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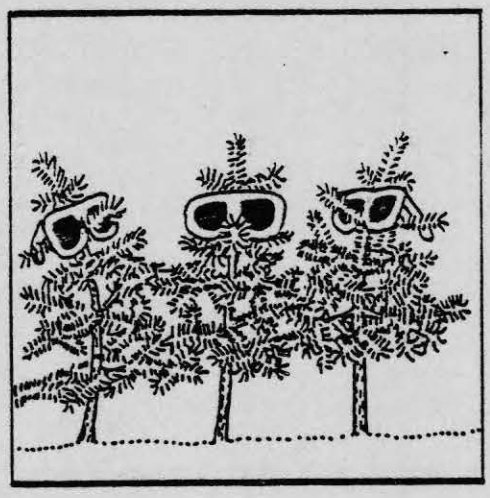
Pacific Southwest
Region

Central Zone Tree Improvement Annual Report 1990



- Superior Tree Selection
- Progeny Evaluation
- Rust Resistant Sugar Pine
- Orchard Management

1990 ANNUAL REPORT

CENTRAL ZONE TREE IMPROVEMENT AND SUGAR PINE GENETICS PROGRAM

ANNUAL REPORT 1990

CENTRAL ZONE TREE IMPROVEMENT

Cooperation between all Tree Improvement groups was a prominent feature this year. The Central Zone had no full scale planting efforts scheduled. The North Zone had their largest program ever. Central Zone supplied 1-2 supervisors for 3 weeks to establish evaluation plantations on the Mendocino National Forest. Later in the year after the release of Central Zone temporary employees, North Zone reciprocated with their help during the sorting at the Chico Tree Improvement Center. Ponderosa pine and Douglas-fir stock were sorted for planting in the spring of 1991 in the Central Zone. Earlier in the year North Zone had assigned personnel to the Rust Program for scoring sugar pine seedlings to identify Major Gene Resistant sugar pine parent trees. These are just a few examples of how the Zones and the Chico Tree Improvement Center cooperate. A valuable sharing of equipment, displays, techniques and ideas also take place. This cooperation continues to be an essential part of how we get the job done.

Central Zone selection crews began the year finishing white fir Breeding Zone 3. Then a new species and area were tackled. Jeffrey pine BZ 1 encompases the east side of the Plumas and Tahoe National Forests. Much of this area represents productivity classes that are comparatively low to west-side Sierra timber types. However, the nearly 900,000 annual seedling needs projected and reported to the Regional Geneticist in 1985 make it deserving of a program. To date 69 selections have been made. Additional efforts were made to relocate 46 MGR parent sugar pine and evaluate them as superior trees. Cone crops in all but sugar pine were virtually non-existant. Scionwood were collected from white fir, Douglas-fir and sugar pine from both the field and orchards belonging to the USFS and Tree Improvement Association members. Pacific yew was another new species. It provided an enjoyable learning process while 6 stands were sampled as part of range-wide USFS effort.

There were many accomplishments and challenges met by the Rust Resistance Program. A petition to list sugar pine as a threatened species was sent to the State Department of Fish and Game. As most of the the growing stock of this species is on USFS land, our agency was faced with addressing each of the concerns offered in the petition along with the CDF. Though time consuming it proved to enhance the already strenghtening cooperation taking place between the USFS, CDF, Univ of Calif, private industry, special interest groups and Calif Dept of Fish and Game. With last years Sugar Pine Workshop it provided another opportunity to disperse information and display the already large and growing effort to manage with Blister Rust. An example of this is that the sugar pine crop was taken advantage of by collecting cones from nearly 3103 candidate trees within the Region for evaluation of MGR and "Slow Rust" resistance. Last spring, 4188 seedlings were planted at the Happy Camp Outplant Site for evaluation of slow rust resistance. A greenhouse was constructed and will be finished soon. In the mean time it houses some of the 80,000 seedlings from 1325 candidate trees to be evaluated this winter for MGR.

Estalishment of both the seed orchard and clone bank for Douglas-fir Breeding Zone 7 were begun. A PSW project with Jack Stein on ponderosa pine seed insect "Life Table" has moved into the data analysis and evaluation phase. An adiministrative study of ponderosa pine pollination was also completed at Foresthill. Administrative studies at Badgerhill included "bark scoring" to reduce sugar pine graft rejection and a complete survey of sugar pine cone, conelet and pollen production by ramet.

Personnel with the CZTI and Institute of Forest Genetics hosted an afternoon field session for the California Tree Imrpovement Association. We also participated with the Placerville Nursery in the Arbor Day celebration at which Regional Forester Paul Barker announced his "New Perspectives" Ranger Districts. Members attended and in some cases gave presentations at the WFGA meeting in Olympia, IUFRO Population Genetics of Forest Trees in Corvallis and Servicewide Workshop for Tree Improvement and Silviculture in Wenatchee. The Sugar pine program was invited to a poster session in the Region-6 Biodiversity Workshop in Spokane. CZTI was also represented well at the Region 5 Workshop for Vegetation Management and GENE. Most members of CZTI and the Sugar Pine Genetics Program (SPGP) now hold First Responders or Advanced 1st Aid certificates and CPR cards.

Transition continued with the loss of Steve Witkowski who is now a Washington Office liason with the California Department of Forestry. Steve is stationed in Sacramento but hasn't foresaken us. He continues to provide consultation and has set up two new PC systems recently purchased.

Three new faces are now present. Rose Loveall-Sale who has taken Karen Lee's former duties with a different position description. Rose's background in horticulture and plant physiology will be invaluable in the Rust Program and to the extent possible in the orchards. Clara Dair came to us from the Sequoia National Forest to assume Pam Borman's position. Her experience as an assitant Culturist will be valuable to both selection and progeny work. At Foresthill, Loretta Colin filled a recently created position. Travis Reid retired after many dedicated years.

Ralph Sanders has returned and has taken up where he left off in progeny testing. Ralph applies his skills in progeny test maintenance. He is invaluable with maintaining or even building equipment we need for different tasks. He has also procurred many valuable items from surplus for not only CZTI and the Rust Program, but Foresthill, CTIC and NZ.

The SPGP has hosted two volunteers from Germany. Andreas Schuck collected data on the performance of the sugar pine in the progeny tests for his thesis. This work has provided the region with 5 new selections for Slow Rust. Maiken Bruhns was with us for two months and was an asset during the cone receiving season. There were many other detailers from Forests that helped during the scoring. Without them, the job would not have been accomplished.

I hope, we can continue to provide positive challenges and interest for all stationed here at the Placerville Nursery and Foresthill. For my part I couldn't be happier working with this group of people.

Paul Stover
Zone Geneticist

Safiya Samman
Program Manager SPBR

ACCOMPLISHMENTS AND PLANNED ACTIVITIES BY BREEDING ZONE FOR CENTRAL ZONE

PONDEROSA PINE

ACTIVITY	SPECIES ZONE	PP BZ-2*	PP BZ-3	PP BZ-4	PP BZ-21	PP BZ-30
SELECT TREES		C	C	C	C	C
COLLECT SEED		C	C	C	C	C
SOW SEED		C	C	C	C	C
SELECT SITES		C	C	C	C	C
PREPARE SITES		C	C	C	C	C
OUTPLANT PROGENY		C	C	91	C	C
COLLECT SCION AND GRAFT		C	C	87-?	91	?
PLANT CLONEBANK		C	C	91	92	?
PLANT ORCHARD		C	C	?RB	91	?
USFS TREES SELECTED		224*	217	202	--	--
CO-OP TREES SELECTED		--	--	--	141	182
TREES WITH SEED (min 100)		132*	138	132	?	?
TREES UNTESTED W/SEED (min 400)		1	6	4	?	?
TREES SOWN THIS YEAR		--	--	97***	--	--
SITES SELECTED		5*	5	4/4**	6	4
FAMILIES OUTPLANTED		185	182	90	131	135
CLONES ESTABLISHED		176	183	159	58	?

* North Zone included
** Sets 1&2/Sets 3&4
*** Includes SZ 532
RB Planned originally for surrendered Red Bluff site

SUGAR PINE

ACTIVITY	SPECIES ZONE	SP BZ-3*	SP BZ-4	SP BZ-5
SELECT TREES		C	C	C
COLLECT SEED		91	C	91
SOW SEED		?	?	?
SELECT SITES		?	?	?
PREPARE SITES		?	?	?
OUTPLANT PROGENY		?	?	?
COLLECT SCION AND GRAFT		76-?	87-?	89-?
PLANT CLONEBANK		76-?	89-?	89-?
PLANT ORCHARD		?	?	?
USFS TREES SELECTED		125	182	213
CO-OP TREES SELECTED		10	2	34
TREES WITH SEED (min 100)		172**	158	154
TREES UNTESTED W/SEED (min 400)		108**	127	123
TREES SOWN THIS YEAR		--	--	--
SITES SELECTED		4	--	--
FAMILIES OUTPLANTED		45	--	--
CLONES ESTABLISHED		210	55	17
RRSP TEST ***		484	707	242
TREES RESISTANT **		61	89	88

* North Zone included
** Includes some Showalter selections
*** All trees screened to date

WHITE FIR AND DOUGLAS FIR

ACTIVITY / SPECIES ZONE	WF BZ-1	WF BZ-2	WF BZ-3	DF BZ-7
SELECT TREES	C	C	C	C
COLLECT SEED	87-91	C	91-92	C
SOW SEED	92	C	93	C
SELECT SITES	C	C	91-92	C
PREPARE SITES	89-91	C	92-93	C
OUTPLANT PROGENY	93	C	94	91
COLLECT SCION AND GRAFT	87-91	C	91-92	C
PLANT CLONEBANK	88-92	C	92-93	90-91
PLANT ORCHARD	88-92	C	92-93	90-91
USFS TREES SELECTED	213	107	199	70
CO-OP TREES SELECTED	20	189	--	198
TREES WITH SEED (min 100)	101	44	1	62
TREES UNTESTED W/SEED: (min 400)				18
(min 800)	86	3	0	
TREES SOWN THIS YEAR	--	--	--	197*
SITES SELECTED	4	3/2**	--	1/6**
FAMILIES OUTPLANTED	--	63/143**	--	46/153**
CLONES ESTABLISHED	188	104/173**	--	65/133**

* Includes Private Industry
** Forest Service/Private Industry

JEFFREY PINE

ACTIVITY / SPECIES ZONE	JP BZ-1	JP BZ-2	JP BZ-3	JP BZ-4
SELECT TREES	90-93	93-95	--	--
COLLECT SEED	91-94	93-96	--	--
SOW SEED	95	97	--	--
SELECT SITES	92-93	94-95	--	--
PREPARE SITES	94-95	96-97	--	--
OUTPLANT PROGENY	96	98	--	--
COLLECT SCION AND GRAFT	93-94	95-96	--	--
PLANT CLONEBANK	94-95	96-97	--	--
PLANT ORCHARD	94-95	96-97	--	--
TREES SELECTED	69	--	--	--
CO-OP TREES SELECTED	--	--	--	--
TREES WITH SEED (min 100)	--	--	--	--
TREES UNTESTED W/SEED: (min 400)	--	--	--	--
TREES SOWN THIS YEAR	--	--	--	--
SITES SELECTED	--	--	--	--
TREES OUTPLANTED	--	--	--	--
CLONES ESTABLISHED	--	--	--	--

SELECTION/COLLECTION

1990 SELECTION/COLLECTION ACCOMPLISHMENTS

A. Selection of Superior Trees:

In 1990, Central Zone Tree Improvement concentrated their selection efforts in JP-1, resulting in 69 Jeffrey pine selections. In addition, 4 selections were made in WF-3, and 46 resistant sugar pine selections were located in the field. Of these 46 sugar pines, 44 were measured and tagged, one was dead, and the last had an identity problem to be investigated prior to tagging. Seven of these trees were measured and tagged by Duane Nelson at Placerville District. In all, Tree Improvement crews made 110 selections in 92 crew days, averaging 1.2 selections per crew day.

Of the 69 Jeffrey pine selections, 27 were inspected in the field. Some measurement problems, in ages and heights, were discovered in the early inspections. The age errors were due to considerable slowing of the growth rates in the last 10 to 30 years, resulting in very tight spacing of growth rings. This problem was corrected using hand lenses and closer scrutiny. The height measurement problems were attributed to one temporary employee and was corrected with additional training and close monitoring. Because of these problems, all Jeffrey pine selections made up to that point were checked and reevaluated by the crews. This resulted in some selection changes but no rejections.

1990 Superior Tree Selection

Species	Breeding Zone	#Selections	#Inspected	#Rejected	Net Selections
WF	3	4	0	0	4
JP	1	68	27	0	68
TOTAL		72	27	0	72

B. Scion Collection:

The major scion collection effort was in WF-1, PP-4, and rust resistant sugar pine. Field collections were made from 42 selections in WF-1 and from 1 selection in WF-2. Collections were also made from 46 clones from WF-1 and 43 clones from WF-2 at the Badger Hill clonebank.

Field collections were also made from 18 PP selections in BZ-4 and 2 DF selections in BZ-7. In addition, scion was collected from 11 PP clones in the Fiberboard (L-P) clonebank at Sonora.

1990 Scion Collection

Species	Breeding Zone	#Trees Collected	#Scion Collected
WF	1(FS)	95	1329
	1(PRI)	3	48
	2(FS)	43	157
	2(PRI)	1	12
	3	1	12
Subtotal		143	1558
PP	3(PRI)	11	98
	4	18	148
Subtotal		29	246
SP	3	10	51
	4	26	224
	5	6	42
Subtotal		42	317
DF	7	2	28
TOTAL		216	2149

C. Yew Collections:

During 1990, Central Zone personnel were involved in the range-wide effort to select representative trees of pacific yew and collect bark, scionwood, and vegetative material for taxol testing and propagation. We selected five stands on three forests and collected material from three trees in each stand.

1990 Yew Collection

Forest	District	# of Stands	Trees/Stand
Plumas	La Porte	1	3
Tahoe	Downieville	1	3
	Foresthill	1	3
Eldorado	Pacific	1	3
	Placerville	1	3
TOTAL		5	15

D. Cone Collection:

The only good cone crop in 1990 was on sugar pine and much of that was hit hard by squirrels. Of the 19 sugar pine selections bagged in the spring, only nine were collected. The remaining 10 lost their crops, mainly to squirrels. Central Zone personnel were also able to assist Placerville District and Calaveras District, by bagging and collecting cones on resistant sugar pine. This effort resulted in the collection of 17 bushels of cones for Placerville and 10 bushels for Calaveras. We also provided assistance to Oroville District, collecting several bushels of Douglas-fir and gaining valuable spur climbing experience.

With considerable help from Placerville Nursery folks, Central Zone and Sugar Pine Program personnel processed 53 small seed lots from the Badger Hill clone bank and 2247 sugar pine and western white pine selections for screening.

1990 Superior Tree Cone Collection

Species	Breeding Zone	#Trees Collected	# Bagged	#Lost[1/]	%Lost
SP	3	2	2	0	0%
	4	1	1	0	0%
	5	6	16	10	63%
TOTAL		9	19	10	53%

1/ Number of trees that had been bagged that were lost to squirrels, abortion, etc.

E. Pollination:

In 1990, white fir pollen was very scarce in BZ-1. Pollen was collected from only one superior tree. The female flower crop was virtually non-existant, so no cross-pollination was done.

In BZ-3, more pollen was found, enabling collection from three superior trees. The female flower crop was scattered and not worth the considerable effort necessary to establish crosses.

1990 Pollen Collection

Species	BZ	# of Trees	# of Bags
WF	1	1	2
	3	3	5

F. Computer Work:

Work on growth projections based on progeny test data is nearing completion and looks very promising. This was done using two growth models, SYSTUM-1 on PC and CACTOS on DG, rather than PROGNOSIS as was originally planned. SYSTUM-1 was designed to grow small trees, especially in a plantation environment. Neither CACTOS nor PROGNOSIS handle growing small trees very well.

