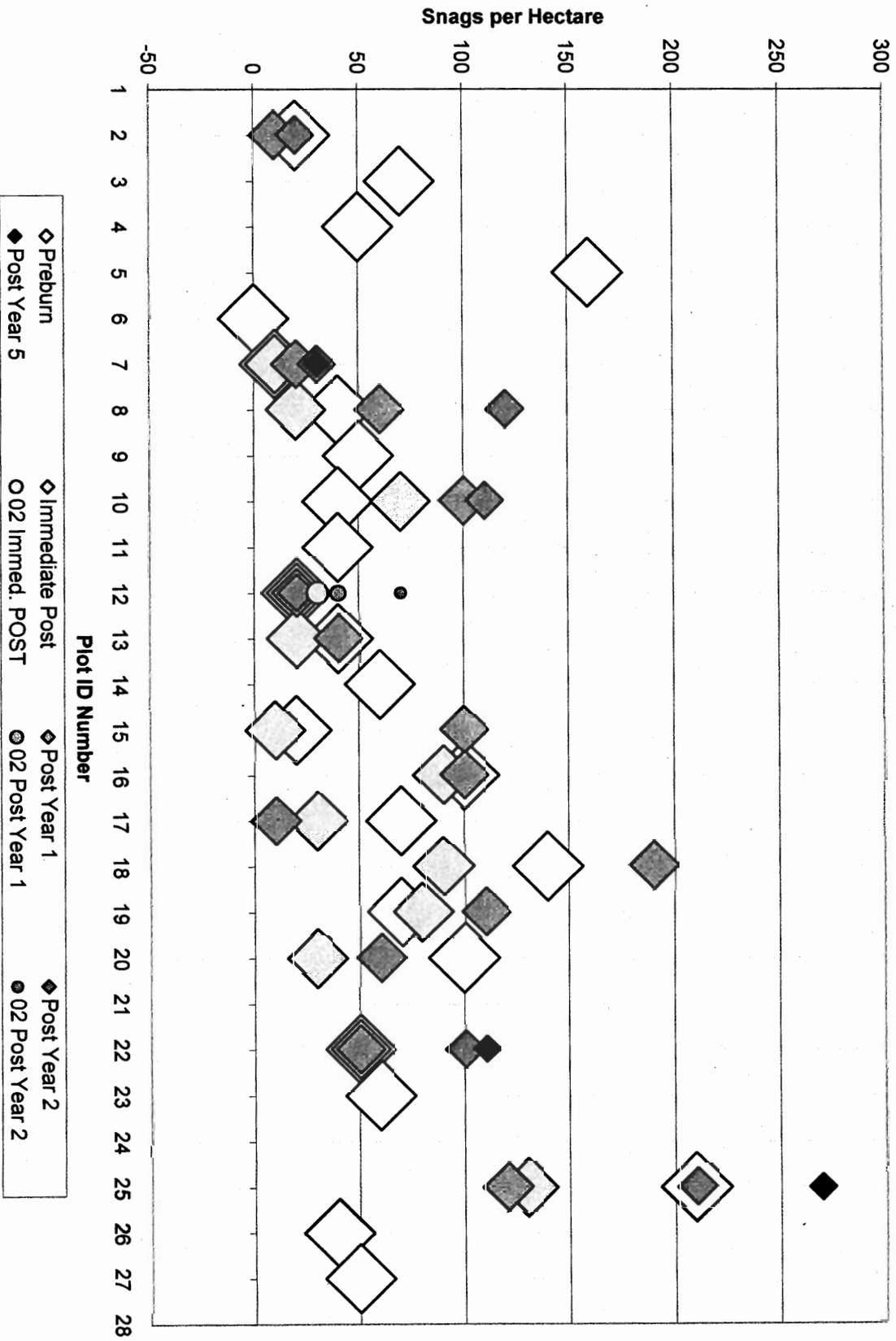


Figure 33. 6 - 15.9" DBH Snag Densities, by plot
December 2002



North Rim Ponderosa Pine with White Fir Encroachment (PIAB)