SYSTUM-1 was used to grow trees, using progeny test data from Set 4 at Badger Hill, to a size that would be better handled by CACTOS. CACTOS was used because: 1) it is much easier to work with and to adjust management of a stand than PROGNOSIS and 2) it projects diameter growth from height growth, which is the more heritable trait and better represents our expectations in a managed stand. PROGNOSIS projects height growth from diameter growth.

Results of this work will be presented at the Tree Improvement annual meeting and will be written up for distribution within the region.

1991 SELECTION/COLLECTION WORK PLANS

A. Selection of Superior Trees:

Selection for 1991 will focus on JP-1 and on continuing to locate, measure, and tag district sugar pine selections that prove to be resistant. We will select from 50 to 80 Jeffrey pine, depending on the impact of resistant sugar pine and the amount of time that a third crew can be utilized for selection.

While doing cone survey in WF-3, enough mortality could be discovered to warrent additional selections. If this is determined early enough in the season, some selection work could be diverted from JP-1 to WF-3, especially if a good cone crop exists in WF-3.

Selection Needs by Breeding Zone and Seed Zone

SPECIES	BZ	SEED ZONE	TARGET	# SELECTED	# NEEDED	YEAR PLANNED
JP	1	523,771	100-125	31	69-94	91-93
		525,772	100-125	38	62-87	91-93
TOTAL			200-250	69	131-219	91-93

B. Cone Collection:

High priorities for cone collection in 1991 are WF-1, including locals and crosses, for progeny sowing in 1992, the few remaining uncollected sugar pine in BZ-3 and 5, and JP-1, especially in SZ 523 and 771 where seed is needed for isozyme testing. A few cones from some DF-7 trees, needed for isozyme testing, will be the highest priority. Cones from WF-3 will be collected if time and cone crops allow. Sugar and Jeffrey pines will be bagged in the Spring to allow concentration on other high priorities in the Fall.

Cone Collection Needs 1/

SPECIES	BREEDING ZONE	# TREES TO COLLECT
JP	1	69
SP	3	5
	5	15
WF	1	108
	3	199
DF	7	6
TOTAL		404

1/ Total number of selections that do not have adequate seed on hand for testing as of 12/31/90. Actual collection will be less, depending on seed crop.

C. Scion Collection:

Scion collection will depend on what rootstock is available. Top priority will be to finish filling out the WF-1 seed orchard. Scion will also be collected from rust resistant sugar pine.

D. Field Pollination:

Field pollination of white fir in BZ-1 will be continued to provide controlled-crosses for inclusion in the WF-1 progeny test. Since this is our last opportunity to get crosses before sowing in 1992, a strong effort will be made to establish several crosses in order to increase our chances of collecting enough seed for the test.

E. Computer Work:

The completion of the first set of growth projections based on progeny data leaves a number of ways to go with this work. The first and most obvious direction to take this work is to do similar projections for other plantations in different breeding zones or on different site classes.

Another very important project would be to run the same data through PROGNOSIS, using the same stand management developed in this first project, in order to compare the results from both CACTOS and PROGNOSIS. This is important because the data base that CACTOS was developed from only extends down to the upper Stanislaus, making the use of it questionable for sites further south. It is likely that PROGNOSIS will have to be used for those southern sites. As of yet, nobody has done comparisons of the two models and reported the results.

In addition, economic analyses will be run on these growth projections to demonstrate the value of using these tree improvement stratagies at the district level.

PROGENY

MAJOR PROGENY TEST ACCOMPLISHMENTS 1990

1. Site Selection:

   Contact with the Forest and Districts has begun for white fir, Breeding zone 3. One possible site is in a burned area on the Greenhorn R.D.

2. Site Prep/Design Layout:

   PP BZ-4/DF BZ-7: The four ponderosa pine sites, and the Douglas fir site have been site prepped and four of these sites have been sprayed with herbicides. All but Nobe Young have been flagged and are ready for planting this spring.

   WF BZ-1: Two sites are ready to be flagged. One site needs stump removal and one site needs logging.

3. Planting/Sorting:

   -Planted four sites on the Mendocino N.F. for the North Zone tree improvement. This was accomplished in three weeks because of drying soils, fast rescheduling by Steve Laws and good planting crews. Thanks! to everyone involved.
   -Planting and sorting of a "Brush Competition" study (a cooperative study with PSW-Redding) was accomplished by the Central Zone Tree Improvement and the Georgetown R.D. See appendix III.
   -Seedlings were sorted into their test design for ponderosa pine BZ-4, sets 3,4 and Douglas fir BZ-7, sets 1-5 at the Chico Tree Improvement Center.

4. Thinning/pruning:

   -PP BZ-2,3 sets 1,2 and 3 for all eight sites were thinned this year except for Foresthill which was thinned last year. The PP Aspect study on the Eldorado N.F. was also thinned .
   -After thinning Badger Hill in the spring of 1990 we experienced an Ips attack which killed 115 trees, mainly in set 3 of the ponderosa pine. Other areas that were thinned and chipped at Badger Hill were not affected by this attack.

5. Maintenance:

   Mowing (9 ac): At the Inskip site the brush was mowed along the west side to facilitate fire control. At the Challenge site some stumps were cut flush with the ground and sets 4 and 5 were mowed.
   Rototilling (6 ac): Rototilled the new Barnes Mtn site before flagging for site prep and 6 blocks at the white fir Crusher site. We tried to rototill the remaining bear clover at Nobe Young but due to equipment failure could not accomplish it.

Herbicides (29 ac): All four new Ponderosa pine sites and one white fir site were sprayed with either Glyphosate or atrazine this year. The brush competition study was the only other test site sprayed this year.

Gopher baiting was done at Kawanami, Crusher and Jawbone.

See the accompanying table for specific plantations and sets receiving maintenance.

6. Data Collection: (24,200 trees)

1. Third Year Heights and Conditions
   White fir BZ-2
      Crusher, Jawbone (14 blocks) Sets 1,2,3,4

2. Seventh Year Heights and Conditions
   Ponderosa pine BZ-4
      Barnes Mtn, Happy Gap, Dog, Pettit Sets 1,2

3. Fifteenth Year Heights, Diameters and Conditions
   White fir PROVENANCE
      Cottonwood Set 1

   White fir Seed tree BZ-1
      Foresthill Sets 8,9

-Other WF sites were reviewed for viability with only one site being of interest on Sopher-Wheeler land.
-Site monitoring and data collection at the Brush Competition Study was done throughout the season collecting deer browsing damage/height reduction, fire damage and checking on their general health.
-All Ponderosa pine "moved" trees for Sets 4 and 5 of breeding zones 2 and 3 were tagged for ease of data collection.
-The data for ponderosa pine BZ-30 (Central Sierra Assn) has not been received as yet

7. Computer work:

A lifetime of computer work and data analysis remains as we continue to add more data to the pile. We started down the road of data analysis when we hired a data manager last year. He was able to set up our PC's and worked out SAS data runs (meanranks, varcomps etc.) for progeny test data analysis. Various other programs have been reviewed for use with the PC. Quatro Pro was obtained for its graphics and spreadsheet capabilities.
D470 was also purchased as a alternative to DG-Connect and ST-400.

Paul, Bruce and Safiya took a crash training session from Steve in order to learn how to run the PC and SAS before Steve transferred. Bruce has taken some Oracle training and we now have three data base types (Supertree, famdat from SAS, and clonestat) on the DG from which various reports can be run merging all three data bases into one report. See appendix I.

All of last year's data on 118,000 trees was keyed into the DG and block summary reports were completed. SAS data-runs of meanranks and varcomps have been run for some of the data, See Appendix II for a complete listing.

8. Special Projects:

BRUSH COMPETITION STUDY

720 seedlings were planted this spring on Georgetown R.D.'s Chaix site. Heights and diameters were taken just after planting and free-to-grow plots were randomly selected, marked and sprayed with Roundup. Some damage occurred to the seedlings just after planting due to deer browsing and an escaped fire. Both of these events were recorded and damaged seedlings tallied and/or measured. PSW-Redding took the first year survival, height/ diameter, and vegetation measurements. Survival and growth are excellent!

SHADE STUDY

This is the third year that a shading study has been in place on three of our WF test sites. Only two of the sites were measured this year due to time/work constraints. From the table below you can see that for the two sites, Crusher and Jawbone, there is no difference between the shaded and unshaded trees for height or survival. Shading WF trees in this case only produced greener trees. We will need to collect the rest of the height data at Kawanami and Jawbone to finish up the study.

Table I

	AVERAGE HEIGHT cm		(% SURVIVAL)	
block	shaded	unshaded	shaded	unshaded
	Jawbone		Crusher	
A	32.0 (75.9)	33.8 (68.4)	43.9 (96.6)	45.4 (98.8)
B	32.8 (69.0)	33.6 (77.2)	46.6 (98.0)	42.2 (96.3)
C	33.5 (88.8)	38.4 (82.7)	43.7 (98.0)	44.9 (97.3)
D			37.2 (97.6)	36.3 (95.6)
AVG	32.8 (77.9)	35.3 (76.1)	42.9 (97.6)	42.2 (97.0)

POLLEN MIX VS WILD STAND - a quick look

Two studies were planted in Breeding zones 2 and 3 using 10 to 12 families of wind pollinated and controlled pollinated (PM) seedlings. Ten year height and diameter data was analyzed and a highly significant effect was found for plantation, blocks within a plantation, female parent, and pollination type for both breeding zones. An addition effect for breeding zone three was found for plantation by female parent. The average values for height are displayed below.

Table II

		wild stand	Pollen mix	Avg
BZ-2	Challenge	437	477	
BZ-2	Forest Hill	512	543	
	BZ-2 avg			444
BZ-3	Badger Hill	507	536	
BZ-3	Board Ranch	357	375	
	BZ-3 avg			492

There is a 5.3% and 7.2% diference in height (BZ-2 and BZ-3) between wild stand and the pollen mix types. Two things worthy of note, the pollen mix seed was much larger (clone bank effect?) and the pollen mix itself consisted of primarily lower elevation trees.

Wood cores were taken from all of the ponderosa pine trees to be thinned from set 3 at Badger Hill and sent to Chico for specific gravity determination.

SOWING DATE and SEVEN YEAR FIELD PERFORMANCE
See Handout.

SEED ORCHARD SITE TRIAL
The Seed Orchard Site trial (SOST) was mowed only three times this year due to slow grass growth. A underground drip system was installed for the white fir part of the SOST to facilitate mowing.

9. Other

From the military bases Ralph was able to obtain three additional trailers, some tools and foot lockers for CTIC; 1347 lbs of tools for CZTI and the Eldorado N.F.; and a variety of other useful items.

PROGENY WORK PLANS FOR 1991

1. New Plantations

We have eleven set-sites for a total of 24,192 seedlings to plant this year on five sites. We are working with one volunteer group, three force account crews and one negotiated contract for our planting crews. The Nobe Young site still needs to be flagged.

2. Maintenance

Maintenance is planned on all the new planting sites as well as the three WF sites. There are signed EA's for four of the new sites and one we will again go with a Decision memo for spraying. Three sites will be manually maintained, using rototillers and contracted hand release. Some additional rototilling will be done at the Challenge site.

PP BZ-2 set 6 at Inskip, PP BZ-3 set 4 at Board Ranch and Aster along with PP BZ-4 sets 1 and 2 at Pettit, Barnes Mtn. and Happy Gap will be thinned this year. Set 4 at Badger Hill, Aster and Board Ranch will pruned.

3. Data Collection

We are looking forward to measuring 38,737 trees this season. This year's data collection will include the white fir BZ-2 shade study, the Douglas fir BZ-7, and the three, seven, ten and twelve year data for ponderosa pine BZ-2 and BZ-3. Also, survival data will be taken on our new plantations.

We are continuing to tag individual trees that are left after the final thinning to help in data collection. Move trees will be tagged or painted blue to call attention to those trees that have been moved to the outside of the block. We will also need to re-establish some of the blocks at Board Ranch to be able to measure accurately.

4. Computer work

Two additional PC's were purchased in fy 91 to facilitate data processing for Progeny and Sugar pine.

Lots of computer time needed as we have mountains of data to play with. Some the things we need to do are:

- Input PP BZ-30 7 year data and run block summary reports
- Input DF BZ-21 5 year data " " " " "
- Input all plantation measurements taken next year
- Input Forest hill coords for the White fir sets 8 and 9.
- Input Progeny test site data.
- Run SAS meanranks, varcomps, etc for all sites
- Run regression analysis for parent tree elevation vs meanrank
- Edit coords to incorporate the fill trees.
- Set up a computer list for inventorying and equipment maintenance schedules.
- Re-enter Cottonwood white fir ten year data.

5. Special Projects

BRUSH COMPETITION STUDY

We will continue to monitor progress and help out with vegetative control.

PONDEROSA PINE ASPECT STUDY

We will take ten year data on the Eldorado sites and analyze past data.

SEED ORCHARD SITE TRIAL

We will continue to maintain and do some regrafting on the White fir this year.

PONDEROSA PINE PROVENANCE TRIAL-Peanut Spr. and Cherry Hill

Ten year height data needs to be taken this year, then they will be thinned.

6. Other

- A major undertaking to update all our files and obtain missing or needed information needs to be done, ie soils and site class information.
- Prepare a TOP Performers list for the Ponderosa pine to give to the Forests by this summer for the 1991 cone collection season.
- Analysis of damage codes and determine which ones we wish to continue with.

PROGENY TEST ACCOMPLISHNMENTS 1990

	Establishment Phase				Maintenance Phase			Data Collection Phase	
Plantation Name	Site Selection	Site Prep	Design Layout	Planting	Pruning/ Thinning	Vegetatn Managemt	Other	Survival	Measurements
Inskip						Mowed Fire Break (4ac) Chip Sets 1,2,4 (4ac)			
Challenge		Cut Stumps			PP 83 Marked	Mowed Parts Set 5-6 (2ac)	Tagged moved trees sets 4,5,6		
Sugarloaf #1					PP 80 Marked/thinned PP 82 Marked		Tagged moved trees sets 4,6		
Sugarloaf #2					PP 83 Marked				
Foresthill		Layout DF Sets 3-4							WF Seed Tree 15th yr
Badger Hill					PP 83 Marked/Thin	Spot Spray Clone Bank (4ac)			PP Set 3 12mm cores
Aster					PP 83 Marked/Thin				
Board Ranch					PP 83 Marked/Thinned				
Crusher						Roto 5 Blks WF 2ac			WF 8 Blks Shade Study
Cottonwood									WF Seed Tree 15th yr
Kawanami						WF Herbicide (10ac)			
Jawbone									WF 6 Blocks Shade Study
PP-4									
Barnes Mountain #1					Marked Sets 1-2				PP Sets 1-2 7th yr
Barnes Mountain #2		Roto (2ac)	16 Blocks			PP Herbicide (2ac)			
Happy Gap									PP Sets 1-2 7th yr
McKensey			16 Blocks			PP Herbicide (5ac)			
Dog									PP Sets 1-2 7th yr
Nobe Young			4 Blocks			PP Herbicide (5ac)			
Pettit #1									PP Sets 1-2 7th yr
Pettit #3			16 Blocks						
Totals					Layout 13 acres Thinned 14 acres Marked 14 acres Pruned 10 acres		Veg. Mgt 38 acres		Measured 20 acres (24,195 trees)

PROGENY TEST WORK PLANS 1991

	Establishment Phase				Maintenance Phase			Data Collection Phase	
Plantation Name	Site Selection	Site Prep	Design Layout	Planting	Pruning/ Thinning	Vegetatn Managemt	Other	Survival	Measurements
									PP Set 4 12th yr
BZ-2					PP 83 Mark/Thin	Mow All Sets			PP Set 5 10th yr
Inskip					PP 80-82 Mark/Thin				PP Set 1-2 10th yr
Meadow Valley		Blast stumps disk	WF-1						PP Set 4 12th yr PP set 5 10th yr
HumBug		Log/stump	WF-1						
Challenge					PP 80 Mark/Thin				PP Set 4 12th yr PP Set 5 10th yr
Sugarloaf					PP 80 Mark/Thin				PP Set 4 12th yr PP Set 5 10th yr PP Set 1-2 10th yr
Foresthill			DF Sets 3-4		PP 80 Mark/Thin			Survival Set 3-4	PP Set 4 12th yr DF Set 1-2 7th yr PP Set 5 10th yr
BZ-3									
Badger Hill					PP 80 Mark/Thin Thin Set 3 Insect Kill KxM Thin				PP Set 4 12th yr PP Set 5 10th yr KxM Heights PP Set 7 7th yr
Aster					PP 80 Mark/Thin PP 80 Prune				PP Set 4 12th yr PP Set 5 10th yr PP Set 7 7th yr
Board Ranch					PP 80 Mark/Thin/Prune PP 83 Mark/Thin PP 80 Prune				PP Set 4 12th yr PP Set 5 10th yr PP Set 7 7th yr
Crusher					PP 80 Mark/Thin/Prune PP 83 Prune	WF Sets 1-5 Hand Release			PP Set 4 12th yr PP Set 5 10th yr PP Set 7 7th yr
Kawanami						WF Sets 1-5 Spray 100%			
Jawbone						WF Sets 1-4 Hand Release 100%			

	Establishment Phase				Maintenance Phase			Data Collection Phase	
Plantation Name	Site Selection	Site Prep	Design Layout	Planting	Pruning/ Thinning	Vegetatn Managemt	Other	Survival	Measurements
PP BZ-4									
Dog									
Happy Gap									
Barnes Mt. #1					PP 84 Thin				
Barnes Mt. #2				Sets 3-4		Roto/Spray Sets 3-4		Survival Sets 3-4	
Nobe young		Flag 12 Blks		Sets 3-4		Roto/Spray Sets 3-4		Survival Sets 3-4	
McKensey				Sets 3-4		Spray Sets 3-4		Survival Sets 3-4	
Pettit #1					PP 84 Mark/Thin				
Pettit #3				Sets 3-4		Spray Sets 3-4		Survival Sets 3-4	
Long Saddle									
Harrel's F.T.									PP Aspect 10th yr
Seed Orchard Trial						Mow and Hand Release			Flowering

Totals	Veg. Mgt	52 acres	
	Thin/Mark	34 acres	
	Measurements	44 acres	(38,737 trees)
	Survival	20 acres	(18,816 trees)
		160 acres	(57,553 trees)

Planting 10 Set/sites (20 acres)

SUGAR PINE GENETICS PROGRAM

PSW REGION 5 WHITE PINE BLISTER RUST PROGRAM

Ecologically and economically, sugar pine (Pinus lambertiana) is one of the most important trees of the mixed conifer forest in the PSW Region. It extends from northern California south to the Baja desert. It generally comprises 5 to 25 percent of the type and occasionally up to 60 percent. It is also a minor component of some ten other forest types (Kitzmiller, 1982). It is adapted to a wide range of sites, and produces more volume than most of its cohorts. Old growth produces high quality products and commands premium prices, and there is no reason to believe that young growth will not maintain its relative importance.

However in the past two decades, white pine blister rust (Cronartium ribicola) (WPBR) has greatly increased in extent and intensity. It has spread in parts of the Sierra Nevada where it was thought that environmental conditions would inhibit serious development of the disease in the Sierra Nevada south of the Eldorado National Forest. However, recent surveys indicates that the rust has spread in parts of the Sierra that were not infected before, and has moved upward into the stands of western white pine and evidence suggests it in whitebark pine.

Regional Strategy for Developing Resistance to WPBR in Sugar Pine

The objective of the program is to develop levels of resistance in sugar pine that will provide a stable, durable population against new races of the rust. Plus, eventually integrate the different resistant factors, major gene resistance (MGR), "slow rust" resistance (SRR) mechanisms, and adaptive traits, superior growth and form into clones used in production seed orchards. In order to achieve the objectives of the program the strategy was revised and it includes the following actions:

1. Test and screen enough parents to identify sufficient numbers of seed trees to provide planting stock with a relatively high level of resistance (50%) from MGR parents. The Region has identified 302 genotypes that are fairly evenly distributed among seed zones and stratified by elevational bands (Table 1). Seed to meet the short term needs is being produced from:

   . 1) Protected and managed MGR parents in wild stands.
   2) Developed seed production areas that contain a fair number of MGR parents and good phenotyes
   3) MGR parents in the clone bank at Badger Hill
   4) Non-MGR superior phenotypes in clone bank (control-pollinated with MGR pollen).

2. Establish production seed orchards from MGR parents and F_1 progenies combined with some SRR progenies from the testing phase at Happy Camp. There are three planned locations for the seed orchards, Chico Tree

Table 1. DISTRIBUTION OF RESISTANT SUGAR PINE PARENTS BY SEED ZONE/ELEVATION UNIT

SEED ZONE	20	25	30	35	40	45	50	55	60	65	70	75	TOTAL/SZ
091	1												1
301	1		2	1	6	10	4	-->					24
302					<--	3	1						4
311				<--	2	1	1	-->					4
321			<--	2	—	—	—	-->					2
331						1	2	-->					3
371					1	—	—	-->					1
372				1	1	1	1	—	—	-->			4
521		<--	—	—	—	—	—	1					1
522							2	3	-->				5
523					1	—	—	6	—	—	-->		7
524		1	1	—	1	3	17	1	—	-->			24
525				<--	3	7	2	8	3	2			25
526			2	—	6	5	6	6	10	2	—	6	43
531			<--	—	4	8	7	13	7	1	2		42
532						2	4	3	3	4			16
533					<--	—	—	3	2	4	2		11
534						<--	5	1	12	10	5	-->	33
540							1		3	5	2	-->	11
732							<--	—	—	-->			1
741				1									1

742							1						1
772								1					1

Arrows indicate the elevation range of sugar pine within the seed zone.

Improvement Center, Foresthill (Tahoe NF) and one will be located on the Mendocino NF. Each seed orchard will include a minimum of 50 MGR parents and progeny with SRR.

Five sugar pine breeding zones were identified in the original Tree Improvement Master Plan for Region 5 (Kitzmiller, 1976) and two more were added in 1983 revision (Figure 1). The Plan set a goal of 200 resistant parents per breeding zone for orchard establishment with potential roguing to 50-60 parents based on other timber and breeding traits. The strategy is carried out in each zone with some variations depending on the severity of WPBR and the frequency of resistance. The frequency of MGR increases from north to south, it approaches zero in the Klamath and Siskiyou mountains and goes up to 8% in parts of the Sierra Nevada range.

The strategy (Figure 2) entails four stages of selection:

1. Parent trees in natural stands free of visible rust infection. Selection criteria in the North Zone Forests is relaxed to include rust-free trees with average growth traits. This was necessary due to the limited number of rust-free trees available from that area. In the Central Zone (Sierra Mtn.) selection of rust-free candidates and rust-free superior phenotypes are both included.

2. Progeny in greenhouse proven to possess MGR from both MGR parents and non-MGR parents.

3. MGR progeny at Happy Camp (HC) proven to have one or more "slow rust" mechanisms. This opportunity was created by the "virulent" race (HC-race) at the outplanting site at HC, which allows the identification of individuals with both MGR and other forms of resistance. In the absence of HC-race, MGR masks other forms of resistance since the rust is aborted at infection sites in the needle tissues.

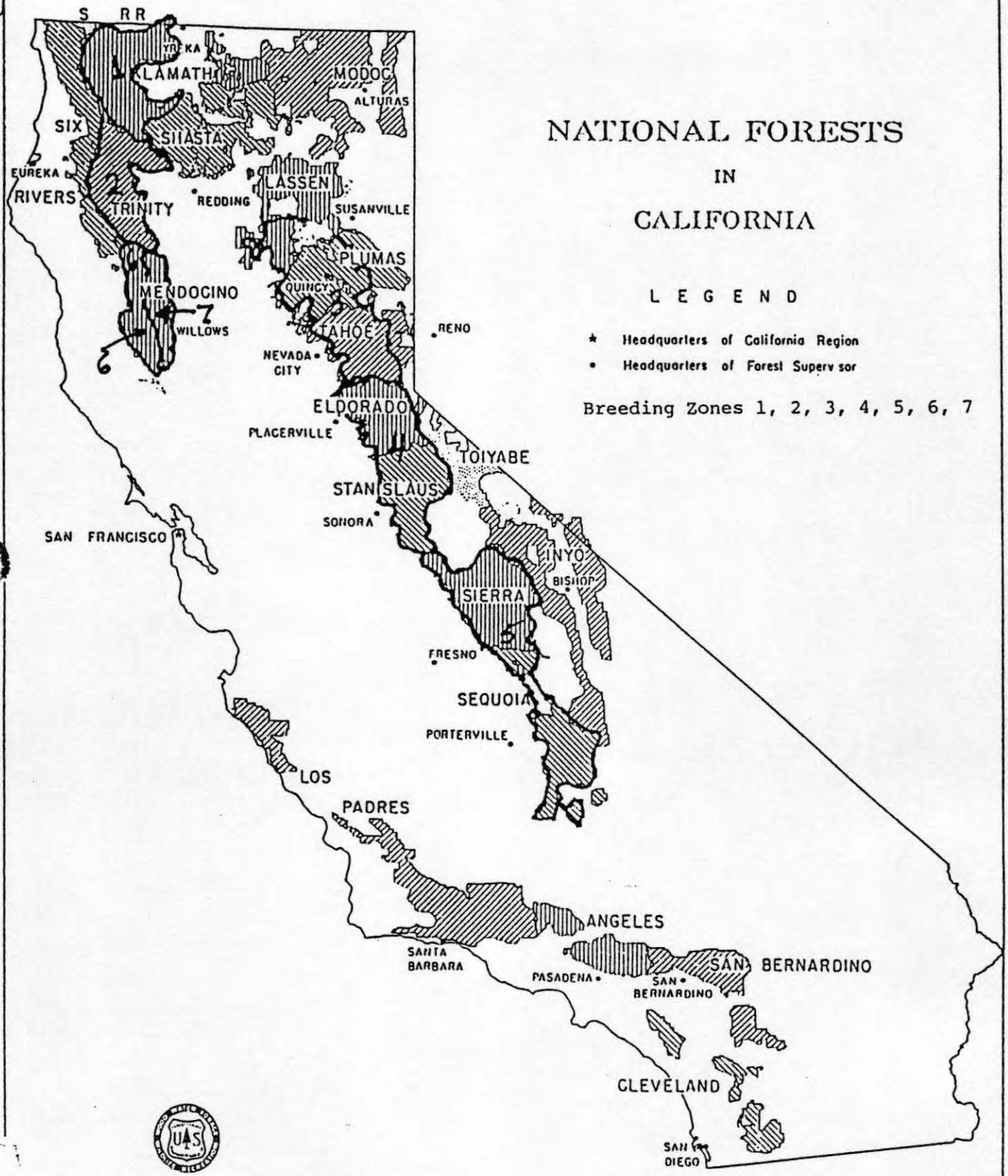
4. Non-MGR progeny at Placerville proven to have one or more SRR mechanisms.

5. Parents that prove to have useable levels of SRR. Selection is made in the evaluation plantations, established 1974 and 1983. Selection in the greenhouse has started on a small scale and 200 families will be sown for SRR screening 1991.

Grafting selected material into clone bank and seed orchards occurs at various stages along the process depending on the need for preserving genotypes.

One of the important components of the strategy involves the broadening of the genetic base through the use of progeny that received MGR from unknown pollen parents. Such progeny have non-MGR seed (female) parents but are valuable to retain in the breeding population because of either inheritance of desired traits from the female or for the increased genetic base alone.