Figure 34. 16" DBH and larger Snag Densities, by plot
December 2002

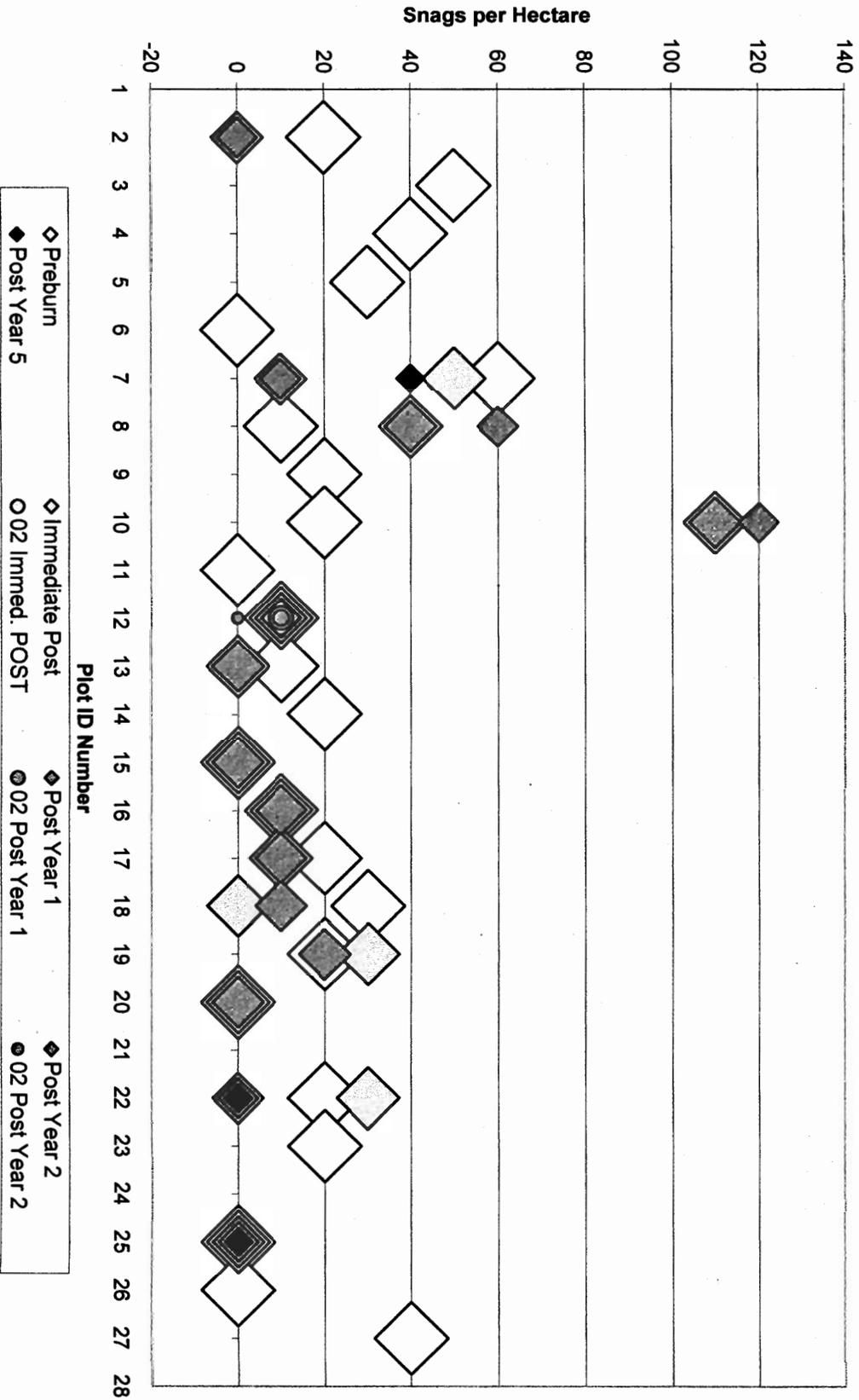


Figure 35. *Abies concolor* Seedling Densities, by plot
December 2002

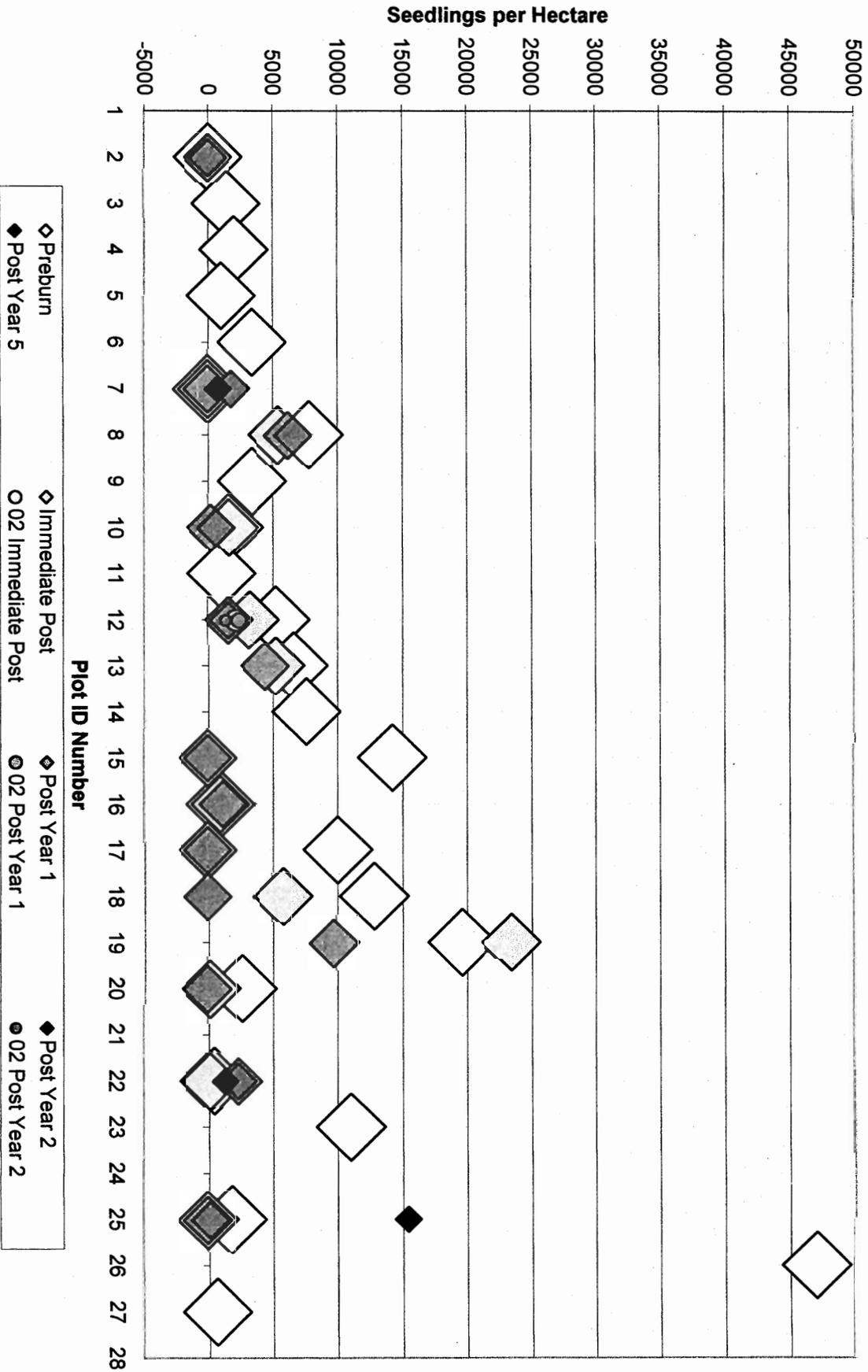


Figure 36. *Pinus ponderosa* Seedling Densities, by plot
December 2002

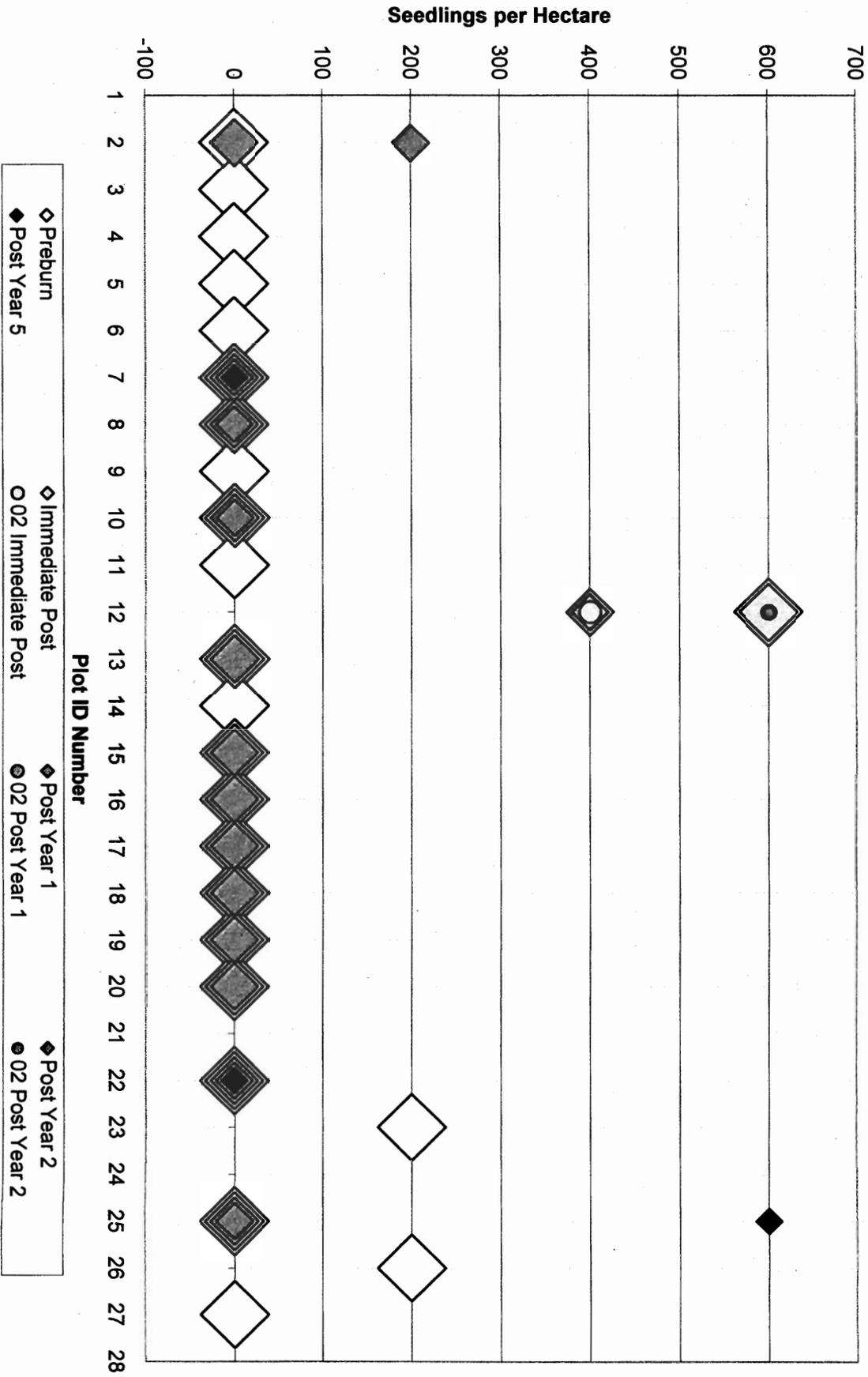
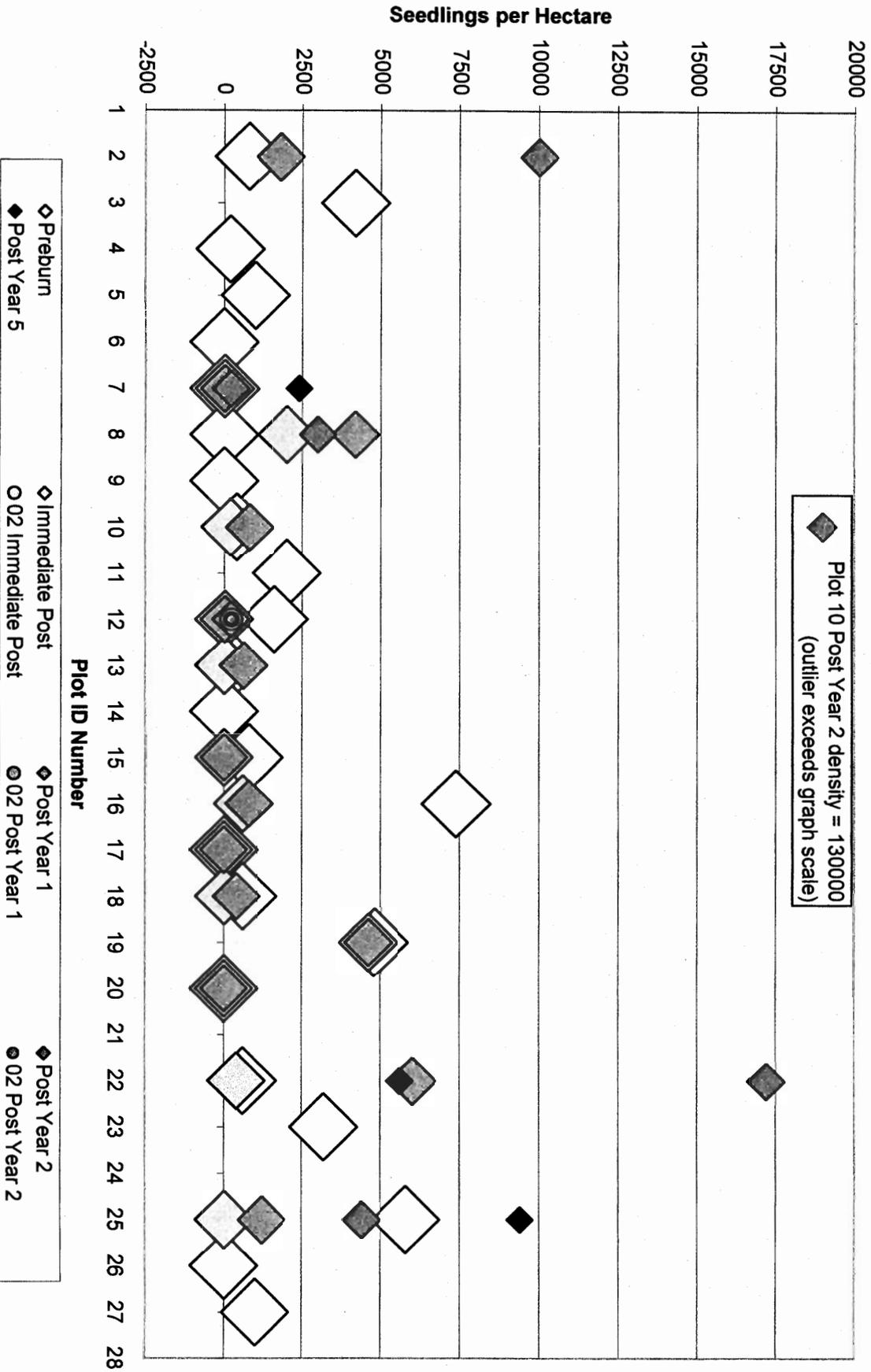


Figure 37. *Populus tremuloides* Seedling Densities, by plot
December 2002



SUMMARY OF RESULTS

Table 12 shows results for all variables that have specific monitoring objectives identified in FMH-4s. After over 13 years of fire monitoring, nine variables can finally be assessed with our minimum level of statistical confidence, but only four 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 two of our stated burn objectives (total fuel load and overstory density for PIPO), we are headed in the right direction on fuel loading for both PIPN and PIAB. Another entry in the burn cycle will hopefully reduce fuels to desired levels. With several more years of Year 5 data, PIPN and PIAB overstory densities may be available in the near future. 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 this year and last 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 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
PIPO	Overstory (PIPO)	Y	Y
	Fuel Load	Y	Y
	Poles (PIPO)	N	Unknown
PIPN	Overstory (PIPO)	Y	Unknown
	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