Figure 1. Breeding zones for sugar pine in California



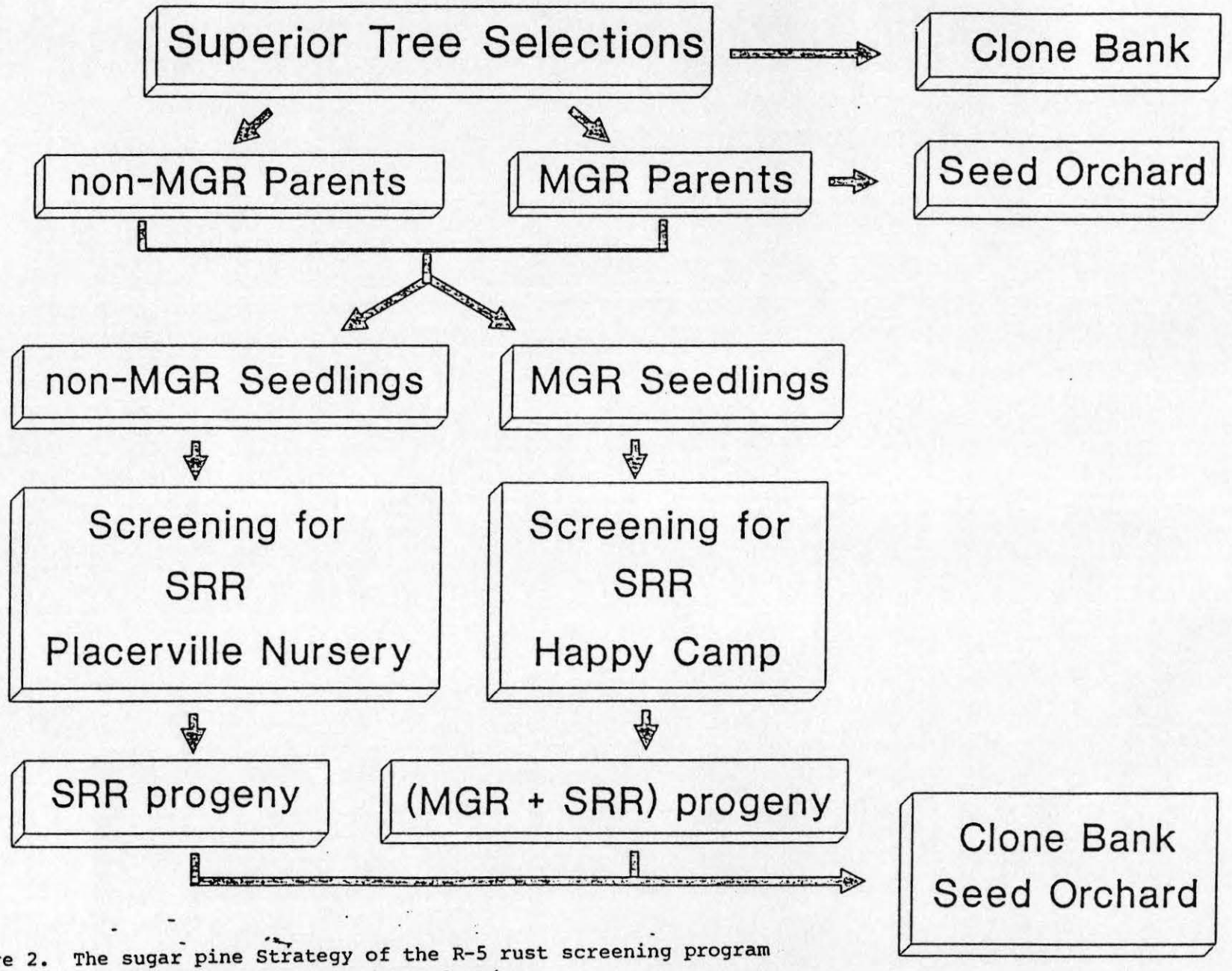
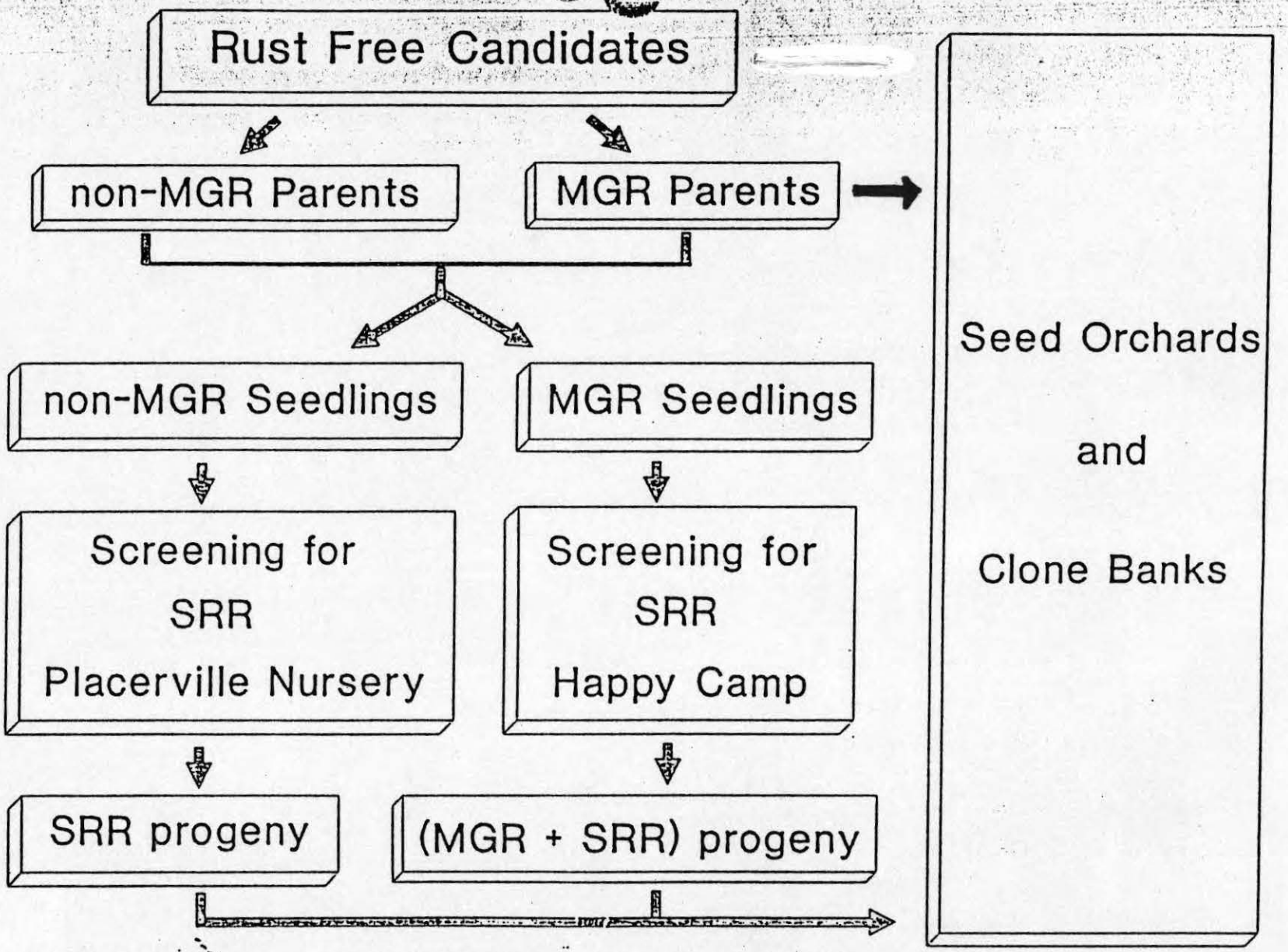
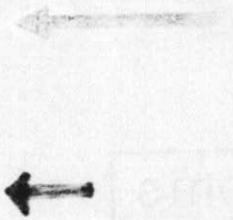


Figure 2. The sugar pine Strategy of the R-5 rust screening program for phenotypically superior selections



Part 2 of Figure 2. The sugar pine Strategy of the R-5 rust screening program for rust-free candidates selected by District personnel



Regional Policy for Sugar Pine Management

The Regional Policy signed by the Regional Forester, Oct 19, 1990, provides direction for National Forests in the management of sugar pine. It identifies the program as one that provides basic support to the Regional biodiversity goal of maintaining sugar pine as an important component of the mixed-conifer ecosystems. A copy of the full text of the policy statement is enclosed; it included Table 2 which indicates the number of candidates to be selected and tested inorder to provide enough MGR to meet seed needs. It establishes the following policy for sugar pine management:

1. Each Forest with sugar pine will develop an action plan by September 1991 for selection, collection and protection of candidate trees to meet the Forest's minimum target for candidate selection by the year 2000.

2. Harvest or precommercially-thin apparently rust-free sugar pine only ifessential to meet other stand management objectives.

3. Protect apparently rust-resistant sugar pine during management activities (such as logging, road construction or maintenance).

3. Continue to plant sugar pine along with other species on appropriate mixed conifer sites.

4. Rapidly build a supply of rust-resistant seed.

United States Department of Agriculture

Forest Service RO

Reply To: 2410/2470

Date: OCT 19 1990

Subject: Regional Policy for Sugar Pine Management

To: Staff Directors and Forest Supervisors

The white pine blister rust remains a serious disease problem for the survival of sugar pine in stands throughout its range. The Regional Tree Improvement Program and the PSW Station Genetics Project have identified genetically-transmitted mechanisms of rust resistance. The program strategy for selecting, genetic testing, propagating, and deploying resistant stock is operational and effective. This program provides basic support to the **Regional biodiversity goal of maintaining sugar pine as an important component of mixed-conifer ecosystems.** The active involvement of each National Forest and Ranger District with sugar pine is essential to achieve this goal.

I want each National Forest with sugar pine to participate actively in the sugar pine genetics program; by selecting and protecting adequate numbers of potentially resistant sugar pine until they are evaluated for resistance, and until an adequate supply of seed with a broad genetic base is assured. Sugar pine trees will be evaluated for both the dominant major gene (MGR) and other resistance mechanisms ("slow rusting"). Total time for evaluation of parents for MGR takes two years at most. Evaluating other resistance mechanisms may require seven to ten years.

I am establishing the following policy for sugar pine management:

1. **Each Forest with sugar pine will develop an action plan by September 1991 for selection, collection and protection of candidate trees to meet the Forest's minimum target for candidate selection by the year 2000** (see enclosure). The number of selections should meet the requirements of the Base Level Genetics Program: a minimum of 20 resistant parents per 500 ft. elevational band in each seed zone. To meet these requirements for sugar pine, enough candidate parents need testing to identify 20 resistant trees, where possible. Forests in northwestern California, that have very low levels of natural resistance will need more time to achieve the minimum genetic base. Forests should work with the Regional Geneticist or his designates to develop plans.

2. Harvest or precommercially-thin apparently rust-free sugar pine only if essential to meet stand management objectives. Prescriptions will save such sugar pine where feasible in the context of local management objectives. The purposes are to maintain options for regeneration of rust-resistant sugar pine through the base-level Tree Improvement Program, and provide genetic material for the rust-resistant genetics program.

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FS-6200-28 (7-82)

3. Protect apparently rust-resistant sugar pine during management activities (such as logging, road construction or maintenance).

Avoid isolating sugar pines that are known or suspected resistant, making them more susceptible to windthrow or reducing numbers of sugar pines available for pollination. Resistant sugar pines need continual protection to supply seed for natural and artificial regeneration. Trees identified for testing need protection for the duration of testing, which could be up to 10 years.

4. **Continue to plant sugar pine along with other species on appropriate mixed conifer sites.** Use resistant seed lots when available. Resistant seed lots will consist of approximately 50% MGR resistant seedlings. Keep in mind that a portion of the remaining 50% non-MGR stock will escape infection or mortality from rust. When resistant seed is not available, use good quality untested seed from the seed bank. Planting untested lots will provide small numbers of resistant trees, and these survivors will help conserve genetic diversity.

5. **Rapidly build a supply of rust-resistant seed.** Trees that prove resistant will be protected and managed as seed trees to supply seed for regeneration. Forests will continue to identify rust-free (no obvious sign of rust infection) trees and collect two to three cones for screening to meet the objectives established in the action plan (as required in # 1 above).

Funding for tree selection and cone collection for both testing and production seed will be primarily from K-V sources through SAI collections. Do not include in base rates estimation. Limited funding will be available annually to most Forests on request using RO-TM P&M funds.

If you have questions, or need assistance, please contact:

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Joyce T. Muraoka

for PAUL F. BARKER
Regional Forester

Enclosure

*******DRAFT*******

Table 2. Seed and Seed-Tree Needs (Guidelines and Targets)

National Forest	Seed Needs lbs/yr	Seed Zone	No. of MGR Seed Trees			Candidates To Select & Test **
			Total Needed	Already Identified	To Be Identified	
Six Rivers	14	091	10	1	9	540
		302	5	2	3	205a
		303	5	00	5	345a
		Forest Total	**20**	**3**	**17**	1090
Shasta Trinity	214	312	55	0	55	3976
		331	5	3	2	200a
		332	5	0	5	475a
		371	10	0	10	950
		516	0	1	0	
		521	20	1	19	3800
		741	5	0	5	475a
		Forest Total	**100**	**5**	**96**	9876
Mendocino	70	340	15	0	15	2505
		371	15	1	14	1330
		372	20	4	16	832
		Forest Total	**50**	**5**	**45**	4667
Klamath	100	301	40	28	12	984
		302	5		5	345a
		311	20	4	16	1104
		321	20	2	18	1242
		322	20	0	20	1379a
		Forest Total	**100**	**34**	**66**	5054

National Forest	Seed Needs lbs/yr	Seed Zone	No. of MGR Seed Trees Total Needed	Already Identified	To Be Identified	Candidates To Select & Test **
Modoc		742	**5**	1	4	450a
Lassen	145	522	10	5	5	135
		523	50	0	50	800
		524	50	1	49	882
		732	15	1	14	104
		Forest Total	**125**	**7**	**118**	**1921**
Plumas	73	523	20	7	13	208
		524	20	20	00	
		525	10	3	7	112
		771	5	0	5	140a
		Forest Total	**55**	**30**	**25**	**460**
Tahoe	130	525	50	16	34	544
		772	10	1	9	280a
		Forest Total	**60**	**17**	**43**	**824**
Eldorado	40	526	**50**	**43**	**7**	**77**
Stanislaus	104	531	**100**	**42**	**58**	**870**
Sierra	100	532	50	16	34	510
		533	50	11	39	234
		Forest Total	**100**	**27**	**73**	**744**

National Forest	Seed Needs lbs/yr	Seed Zone	No. of MGR Seed Trees: Total Needed	Already Identified	To Be Identified	Candidates To Select & Test **
Sequoia	120	534	50	14	36	252
		540	50	11	39	273
		550	20	0	20	166
		Forest Total	**120**	**25**	**95**	**691**
San Bernadino		993	2	0	2	
		994	5			
		997	5			
		Forest Total	**12**			
Angeles		993	5			
Los Padres		120				
		992				
Grand Total:	**1110 lbs**		**897+**	**239**	**654**	**26904**

a) Gene Frequency was extrapolated from close by seed zones

** "Candidates to select and test" is number of candidates to be selected and tested inord to provide enough MGR to meet seed needs, in many cases these numbers would have to be adjusted to provide the minimum 20 RRSP per 500 ft elevation required to provide adequate genetic base.

Assumptions for Calculating Seed Tree Needs

- Each RRSP parent will supply an average of 1 lb of seed/year in a good crop year.

  Each parent produces an average of 20 cones/year, selected superior trees have supplied 21.4 cones/parent during a good crop year such as 1988.

  Each cone provide 100 viable seed, thus earch parent would provide

  20 cones X 100 seed/cone = 2000 seeds/parent = 1 lb of seed

  Each lb of seed in bare root nursery with 99% purity and 80% germination supplies an average of 900 good seedlings (figures are from PN).

- RRSP seedlots will contain approximately 50 percent rust resistant seed

- 50 percent of the MGR seedlings will survive to become crop trees

- 1 pound seed = 900 good seedlings = 450 MGR seedlings = 225 MGR crop trees

- If desired number of RRSP crop trees per acre = 15,
  then 900 seedlings per pound planted at a rate of 60 seedlings per acre
  would plant 15 acres.

- The MGR frequency per seed zone was used.

- Potential of moving seed between forests

- Relative importance of sugar pine within the seed zone.

- The calculations for the numbers in table were based mostly on the seed needs of the whole forest and the next requirement was left to be incorporated by each forest when the action plan is developed.

- Each seedlot should have 20 RRSP trees per 500 foot elevation
  according to the "Base Level" program guidelines.

*******DRAFT******

Status Report of the Rust Screening Program

The Region has been involved with the screening and testing program for the last twenty years in cooperation with the PSW Experiment Station. However, in 1985 Tree Improvement personnel at Placerville Nursery took over the testing program because of increased seed needs and interest.

Several mechanisms of resistance to blister rust are known in sugar pine and could provide effective control measures of the disease. As mentioned above the Regional program is designed to identify parents with different resistant mechanisms. The Regional accomplishments in the different phases of the program are as follows:

1. **Screening for Major Gene Resistance (MGR)**: During the past two decades 4700 sugar pine parents, 1400 parents in the last two years, have been inoculated using the "detached leaf" method and screened for the MGR. Three hundred and two parents, 124 MGR parents in the last two years, have been identified with MGR (Apendix 1). This screening is done at Placerville Nursery. Progenies of 1350 parents were inoculated Fall of 1990. Results from this year's testing will be available to National Forests and Cooperators by April, 1991. Total time for evaluation of parents for MGR takes two years at most. 1334 seedlots, (727 Central Zone seedlots, 407 from North Zone and 200 from State & Private) were send to CTIC for 1991 MGR sowing. These seedlots are sampled from many seed zones wihtin a breeding zone (Table 3).
   Forests and private companies selected and collected 3103 candidates for screening (Table 4).

2. **Screening of MGR Seedlings for "slow rusting" resistance mechanisms (SRR)**: SRR is a term used to describe collectively mechanisms of resistance such as reduced infections per individual and bark reactions. Their net effect is to reduce the probability of infection and mortality. 10,258 MGR seedlings representing 1159 parents were established at HC testing site since 1987. Normally at Happy Camp, the seedlings are protected by Bayleton, a systemic fungicide, from rust infection for 3 growing seasons, before they are released to the HC-race. However, the natural inoculum at the site has been erratic, and thus undependable. To insure sufficient inoculum at the site, Ribes nigrum potted plants, are send to the HC site to be inoculated on site with the HC-race. These plants provided a good inoculum levels to inoculate the established MGR seedlings.

3. **Screening of non-MGR families for SRR mechanisms.** Two hundred non-MGR families from northern California are in stratification and will be sown 1991 and screened at Placerville Nursery for SRR (Table 5). These families are chosen from the northern part of the range due to the low frequency of MGR and their high needs for resistant seed. Also, progenies sown for Fall 1990 MGR screening that prove non-MGR will be evaluated for SRR at Placerville. During the 1989 MGR scoring of 1988 sowing, some families with no-MGR seem to have other promising symptoms, such as low frequency of needle infections, no cankers even though many around them have developed cankers that produced pycnia, some shed their infected needles without any sign of stem infection. Twenty to 40 individuals each from 73 families were transplanted to a nursery bed for evaluation. All these seedlings had susceptible needle infections, 46 families have surviving individuals. Average survival rate among these families equals 36% (range 3-79%).

Table 3. Number of seedlots send to CTIC, 1991 sowing, for the MGR screening.

Breeding Zone	Seed Zone		# of seedlots per seed zone
SP-1	301		26
	302		7
	311		20
	321		54
	322		12
		sub-total	119
SP-2	312		2
	331		2
		sub-total	4
SP-3	522		25
	523		113
	524		271
	525		55
		sub-total	464
SP-4	526		55
	531		5
		sub-total	60
SP-5	532		53
	533		50
	534		31
	540		72
		sub-total	206
SP-6	340		47
	351		2
	372		37
		sub-total	86
SP-7	371		18
	372		23
		sub-total	41
		Total	980

Table 3. cont.

Seedlots outside designated breeding zones:

091	21
303	3
511	1
521	4
560	11
732	15
742	3
771	38
772	1
972	3
State and Private	254
Total	354
Grand total	1334

Table 4. 1990 sugar pine collections by forest and district from both Central Zone and North Zone National Forests.

CENTRAL ZONE FORESTS

NATIONAL FOREST	DISTRICT	#OF CANDIDATES COLLECTED	#OF SUP.TREES COLLECTED
ELDORADO	AMADOR	120	0
	GEORGETOWN	20	0
	PACIFIC	42	5
	PLACERVILLE	199	17
sub-total		381	22
PLUMAS	GREENVILLE	658	0
	LAPORTE	98	0
	OROVILLE	149	0
	MILFORD	36	0
	QUINCY	21	0
sub-total		962	0
SEQUOIA	HUME LAKE	81	2
	TULE RIVER	09	0
	HOT SPRINGS	38	0
	GREENHORN	184	0
sub-total		312	2
SIERRA	MARIPOSA	74	0
	PINERIDGE	47	2
	KINGS RIVER	100	0
	MINARETS	79	0
sub-total		300	2
STANISLAUS	MI-WOK	32	0
	CALVARAS	34	2
	SUMMIT	35	8
	GROVELAND	25	0
sub-total		126	10
TAHO	DOWNIEVILLE	44	0
	FORESTHILL	51	8
	NEVADE CITY	34	0
	SIERRAVILLE	12	0
sub-total		141	8
TOTAL 1990 CZ FOREST COLLECTIONS		2222	44

Table 4 cont. NORTH ZONE FORESTS

NATIONAL FOREST	DISTRICT	#OF CANDIDATES COLLECTED	#OF SUP.TREES COLLECTED
KLAMATH	SALMON RIVER	61	
	HAPPY CAMP	17	HCOP 7 (128 SEED)
	OAK KNOLL	2	HCOP 1 (141 SEED)
sub-total		80	
MENDOCINO	CORNING	222	
	COVELO	161	
	STONYFORD	219	FIELD 1 (2000 SEED)
	UPPER LAKE	61	
sub-total		663	
LASSEN	HAT CREEK	7	
	EAGLE LAKE	17	
	ALMANOR	13	
sub-total		37	
MODOC	DOUBLEHEAD	2	
SHASTA T	WEAVERVILLE	0	HCOP 1 (690 SEED)
SIX RIVERS	MAD RIVER	5	
	GASQUET	38	
sub-total		43	
FRUIT GROWERS CO.	SCOTT RIVER AND OAK KNOLL AREAS	56	
TOTAL 1990 NZ FOREST COLLECTIONS		881	
	USFS	825	
	FGS	56	

Table 5. Number of seedlots send to CTIC for sowing 1991 for the MGR screening.

Breeding Zone	Seed Zone		# of seedlots per seed zone
SP-1	301		26
	302		7
	311		20
	321		54
	322		12
		sub-total	119
SP-2	312		2
	331		2
		sub-total	4
SP-3	522		25
	523		113
	524		271
	525		55
		sub-total	464
SP-4	526		55
	531		5
		sub-total	60
SP-5	532		53
	533		50
	534		31
	540		72
		sub-total	206
SP-6	340		47
	351		2
	372		37
		sub-total	86
SP-7	371		18
	372		23
		sub-total	41
		Total	980

Table 2. cont.

Seedlots outside designated breeding zones:

091	21
303	3
511	1
521	4
560	11
732	15
742	3
771	38
772	1
972	3
Unknown seed zone	54
State and Private	200
Total	354
Grand total	1334

Fourteen percent of the surviving seedlings developed no stem infections to date. The high mortality rate cann't be all attributed to rust, cultural activies, such as watering twice a day, needed for newly seeded beds are not conducive for the survival of sugar pine. Arrangements are now made to transplant such stock in an area that allows maintainence separate from the regular nursery beds.

In addition to height data from sugar pine evaluation plantations, rust data were taken. A plantation on the Placerville RD on the Eldorado NF (Park Creek plantation), planted in 1974, demonstrated the presence of individuals with SRR mechanisms. This plantation was challenged by 2 "wave years", high inoculum levels, 1976 and 1983. Five non-MGR families have average survival rate of 65%, surviving individuals of these families have evidence of SRR mechanisms.

Other field evaluations of progeny tests, a set of sugar pine (45 families), planted at four different sites in the Sierra Nevada: - Oroville, and Quincy Ranger Districts (RDs), Plumas NF, Downieville, and Foresthill RDs, Tahoe NF during the spring of 1983. The Downieville site has the highest infection rate (39%) compared to the other sites (15-20%). Overall mortality due to rust was 10%, most infections occurred during the Fall of 1983.

Seed production:

Development of blister rust resistant sugar pine (RRSP) seed is given high priority in the Region. Pollen orchards at Chico and seed orchards at Foresthill are designated for seed production. Table 6 indicates the number of the MGR already identified and planned for these orchards. The Region has two clone banks, Badger Hill and Happy Camp. Badger Hill clone bank has produced a good crop and seed was stored per clone (Table 7). However, more seed was collected and is reported with WCF seed. Seed yield from the HC site was very low.

Field collection of seed from proven RRSP has yielded 151.2 lbs, with the collection from Badger Hill a total of 169.5 lbs of resistant seed is available for the Region (Table 8). Collection from single parents were also kept separate for TI use (Table 9).

Table 6. Report of number of MGR families per breeding zone and orchard.

Breeding Zone	Seed Zone	Forest	# of MGR families	Seed Orchard See(Acres)
SP-1	301	Klamath	28	Chico
	302		4	(13)
	311		4	
	321		2	
	322		0	
		Total	38	
SP-3	522	Lassen (A)	5	Foresthill
	523	Plumas (LP)	7	(24)
	524	Plumas (O)	25	
	525	Tahoe (D, FH, NC)	28	
		Total	65	
SP-4	526	Eldorado	46	Foresthill
	531	Stanisluas	42	(32)
		Total	88	
SP-5	532	Sierra	16	Foresthill
	533		11	(24)
	534	Sequoia	48a	
	540N		14	
		Total	89	
SP-6	340	Mendocino (CO, UL)	00	Unknown
	351		00	(8)
	372W		2	
		Total	2	
SP-7	371	Mendocino (CR, S)	00	Unknown
	372		2	(9)
		Total	2	

A seed production area from a progeny test is planned for SP-2.
a) the 48 MGR selections include 37 parents from Mountain Home State Forest

Table 7. 1990 collections from the sugar pine clone bank at Badger Hill

SEED PARENT		POLLEN PARENT	# OF CONES COLLECTED	TOTAL SEED COUNT	AVERAGE YIELD PER CONE
7012	X	LL MIX	2	00	00
7035	X	LL MIX	5	459	92
7069	X	LL MIX	1	78	78
7215	X	LL MIX	2	288	144
5000	X	CHICO 4	3	284	95
5000	X	W(BH)	1	73	73
5005	X	~	4	134	34
5008	X	~	5	290	58
5021	X	~	2	181	91
5033	X	~	5	518	104
5034	X	~	2	299	150
5038	X	~	3	348	116
5040	X	~	4	251	63
5041	X	~	1	72	72
5042	X	~	3	353	118
5051	X	~	5	65	13
5414	X	~	4	470	118
5900	X	~	4	298	75
6550	X	~	4	338	85
6551	X	~	4	532	133
6552	X	~	20	3000	150
7009	X	~	2	177	89
7027	X	~	2	251	126
7035	X	~	3	406	135
7046	X	~	1	138	138
7099	X	~	1	11	11
7181	X	~	1	65	65
7215	X	~	1	251	251
7223	X	~	1	102	102
K-9-HC	X	~	2	284	142
K-106-OK	X	~	3	147	49
K36XK17	X	~	6	526	88

Table 8. 1990 collections from the proven rust resistant parents send to the Placerville Nursery from National Forests.

LOT ID	SOURCE IDENTIFICATION CODE	SACKS RECEIVED	BUSHELS RECEIVED	LBS. YIELD
03446	*117-301.15-05-52-2-0101-90	1	1.00	0.90
03448	117-301.20-05-52-2-0101-90	4	1.50	2.35
03441	117-301.40-05-52-2-0103-90	5	1.50	1.25
03443	117-301.45-05-52-2-0106-90	16	4.25	4.40
03449	117-301.50-05-52-2-0107-90	9	2.50	2.60
03447	117-302.40-05-58-2-0103-90	3	1.75	0.80
03442	117-302.45-05-58-2-0105-90	6	2.00	2.05
03450	117-331.45-14-56-2-0104-90	5	1.00	1.15
03444	117-331.50-14-56-2-0102-90	3	2.00	1.30
03445	117-524.50-11-54-2-0104-90	5	1.75	1.50
03468	**117-525.45-17-54-3-0101-90	2	2.00	0.75
03436	117-525.55-17-54-3-0401-90	12	12.00	9.65
03437	117-525.65-17-54-3-0101-90	1	0.50	0.35
03415	117-526.35-03-56-3-0102-90	3	3.00	1.30
03412	117-526.45-03-55-3-0101-90	2	2.00	3.05
03453	117-526.45-03-56-3-0102-90	2	2.00	0.90
03413	117-526.50-03-55-3-0201-90	2	1.00	0.45
03417	117-526.55-03-56-3-0201-90	10	8.00	12.55
03414	117-526.60-03-55-3-0101-90	2	1.50	0.80
03452	117-526.60-03-56-3-0104-90	31	31.00	43.35
03451	117-526.65-03-56-3-0201-90	8	8.00	9.40

Table 8 cont.

LOT ID	SOURCE IDENTIFICATION CODE	SACKS RECEIVED	BUSHELS RECEIVED	LBS. YIELD
03419	117-531.55-16-53-3-0201-90	9	9.00	6.90
03420	117-531.60-16-00-3-0401-90	7	5.50	9.35
03418	117-531.65-16-00-3-0201-90	26	27.25	29.95
03421	117-531.70-16-53-3-0201-90	7	6.50	5.95
03467	117-533.70-15-53-3-0201-90	8	7.50	7.50
03454	117-534.70-13-51-3-0101-90	4	4.00	4.75
03455	117-534.70-13-51-3-0101-90	4	3.50	4.25

*A TYPE 2 COLLECTION DENOTES RRSP COLLECTED FROM THE BADGER HILL CLONE BANK

**A TYPE 3 COLLECTION DENOTES FIELD COLLECTED RRSP

Table 9. 1990 field collections from proven MGR parents for TI use.

TREE ID	SZ.ELEV	SEED COUNT	# OF CONES	AVERAGE YIELD PER CONE	
0356-19561	526.35	794	3	265	
0356-19565	526.40	482	9	54	
0356-7490	526.45	564	4	141	
0355-19524	526.45	571	4	143	
0356-19562	526.45	765	6	128	
0355-19521	526.50	1600	14	114	
0355-19525	526.50	279	4	70	
0356-19566	526.50	167	8	21	TREE DIED
0356-19555	526.55	579	4	145	
0356-19556	526.55	756	4	189	
0356-19563	526.55	192			
0356-19567	526.55	712	4	178	
0356-7503	526.60	525	4	131	
0356-7753	526.60	758	3	253	
0356-7754	526.60	978	4	244	
0356-7755	526.60	751	4	188	
0356-7756	526.60	703	4	176	
0355-19522	526.60	1780	12	148	
0356-19557	526.60	697	5	139	
0356-19559	526.65	995	5	199	
1351-7657	534.70	620	4	155	
1351-19000	534.70	532	4	133	
1553-54	533.70	750	4	188	
1553-55	533.70	680	4	170	

Table 9 cont.

TREE ID	SZ.ELEV	SEED COUNT	# OF CONES	AVERAGE YIELD PER CONE	
1600-19370	531.55	600	5	120	
1600-19371	531.55	419	3	140	
1652-19338	531.60	698	5	140	
1653-19373	531.60	505	4	126	
1653-19376	531.60	578	4	145	A-1
1653-19376	531.60	730	4	182	C-1
1654-007	531.65	118	4	30	
1652-19337	531.65	1136	5	227	
1652-7607	531.70	1235	12	103	
1652-7608	531.70	1543	13	119	
1754-7453	525.45	642	4	161	
1754-7451	525.55	591	4	148	
1754-7468	525.55	440	4	110	
1754-19633	525.55	343	4	86	
1754-19634	525.55	924	4	231	
1754-19635	525.55	758	4	190	
1754-19631	525.65	453	4	113	
1754-19632	525.65	3321			RR

Appendix 1.

RESISTANT SP BY SZ

TREEID	SZ	ELEV	TWN	RANGE	SEC	RR	PCTRR	HC	YR1	TOT1	SUS1	RES1	YR2	TOT2	SUS2	RES2	YR3	TOT3	SUS3	RES3	REMARKS
K70HCXK43SAR						Rr	71.1	27	88	38	11	27									(F1XW(HC) K70=5037
*SZ total. 1 Records																					
1051	6004	091	10	17N	1E	24	Rr	44.7	30	899	85	42	34								SR 1009 G
*SZ total. 1 Records																					
	5033	301	38	17N	7E	12	LL	0.0		68H				70H				71H			K-65-HC 25-N
0552	5000	301	42	45N	12W	8	Rr	0.0		68H				79G							K 11 HC DEAD
0552	5001	301	45	18N	6E	16	Rr	56.0		81	4	2	2	82	21	9	12				K 123 HC
0552	5002	301	28	18N	6E	25	Rr	49.1		81	3	1	2	82	24	13	11	82	29	14	14 K 125 HC DEAD
0552	5003	301	46	15N	5E	25	Rr	41.2		81	4	2	2	82	13	8	5				K 212 HC
0552	5004	301	36	15N	7E	26	Rr	56.5		82	92	40	52								K 206 HC
0552	5005	301	42	45N	12W	8	Rr	0.0		63H				66H				79G			K10HC 88D CTRL90(19C
0552	5006	301	15	15N	6E	2	Rr	46.1	35	882	76	41	35								K 1001 HC
0552	5008	301	28	18N	7E	21	Rr	0.0		77G											K 15 HC
0552	5010	301	41	17N	7E	12	Rr	0.0		62H				66H				67H			K 17 HC
0552	5011	301	40	17N	7E	13	Rr	0.0		65H				66H				79G			K 19 HC DEAD
0552	5021	301	50	15N	5E	24	Rr	50.6	42	77G				88	83	41	42				K31HCss75H(3)88-P1xW
0552	5022	301	50	15N	5E	24	Rr	0.0		77G				79G							K 32 HC
0552	5024	301	48	15N	5E	25	Rr	70.6	36	77G				79G				88	51	15	36 K34HC 88-P1XW(HC)
0552	5034	301	41	17N	7E	13	Rr	74.4	32	77G				79G				88	43	11	32 K66HCDEAD 88-P1XW(HC
0552	5037	301	40	17N	7E	13	RR	0.0		64H				65H				77G			(K70HCDEAD)BH LIVE
0552	5040	301	45	17N	7E	12	Rr	0.0		64H				77G				79G			K 73 HC
0552	5041	301	45	17N	7E	13	Rr	0.0		75H				79G							K 76 HC
0552	5042	301	38	17N	7E	13	Rr	50.0		77G	6	3	3	75H							K 77 HC
0552	5046	301	51	16N	6E	2	Rr	0.0		75H				77G				79G			K 81 HC
0552	5048	301	39	18N	7E	7	Rr	0.0		75H				77G							K 83 HC
0552	5051	301	41	18N	6E	1	LL	0.0		77G	6	6	0	64H				69H			K 86 HC ss-64,77
0552	5054	301	43	17N	7E	12	Rr	38.1		81	21	13	8	67H							K 89 HC
0552	5059	301	38	17N	7E	12	Rr	0.0		72H				75H				79G			K 94 HC
0552	5061	301	42	18N	6E	12	Rr	66.7		77G	6	2	4								K 96 HC
1051	6000	301	34	14N	3E	19	Rr	57.7		79	12	4	8	83	85	37	48				SR 47 G
1051	6001	301					Rr	28.6		81	7	5	2								SR 66 G UNK LOC.
1051	6002	301					Rr	50.0		81	20	10	10								SR 70 G UNK LOC.
1051	6003	301					Rr	66.7		81	6	2	4								SR 71 G UNK LOC.
*SZ total. 29 Records																					
0558	5412	302	45	13N	4E	2	Rr	0.0		77G											K 48 U
0558	5414	302	45	13N	4E	2	Rr	52.5	31	68H				69H				88	59	28	31 K50Uss68H 88-P1xW(HC
1052	5900	302	44				Rr	0.0		79G											SR 74 O DEAD
1052	5901	302	47	14N	4E	33	Rr	38.9		81	18	11	7								SR 26 O
*SZ total. 4 Records																					
0554	5500	311	51	39N	11W	20	LL	0.0		67H											K 44 SAR

Appendix 1.

RESISTANT SP BY SZ

TREEID	SZ	ELEV	TWN_RANGE_SEC_RR_	PCTRR	HC_YR1_TOT1_SUS1	RES1	YR2	TOT2	SUS2	RES2	YR3	TOT3	SUS3	RES3	REMARKS
0554	5501	311 40	37N 11W 15 Rr	52.3	81 16 11	5	82	28	10	18					K 13 SAR
0554	5502	311 42	37N 11W 14 Rr	37.5	81 16 10	6									K 17 SAR
0554	5503	311 40	37N 11W 15 Rr	43.8	81 16 9	7									K 195 SAR
*SZ total.	4 Records														
0551	5700	321 36	47N 8W 15 Rr	0.0	77G		79G								K 1 OK Rr?-79G DEAD
0551	5701	321 36	47N 11W 36 Rr	38.2	77G 6 4	2	77G	7	5	2	83	76	46	30	K 130 OK
*SZ total.	2 Records														
1456	6550	331 48	38N 9W 34 Rr	0.0	77G										ST 2 W
1456	6551	331 49	38N 9W 34 Rr	0.0	68H										ST 4 W DEAD
1456	6552	331 41	36N 6W 34 Rr	0.0	77G										ST 6 W
*SZ total.	3 Records														
0851	11000	371 40	24N 8W 32 Rr	66.7	30 896 78 25	50									ME 1027 CR
*SZ total.	1 Records														
0853	11200	372 50	19N 7W 8 Rr	44.3	35 882 79 44	35									ME 1056 S
0853	11201	372 45	19N 7W 16 Rr	48.3	42 882 88 45	42									ME 1067 S
0854	11300	372 39	17N 10W 2 Rr	51.7	79 13 9	4	81	22	10	12	83	85	39	46	75H ME 63 UL
0854	11301	372 31	19N 10W 25 Rr	50.0	82 60 30	30									ME 47 UL
*SZ total.	4 Records														
1461	6250	521 53	38N 2E 6 Rr	0.0	75H		77G								ST 7 MC
*SZ total.	1 Records														
0651	6751	522 50	29N 3E 35 Rr	53.6	79 9 6	3	81	19	7	12					L 18 A
0651	6752	522 51	28N 3E 2 Rr	51.0	81 14 8	6	83	90	43	47					L 13 A
0651	6753	522 54	28N 3E 5 Rr	50.0	80 21 12	9	82	11	4	7					L 45 A
0651	6755	522 55	28N 3E 5 Rr	51.9	83 79 38	41									L 48 A
0653	6901	522 55	32N 5E 33 Rr	50.0	79 2 1	1	80	28	14	14	81	16	8	8	L 2 HCR Control '90
*SZ total.	5 Records														
1152	19775	523 55	26N 9E 18 Rr	54.3	19 888 35 16	19									
1156	7071	523 53	23N 8E 3 Rr	70.0	28 887 40 12	28									
1156	7072	523 53	23N 8E 3 Rr	55.0	81 20 9	11									
1156	7096	523 53	23N 8E 3 Rr	59.1	81 22 9	13									
1156	7098	523 53	23N 8E 3 Rr	62.5	79 16 6	10	75H								
1156	7106	523 53	23N 8E 3 Rr	38.9	81 18 11	7									
1156	7362	523 39	24N 8E 27 Rr	38.0	79 13 13	0	79	15	10	5	84	64	34	30	
*SZ total.	7 Records														
0651	6754	524 50	28N 5E 27 Rr	42.5	81 21 9	12	83	91	52	33					L 73 A
1154	7006	524 47	23N 6E 31 Rr	53.8	79 26 12	14									

Appendix 1.

RESISTANT SP BY SZ

TREEID	SZ	ELEV	TWN_RANGE_SEC_RR_	PCTRR	HC_YR1_TOT1_SUS1	RES1	YR2	TOT2	SUS2	RES2	YR3	TOT3	SUS3	RES3	REMARKS
1154	7010	524 47	23N 6E 31 Rr	0.0	75H		73H				69H				
1154	7011	524 47	23N 6E 31 Rr	0.0	71H										
1154	7016	524 47	23N 6E 31 Rr	0.0	71H		75H								
1154	7017	524 47	23N 6E 31 Rr	40.0	82 25 15	10	75H				74H				
1154	7020	524 47	23N 6E 31 Rr	0.0	71H										
1154	7023	524 47	21N 6E 31 Rr	45.5	79 11 6	5	75H								
1154	7030	524 47	23N 6E 30 Rr	31.6	81 19 13	6									
1154	7034	524 47	23N 6E 30 Rr	33.3	72H		75	6	4	2					
1154	7139	524 48	24N 6E 32 Rr	40.0	79 5 3	2									
1154	7197	524 46	24N 6E 32 Rr	33.3	79 6 4	2									
1154	7202	524 46	23N 6E 5 Rr	70.0	79 20 6	14									
1154	7210	524 46	23N 6E 5 Rr	20.0	79 10 8	2									
1154	7267	524 46	24N 6E 32 Rr	0.0	74H										
1154	7298	524 46	23N 6E 6 Rr	75.0	81 12 3	9	75H								PPT223
1154	7399	524 52	23N 6E 22 Rr	68.4	81 19 6	13									
1154	7402	524 43	22N 5E 3 Rr	51.3	82 25 12	13	82	95	46	48					
1154 CTJ	14	524 22	21N 5E 2 Rr	49.4	30 896 78 39	38									
1154 RCO	1	524 30	22N 6E 33 Rr	53.0	30 899 66 31	35									
1154 WMD	3	524 39	22N 6E 16 Rr	52.5	30 891 71 38	42									
DI	21	524 46	24N 4E 24 Rr	57.8	26 85F 55 19	26									
DI	25	524 44	24N 5E 27 Rr	38.3	18 85F 55 29	18									
DI	38	524	Rr	44.1	30 87A 69 38	30									LOGGED 8/18/88
DI	42	524 44	Rr	73.8	40 87A 61 16	45									
*SZ total.	25 Records														
1153	10	525 40	20N 9E 19 Rr	48.4	30 895 64 33	31									
1153	20	525 45	21N 8E 28 Rr	49.3	30 893 74 38	37									
1153	31	525 50	21N 9E 20 Rr	43.6	24 893 68 31	24									22 O's sent to HC
1754	25	525 55	14N 13E 19 Rr	48.2	41 884 88 44	41									14NS
1754	100	525 55	15N 12E 4 Rr	46.8	30 895 77 41	36									
1754	7451	525 54	15N 12E 4 Rr	43.4	82 28 16	12	82	96	53	41					
1754	7453	525 46	15N 12E 30 Rr	41.0	33 88B 45 21	5	898	83	41	38					SC '90
1754	7463	525 60	15N 13E 33 Rr	50.0	79 10 5	5									Z435
1754	7468	525 53	15N 13E 6 Rr	72.7	81 11 3	8									
1754	19630	525 60	15N 13E 33 Rr	50.0	30 886 80 40	40									10 BH
1754	19631	525 65	15N 13E 5 Rr	51.1	30 883 92 45	47									15/BH
1754	19632	525 65	16N 13E 32 RR	100.0	87 886 87 0	87									
1754	19633	525 55	15N 12E 4 Rr	42.5	34 884 80 46	34									
1754	19634	525 55	15N 12E 4 Rr	45.0	30 887 82 44	36									6/BH
1755	13	525 44	18N 10E 24 Rr	24.2	22 86F 93 34	0	88C	57	21	0	890	36	14	22	Test87/59Total/0Data
1755	119	525 45	17N 10E 22 Rr	48.3	30 892 58 30	28									
1755	124	525 55	17N 11E 21 Rr	58.1	30 895 62 26	36									
1755	7456	525 39	18N 9E 24 Rr	58.6	30 896 88 36	51									
1755	7464	525 56	17N 12E 6 Rr	68.8	79 16 5	11	75H								Z424 HAD RUST9/25/90

Appendix 1.

RESISTANT SP BY SZ

TREEID		SZ	ELEV	TWN	RANGE	SEC	RR_	PCTRR	HC_YR1	TOT1	SUS1	RES1	YR2	TOT2	SUS2	RES2	YR3	TOT3	SUS3	RES3	REMARKS
LPO		103	525				Rr	45.5	28	81	14	7	7	87E	71	35	28				
LPO		104	525				Rr	50.0		81	16	8	8								
LPO		105	525				Rr	64.7		81	17	6	11								
LPO		106	525				Rr	34.8		81	23	15	8								
LPO	383	2	525	40	21N	7E	34	Rr	35.1		84	57	37	20							
LPO	383	8	525	44	21N	7E	13	Rr	58.3		84	12	5	7							
SW		2	525	39	20N	7E	14	Rr	45.7	30	885	82	44	37							7 BH
SW		3	525	40	20N	7E	14	Rr	52.3	23	885	52	21	23							
SW		4	525	39	20N	7E	14	Rr	60.6	30	886	94	37	57							27 BH
*SZ total.		28 Records																			
0351		6	526	60	8N	15E	16	Rr	51.9	29	896	106	50	54							
0351		7	526	60	8N	15E	17	Rr	67.9	30	897	86	27	57							
0353		18	526	45	12N	11E	1	Rr	40.5	30	887	84	50	34							4 BH
0353		136	526	45	14N	13E	26	Rr	59.2	30	898	83	31	45							
0353		170	526	60	14N	13E	12	Rr	50.8	30	898	63	29	30							
0353		180	526	40	12N	11E	1	Rr	50.9	30	892	59	28	29							
0353		7519	526	30	11N	11E	2	Rr	44.1	30	883	68	38	30							E43
0353		7551	526	40	12N	12E	6	Rr	55.4	40	882	82	37	46							6 SENT TO BH
0355		62	526	50	11N	13E	10	Rr	55.8	30	897	88	38	48							
0355		63	526	50	11N	13E	11	RR	100.0	30	891	56	0	55							
0355		7504	526	71	14N	14E	23	Rr	55.0		80	20	9	11							P42
0355		19520	526	58	11N	13E	11	Rr	45.5	25	883	55	30	25							
0355		19521	526	50	11N	13E	11	Rr	96.6	38	883	62	2	57							
0355		19522	526	60	12N	15E	20	Rr	44.6	31	883	83	46	37							6/BH
0355		19523	526	50	11N	13E	12	Rr	51.6	30	887	91	44	47							17 BH
0355		19524	526	45	11N	13E	15	Rr	66.2	30	886	76	25	49							19 BH
0356		51	526	39	9N	13E	22	Rr	44.1	30	893	68	38	30							
0356		52	526	39	9N	13E	22	Rr	41.6	30	891	78	45	32							
0356		63	526	45	10N	13E	23	Rr	54.1	30	894	87	39	46							
0356		69	526	54	9N	14E	4	Rr	58.9	30	895	73	30	43							
0356		77	526	38	10N	13E	20	Rr	54.2	30	898	85	38	45							
0356		81	526	40	10N	13E	10	Rr	52.6	30	895	78	37	41							
0356		150	526	54	9N	14E	4	Rr	52.0	30	895	75	36	39							
0356		151	526	54	9N	14E	4	Rr	44.7	30	899	89	47	38							
0356		7230	526	50	10N	11E	10	Rr	58.3		79	12	5	7							ORIGINAL PARENT DEAD
0356		7490	526	45	10N	13E	23	Rr	56.5	13	87A	24	10	13							
0356		7503	526	58	10N	15E	3	Rr	42.9		80	28	16	12							E32/SPA1
0356		7518	526	48	9N	14E	5	Rr	42.3	32	87B	78	45	33							
0356		7750	526	54	9N	14E	4	Rr	39.0	26	87B	80	47	30							
0356		7753	526	58	10N	15E	30	Rr	0.0												OLD#31/SPA1
0356		7754	526	58	10N	15E	30	Rr	0.0												OLD#15/SPA1
0356		7755	526	58	10N	15E	30	Rr	0.0												OLD#11/SPA1
0356		7756	526	58	10N	15E	30	Rr	0.0												OLD#27/SPA1

Appendix 1.

RESISTANT SP BY SZ

TREEID	SZ	ELEV	TWN_RANGE_SEC_RR_	PCTRR	HC_YR1_TOT1_SUS1 RES1	YR2 TOT2 SUS2 RES2	YR3 TOT3 SUS3 RES3	REMARKS
0356	7903	526 71	14N 14E 23 Rr	0.0				
0356	7904	526 71	14N 14E 23 Rr	0.0				
0356	7905	526 71	14N 14E 23 Rr	0.0				
0356	7906	526 71	14N 14E 23 Rr	0.0				
0356	7907	526 71	14N 14E 23 Rr	0.0				
0356	19555	526 52	10N 14E 22 Rr	42.5	16 87B 46 23 17			
0356	19556	526 55	10N 15E 33 Rr	45.1	30 883 72 39 32			2/BH
0356	19557	526 65	10N 15E 25 Rr	50.0	36 886 72 36 36			
0356	19558	526 50	10N 14E 1 Rr	57.6	30 882 66 28 38			8/BH
0356	19559	526 65	10N 15E 23 Rr	48.7	30 883 82 39 37			7/BH
526 Z271		526	Rr	50.0	80 6 3 3			
AFPM	506	526 47	13N 13E 19 Rr	65.0	81 20 7 13			FGS TREE
*SZ total.	45 Records							
Z619		531	Rr	80.0	80 5 1 4			
Z771		531	Rr	80.0	80 5 1 4			
1651	003	531 37	1N 16E 24 Rr	60.0	30 893 65 26 39			
1651	012	531 45	1N 17E 10 Rr	57.8	30 893 64 27 37			
1651	014	531 43	2N 17E 34 Rr	65.3	30 895 69 25 47			
1651	017	531 43	2N 17E 35 Rr	52.2	30 893 69 33 36			
1651	093	531 45	3N 17E 18 Rr	63.5	30 893 52 19 33			
1651	7555	531 51	3N 17E 29 Rr	31.7	30 84 12 5 7	87G 77 47 0	895 80 43 37	
1651	7585	531 47	2N 17E 34 Rr	48.7	38 87A 84 40 38			
1651	7591	531 50	3N 16E 25 Rr	58.1	25 888 43 18 25			
1652	120	531 50	6N 16E 34 Rr	45.9	30 896 85 46 39			
1652	133	531 60	6N 16E 15 Rr	47.7	30 894 89 46 42			
1652	154	531 55	7N 16E 10 Rr	48.4	30 893 64 32 30			
1652	180	531 55	5N 17E 21 Rr	46.0	30 893 65 34 29			
1652	7328	531 55	5N 17E 12 Rr	45.2	30 895 73 40 33			
1652	19335	531 60	6N 16E 14 Rr	47.4	30 887 78 41 37			7 BH
1652	A2 2	531 50	6N 16E 33 Rr	56.2	30 888 90 39 50			16BH LOGGED
1653	1	531 50	4N 18E 4 Rr	37.8	34 883 85 56 34			
1653	15	531 60	4N 18E 4 Rr	40.4	20 885 55 31 21			
1653	049	531 60	5N 18E 10 Rr	46.0	29 893 68 34 29			REINOC. 21/'90
1653	055	531 55	5N 18E 15 Rr	57.8	30 893 84 19 26			REINOCULATE 25/'90
1653	070	531 55	5N 18E 28 Rr	44.1	30 893 71 38 30			
1653	123	531 55	5N 18E 7 Rr	48.7	30 894 79 39 37			
1653	128	531 55	5N 18E 6 Rr	57.3	30 894 82 35 47			
1653	7576	531 53	5N 18E 32 Rr	53.1	83 97 45 51			
1653	7577	531 54	4N 18E 8 Rr	51.1	38 87A 21 12 8	896 68 31 37		
1653	7578	531 55	4N 18E 21 Rr	44.6	83 92 51 41			
1653	7607	531 68	4N 18E 26 Rr	52.9	84 51 24 27			T31
1653	7608	531 68	4N 18E 26 Rr	37.7	84 53 33 20			T27
1653	7609	531 56	4N 18E 21 Rr	50.0	84 82 41 41	81		T137

Appendix 1.

RESISTANT SP BY SZ

TREEID		SZ	ELEV	TWN_RANGE_SEC_RR_			PCTRR	HC_YR1_TOT1_SUS1			RES1	YR2	TOT2	SUS2	RES2	YR3	TOT3	SUS3	RES3	REMARKS
1653	19370	531	55	4N	18E	4 Rr	54.0	30	884	89	40	47								4BH
1653	19371	531	55	5N	18E	32 Rr	63.0	32	883	83	30	51								19/BH
1654	7	531	65	2N	18E	13 Rr	48.7	30	881	76	39	37								7 SENT TO BH
1654	124	531	40	1N	18E	22 Rr	50.0	30	893	70	35	35								
1654	126	531	40	1N	18E	22 Rr	51.3	30	891	81	38	40								
1654	133	531	45	1N	18E	19 Rr	47.7	29	893	91	34	31								
1654	137	531	45	1N	18E	17 RR	100.0	31	893	64	0	64								
1654	138	531	45	1N	18E	8 Rr	58.5	30	891	84	34	48								
1654	162	531	50	1S	19E	16 Rr	38.1	30	893	63	39	24								
1654	163	531	40	1N	18E	21 Rr	57.9	30	891	76	32	44								
1654	165	531	45	1N	18E	8 Rr	41.1	24	893	94	33	23								RI
1654	166	531	50	1N	18E	31 Rr	61.0	30	893	81	23	36								
1654	19405	531	60	2N	18E	24 Rr	54.8	30	881	63	28	34								4/BH
*SZ total.		43 Records																		
Z159		532				Rr	81.8		80	11	2	9								Rr ?
1551	7370	532	57	5S	21E	33 Rr	45.6	30	87A	74	37	31								
1551	7373	532	51	6S	22E	26 Rr	53.8	32	87A	68	30	35								
1551	7628	532	62	6S	22E	25 Rr	35.0	36	87G	36	21	0	888	84	46	36				Z182
1551	7630	532	51	6S	22E	7 Rr	52.8		83	89	42	47								
1551	7631	532	52	6S	22E	21 Rr	52.0		82	25	12	13								
1551	7660	532	48	5S	21E	4 Rr	51.1	24	894	85	23	24								RI
1551	7712	532	54	6S	22E	15 Rr	40.7	23	87B	71	35	24								
1551	19186	532	53	6S	22E	21 Rr	63.2	30	886	68	25	43								13/BH 7/NS
1551	19187	532	45	6S	22E	17 Rr	46.9	23	884	51	26	23								
1554	7654	532	51	6S	24E	5 Rr	40.4	34	88D	75	45	4	899	90	36	51				SC '90
1555	7356	532	62	6S	24E	1 Rr	53.1		83	96	45	51								
1555	7382	532	45	7S	23E	9 Rr	46.3	36	87B	54	33	10	896	78	32	46				SC '90
1555	7652	532	59	7S	23E	33 Rr	57.3		83	82	35	47								
1555	19185	532	65	7S	23E	34 Rr	51.2	30	883	85	40	42								12/BH
1555	19188	532	60	6S	22E	36 RR	100.0	39	883	53	0	48								9/BH
1555	19189	532	65	7S	23E	13 Rr	46.3	30	887	82	44	38								8 BH
*SZ total.		17 Records																		
1553	7	533	54	7S	25E	4 Rr	50.0	30	883	81	40	40								10 SENT TO BH
1553	47	533	70	7S	24E	19 Rr	47.5	30	897	83	42	38								
1553	54	533	65	6S	25E	15 Rr	71.1	30	896	84	24	59								
1553	55	533	65	6S	25E	15 Rr	63.3	30	891	60	22	38								
1553	7405	533	52	9S	25E	34 Rr	45.7	39	80	4	3	1	87H	53	26	9	898	79	34	43 Z537 SC '90
1553	7635	533	63	6S	25E	16 Rr	67.4		83	93	30	62								
1553	7646	533	56	10S	25E	5 Rr	54.4	40	87A	81	36	43								
1553	7724	533	59	10S	25E	6 Rr	44.1	30	87C	42	12	0	896	81	40	41				SC '90
1554	7640	533	51	11S	26E	25 Rr	54.9		83	92	41	50								
1554	7642	533	63	10S	26E	7 Rr	55.6		83	81	36	45								

Appendix 1.

RESISTANT SP BY SZ

TREEID	SZ	ELEV	TWN_RANGE_SEC	RR_	PCTRR	HC	YR1	TOT1	SUS1	RES1	YR2	TOT2	SUS2	RES2	YR3	TOT3	SUS3	RES3	REMARKS
1554 19255	533	70	11S 28E 6	Rr	57.8	24	887	45	19	26									
*SZ total.	11 Records																		
1351 2	534	50	14S 27E 12	Rr	65.7	30	887	68	23	44									BH-14 DUPLOT#
1351 5	534	50	14S 27E 12	Rr	47.6	39	888	82	43	39									1/SCION DUPLOT#RT/91
1351 15	534	55	13S 28E 13	Rr	43.8		891	85	27	21									38 RI
1351 17	534	64	13S 27E 12	Rr	44.9	30	899	78	43	35									
1351 22	534	68	13S 28E 18	Rr	51.9	30	896	83	37	40									
1351 7538	534	62	14S 28E 18	Rr	52.6	30	87A	58	27	30									
1351 7614	534	59	13S 28E 30	Rr	44.7	21	87B	57	26	21									
1351 7657	534	70	14S 28E 11	Rr	52.5		80	4	2	2	84	55	26	29					Z01
1351 7685	534	56	14S 27E 12	Rr	47.6		84	82	43	39									F23
1351 7686	534	56	14S 27E 12	Rr	46.6	41	881	89	47	41									F32
1351 7689	534	50	14S 27E 12	Rr	45.8	38	87A	86	45	38									
1351 1 6	534	50	14S 27E 12	Rr	48.2	30	885	83	43	40									10 BH
1351 1 10	534	50	14S 27E 12	Rr	49.4	30	883	89	45	44									14 SENT TO BH
1352 7675	534	57	19S 30E 35	Rr	38.2	43	87B	73	53	16	896	88	41	42					SC '90
MTH 4	534			Rr	50.0		82	18	9	9									
MTH 7	534			Rr	39.1		82	24	16	8	83	48	22	26	88D	19	15	0	88E 34T, 10S, OR
MTH 38	534			RR	100.0		82	24	0	24									
MTH 39	534			RR	100.0		82	17	0	17	88	172	0						ALL RR- 162 TO CTIC
MTH 58	534			Rr	45.0		82	20	11	9									
MTH 61	534			Rr	34.0		82	5	1	4	83	28	16	12	88D	42	14	0	
MTH 66	534			Rr	42.9		82	21	12	9									
MTH 85	534			Rr	40.0		82	25	15	10									
MTH 115	534			Rr	61.9		82	21	8	13									
MTH 116	534			Rr	50.0		82	20	10	10									
MTH 117	534			Rr	66.7		82	9	3	6									
MTH 125	534			Rr	19.0	1	82	4	1	3	88D	37	16	1					
MTH 139	534			Rr	87.5		82	16	2	14									
MTH 152	534			Rr	26.9	1	82	11	5	6	88D	19	6	0	88E	17	8	1	
MTH 154	534			Rr	50.0		82	12	6	6									
MTH 155	534			Rr	42.9		82	14	8	6									
MTH 156	534			Rr	22.2	2	82	13	7	6	88D	52	21	2					
MTH 166	534			Rr	64.3		82	28	10	18									
MTH 206	534			Rr	52.4		83	82	39	43									
MTH 208	534			Rr	63.9		83	36	13	23									
MTH 211	534			Rr	52.8		83	36	17	19									
MTH 215	534			Rr	53.7		83	67	31	36									
MTH 217	534			Rr	56.7		83	60	26	34									
MTH 218	534			Rr	44.4		83	45	25	20									
MTH 220	534			Rr	56.1		83	41	18	23									
MTH 223	534			Rr	41.5		83	41	24	17									
MTH 224	534			RR	100.0		83	60	0	60	88	99	0	99					89 SENT TO CTIC

Appendix 1.

RESISTANT SP BY SZ

TREEID	SZ	ELEV	TWN	RANGE	SEC	RR	PCTRR	HC	YR1	TOT1	SUS1	RES1	YR2	TOT2	SUS2	RES2	YR3	TOT3	SUS3	RES3	REMARKS
MTH	236	534				Rr	56.9		83	72	31	41									
MTH	244	534				Rr	52.9		83	17	8	9									
MTH	249	534				Rr	46.2		83	39	21	18									
MTH	250	534				Rr	45.5		83	33	18	15									
MTH	251	534				Rr	71.4		83	7	2	5									
MTH	252	534				Rr	55.9		83	59	26	33									
MTH	254	534				Rr	50.0		83	10	5	5									
*SZ total.	48 Records																				
Z075		540				Rr	66.7		80	3	1	2									Rr ?
Z078		540				Rr	50.0		80	4	2	2									Rr?
Z706		540				Rr	80.0		80	5	1	4									
1352	02	540	50	20S	30E	Rr	40.0	30	891	72	39	26									
1352	7682	540	60	21S	31E	Rr	56.4		80	1	1	0	84	77	33	44					Z63
1352	19030	540	65	20S	30E	Rr	51.7	30	887	58	28	30									2 NS
1353	13	540	65	22S	32E	Rr	50.9	30	892	64	28	29									
1353	19060	540	70	24S	31E	Rr	50.7	30	882	86	34	35									5/BH
1353	19061	540	70	24S	32E	Rr	61.4	30	885	57	22	35									5BH
1353	5 1	540	65	23S	31E	Rr	54.8	36	884	76	33	40									6NS MOTORLOG#1353-05
1354	3	540	60	25S	32E	Rr	75.0	30	885	48	12	36									6BH
1354	7697	540	61	25S	32E	Rr	52.4	30	80	8	4	4	896	96	45	50					Z267
1354	7698	540	64	25S	33E	Rr	40.7	41	80	11	6	5	87G	67	32	6	896	97	48	48	Z276 RT/89
1354	19120	540	60	25S	32E	Rr	53.1	30	885	64	30	34									4BH
*SZ total.	14 Records																				
0653	6902	732	55	31N	3E	Rr	53.6	30	886	56	26	30									L 1042 HCR 7 NS
*SZ total.	1 Records																				
0557	5890	741	35	47N	3W	Rr	0.0		77G												K 63 GO LOST/DEAD
*SZ total.	1 Records																				
0956	13601	742	50	44N	5E	Rr	45.7	32	884	71	38	32									MO 1018 DH
*SZ total.	1 Records																				
1756	27	772	52	20N	14E	Rr	46.5	20	893	89	23	20									RI
*SZ total.	1 Records																				
0757	10	992	70	7N	19W	Rr	0.0														
0757	002	992	70	7N	19W	Rr	0.0														
0757	004	992	70	7N	19W	Rr	0.0														
*SZ total.	3 Records																				
Z009		997				Rr	83.3		80	6	1	5									Rr ?

Appendix 1.

RESISTANT SP BY SZ

TREEID	SZ	ELEV	TWN_RANGE_SEC_RR_	PCTRR	HC_YR1_TOT1_SUS1	RES1	YR2	TOT2	SUS2	RES2	YR3	TOT3	SUS3	RES3	REMARKS

*SZ total. 1 Records

Grand Total. 301 Records

BADGER HILL

BADGER HILL

Calendar Year 1990 Accomplishments

CLONE BANK ESTABLISHMENT

Knobcone pine seedlings originally established to produce the attenuata X radiata cross (KMX) were cleared. The land was then ripped with a "winged sub-soiler", and brush-raked. A total of 7 acres were cleared for cloning Douglas-fir from Breeding Zone 7 and sugar pine MGR pollen receptors from northern California. In another area of Badger Hill, some additional rows were rototilled for preserving MGR sugar pine parent clones.

Douglas-fir BZ 7

Grafted compatible rootstock came from both the California Department of Forestry nursery at Davis and the Chico Tree Improvement Center. CDF stock had been grafted in the spring of 1989 and held at Davis though the growing season and following winter. CTIC stock was grafted in the winter of 1989/90. Both were planted in March of 1990.

Table 1. First year Douglas-fir graft survival by agency.

Grafting Agency	# Planted Clones	# Planted Ramets	Dead Rabbits	Dead Other	Rabbit Damaged	Survival % Clones	Survival % Ramets
CDF	69	258	47	16	144	98.5%	75.6%
CTIC	135	539	2	11	7	100%	97.6%
TOTAL	204	797				99.5%	90.5%

From Table 1 it is obvious that the rabbits preferentially browsed CDF grafted rootstock. The reason is unknown. The rootstock was older and grafts cultured differently than at CTIC. Once this damage was recognized, a previously scheduled backbladding to level the ground between the rows also reduced cover. This may have also reduced rabbit visitation. Later additional damage was minimal.

CDF-Davis grafts while suffering rabbit damage, flushed well after establishment. Unfortunately, the grafted scion is not growing vertically on many. It is hoped that pruning and/or staking may encourage vertical growth and cancel regrafting.

CTIC material while surviving well displayed signs of drought stress in the rootstock foliage. Though drip irrigated the Chico material was held at the Tree Improvement Center until close to the date of planting. Root Growth Capactiy may have suffered. The Chico material also suffered more from very cold temperatures experienced in December. New growth after planting still looks good. However most of the previous years needles have taken on a bleached color.

Some CTIC material did not flush well. If there was a flush it was often weak and did not form a large well defined bud for the next growing season. A coding of "NB" for "no normal bud formed" is summarized by grafting agency in Table 2.

Table 2. Occurance of abnormal bud formation (or "NB") in Douglas-fir grafts after first growing season.

Grafting Agency	Total Clones	"NB" Clones	%	Total Ramets	"NB" Ramets	%
CDF-PVT	69	1	1.4%	258	1	0.4%
CTIC-USFS	65	14	21.5%	259	37	14.3%
-PVT	70	46	65.7%	280	125	44.6%
	204		29.9%	797		20.5%

Some scion collected was smaller than desirable for proper grafting. This too may have contributed to poor bud break.

Of the remaining CTIC material which did flush well (70%) some put on more than 4 inches of new growth. This is surely a promising sign for proper graft development in the future.

Rust Resistant Sugar Pine

Sugar pine graft establishment continues to be disappointing (Table 3). Both grafted MGR parents established in the previously existing clone bank and grafted MGR pollen receptors establish in the freshly cleared area produced less than 60% survival for ramets planted. Rabbits killed 2 grafts and browsed one other. It is assumed that Fusarium infection at both the Davis and CTIC nurseries has at least contributed to these poor establishment results..

Table 3. First year sugar pine graft survival by agency.

Grafting Agency	Scion Type	# Planted Clones	# Planted Ramets	Survival % Clones	Survival % Ramets
CDF	MGR-parent	6	23	100%	69.6%
CTIC	MGR-parent	14	41	71.4%	41.5%
	MGR-pollen receptor	29	37	72.4%	55.2%
		49	101	75.5%	52.5%

White Fir BZ 3

Approximately 5 acres along the north boundary of Badger Hill were cleared of an old Douglas-fir Clone Bank. Many of the original grafts for clones from northern California were established here. Unfortunately it was on incompatible rootstock. About 3 acres will be used to establish a clone bank for BZ 3 white fir. The remaining areas on steeper ground will be scheduled for clone preservation of another species to be determined.

Clone Bank Maintenance

In portions of the "west block" sugar pine basal area had climbed to 120 sq ft/acre. Some of the stems were up to 18" DBH. It was decided that approximately 1/3 of the stems would be taken out. Flower and pollen production might be enhanced. Movement of the motorized lift would be easier, reducing damage to remaining ramets.

Even spacing was not the predominant criteria for tree marking. First, no rust resistant sugar pine grafts would be taken out. At least one ramet would be saved from each clone even if it was a proven non-MGR. The number of clones and ramets remaining after thinning would be balaced between seed zones and 500 foot elevational bands. Finally, poorly producing clones or ramets would be thinned more heavily.

Thinning took place in late October. Falling, bucking to commercial lengths and skidding were accomplished by Badger Hill personnel. Due in great part to the care taken by our faller, Dave Alicea, there was no damage to any remaining grafts. Badger Hill was within an existing Salvage Sale area. More than 7 MBF were sold at a stumpage rate of $214/MBF.

Vegetation management was accomplished by manual, mechanical and chemical methods. Hand grubbing and mowing took place in the white fir and sugar pine clone banks. Back bladding to level access rows also controlled vegetation in the newly established Douglas-fir clone bank. Glyphosate application targeted Scotch Broom and other woody plant species throughout all clone banks.

In addition to rabbits, attempts were made to control both gophers and ground squirrels. Gophers have been kept in check with semi-annual "burrow-building". Gas cartridges have not provided adequate control of ground squirrels and alternative methods will be used next year.

Badger Hill
Surveys and Administrative Studies

Sugar Pine Reproduction Survey

Continued failure with controlled pollination has focused our attention on the fate of our female flower crops during their development into cones. A quantitative survey would provide a base line with which to compare current production with that realized with future cultural practices. Past surveys had only been subjective in nature. They had measured crops only as "light, moderate or heavy."

Surveys of pollen, conelet and cone crops were performed for all sugar pine grafts at Badger Hill. The pollen survey was completed in two days in June. Cone and conelet surveys were perfomed in July. Pollen crops were generally heavy. However, results are not reported here. Cone crops were generally light.

A total of 3681 conelets were counted on sugar pine grafts. Of these 3300 or 92% were on grafts 22 years or older. These observations are summarized in Table 4. Figure 1 depicts average conelet production by years after graft establishment.

Eleven rootstock planted in 1960 remained ungrafted and developed with the surrounding grafted clones. Rootstock source is not positively known. However, it was probably from within the area of old seed zone III mid-elevation Sierra Nevada (per com Gaylord Parks). Ellen Ott a now retired orchard pollination leader reported that flower production began on some seedlings as early as 1985 or 26 years after planting. After 31 years 7 out of 11 seedlings produced at least one conelet. One individual produced 37 of the 85 total produced.

As expected, there is considerable difference both between and within clones for conelet production. In ages 22-31, 88% of the conelet crop was produced by half of the clones (Table 5). Within clones, ramets randomly located within the clone bank might produce 0 to 50 conelets without visible differences in graft vigor. Finally, in the 22-31 year old age classes 20% of the clones did not produce conelets in the spring of 1990. Of the 34 total clones not producing, 14 were represented by more than one ramet.

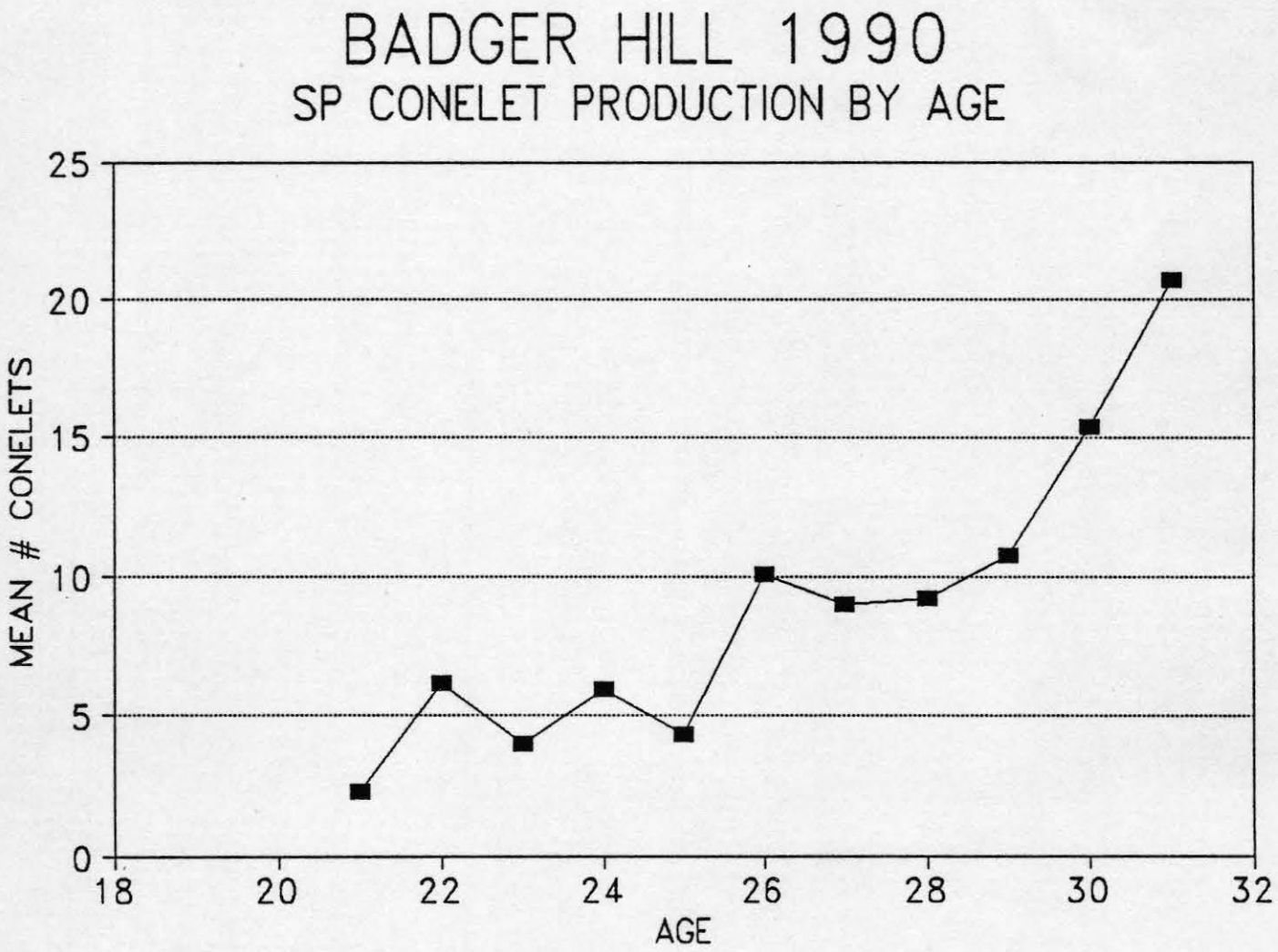
One last observation that has been made before is that Klamath clones apprear to produce better than Plumas clones. In comparing clones of age 19-23 located in the same general area Klamath clones produced more conelets per graft than Plumas clones averaging 3.85 and 2.21 conelets per ramet respectively.

Table 4. Cone and conelet production by age of graft.

Year Planted	Age	No. of Clones	No. of Ramets	Total Cones	Avg/ Graft	Total Conelets	Avg/ Graft
1960	31	19	47	117	2.49	971	20.66
61	30	10	21	78	3.71	324	15.43
62	29	24	42	34	0.81	451	10.74
63	28	28	62	58	0.94	571	9.21
64	27	19	31	68	2.19	279	9.00
65	26	18	31	34	1.10	313	10.10
66	25	14	28	13	0.46	121	4.32
67	24	7	11	1	0.09	66	6.00
68	23	18	23	4	0.17	91	3.96
69	22	13	19	19	1.00	118	6.21
1970	21	20	33	9	0.27	75	2.27

Table 5. Clonal patterns of conelet production.

Age	# of Clones	Average # of Ramets	Total Conelets	Avg/ Ramet	Average Conelets per Ramet Top 50%	Bottom 50%	% of Crop Top 50%	# Clones not Producing
31	19	2.5	971	20.6	30.7	7.1	85.4%	0
30	10	2.1	324	15.4	27.6	3.6	76.5	0
29	24	1.8	451	10.8	16.2	1.9	93.3	1
28	28	2.2	571	9.2	16.8	1.2	93.7	9
27	19	1.6	279	9.0	14.3	2.6	87.1	2
26	18	1.7	313	10.1	20.7	1.4	92.7	3
25	14	2.0	121	4.3	6.5	0.9	91.7	5
24	7	1.6	61	6.0	12.3	3.0	60.7	2
23	18	1.3	91	2.9	6.0	0.1	98.9	8
22	13	1.5	118	6.2	10.5	1.4	90.0	4
	170	1.9	3300	10.2			88.2%	34


BADGER HILL 1990
SP CONELET PRODUCTION BY AGE
MEAN # CONELETS
0
5
10
15
20
25
18
20
22
24
26
28
30
32
AGE

Bark Scoring

In the fall of 1989, some of the sugar pine grafts just didn't look right. A closer look at the graft unions led to the suspicion of developing graft incompatibility in an unusually high number of ramets. A review of the below listed articles by Dr Donald Copes confirmed the suspicion and gave a framework for dealing with the problem.

More than 1000 sugar pine grafts were reviewed for signs of graft incompatibility in March of 1990. Of these, 77 ramets from 50 clones were scored to represent 4 potential stages or, at least, reactions to rejection.

0 - Beginning perforation of union?

1 - Perforated appearance to union.

2 - Definite line and/or patches of sunken cambium.

3 - Ramet overgrowing rootstock.

In the first stages of rejection evenly spaced holes much like computer paper perforation, would appear at the graft union. Later stages (2 and 3) were more suggestive of cambial disruption.

In addition to scoring rejection candidates, initial observations included;

1. Height and diameter
2. Percentage of graft union circumference showing signs of rejection
3. Foliage health (subjectively based on color and needle retention)
4. Presence of frass at union (from Dioryctria mining)
5. Presence of previous bark scoring.

Photographs were taken of the different rejection classes for comparison with later development.

Bark scoring consists of physically wounding a graft with a narrow furrow across its union and to the depth of the outer xylem. It has been found effective in healing or at least prolonging graft survival in Douglas-fir. Gaylord Parks had performed this treatment method on a small number of sugar pine grafts in the past. In some cases it appears to have healed the union in others only prolonged the eventual rejection process.

In developing a study plan, a strategy was taken to keep attempted mitigation to a minimum. This meant not irrigating treated grafts nor applying an insecticide to protect against bark beetle. The incidental loss of grafted materials to date seems to be from Ips rather than Dendroctonus. The 77 grafts were broken into 3 groups. The first would be scored in the spring. The second would be scored in the fall after soil moisture levels had been restored. The third group would be left as control to monitor the progression of grafts through eventual mortality.

On May 2nd, a chainsaw with 18" bar and 11 mm chain was used to cut furrows about 2 inches apart on ramets within the first group. Scoring was done only on the portion of the graft which showed signs of rejection. On May 11th treated grafts were reviewed and 19 of 28 had been attacked by Turpentine beetles (D. valens). Some heavy pitch production was already evident on most of the attacks. On July 3rd new growth was evaluated and an assessment of valens attack made. Attack was in some cases independent of any measure of tree vigor and stage of graft rejection. Some grafts with healthy foliage and only slight signs of rejection were attacked. Others with poor foliage, growth and overtopped rootstock were untouched. Of the 19 attacked 10 appeared to be completely pitched out. New growth was subjectively scored as normal on 17 of 28. However, many of the remainder had not produced normal growth the year previous to treatment. Two grafts had died but may have died anyway. Healing was visible on most treated grafts with the sealing off of exposed sapwood by new tissue. There were no more significant changes in the condition of treated grafts through January of 1991.

The second group has not been treated. Total rainfall to January 15th was about 30% of normal at the Nursery. Supplemental irrigation to perform the treatment was not performed. Treatment of the second group will take place this spring. Monitoring for effectiveness will continue.

References

Copes, D. L. 1980. Anatomical Symptoms of Graft Incompatibility in Pinus monticola and P. ponderosa. Sivae Genetica 29:77-82.

Copes, D. L. 1989. Bark Scoring Problem Grafts in Five Douglas-fir Seed Orchards: A Case History. Res. Note PNW-487. Portland OR: USDA, Forest Service PNW Station. 12p.

BADGER HILL
Calendar Year 1991 Planned Accomplishments

White fir

Land cleared of incompatible Douglas-fir grafts will be prepared for the first clones from white fir Breeding Zone 3. These are scheduled for planting in the spring of 1992. A new 20,000 gallon water tank will provide much needed capacity. However, another drought year will increase dependance on water hauling. The few remaining clones from BZ 1 and 2 will be planted this spring.

A survey of existing white fir graft form is being performed before pruning. Individual ramets and even clonal rows vary from desireable vertical to continued plagiotrophism (or growth parallel to the ground). With help from the Chico Tree Improvement Center various strategies will be developed to bring our problem grafts to a vertical growth form.

Douglas-fir

Cold damage experienced in December is thought to be minor. The need for replacements will, hopefully, be low. Collections from more than fifty new clones, primarily from private industry selections, have been requested. Establishment will take place this spring. Finally, 30 more selections will be made within seed zone 523 for eventual establishment at both Badgerhill and Foresthill.

Sugar Pine

Cone, conelet and pollen surveys will be made again. The second group of candidates for bark scoring will be treated. Surviving grafts from both the CDF nursery in Davis and CTIC will be established this spring. Untested sugar pine clones producing pollen will be crossed with non-MGR trees to determine their MGR status. Open pollination of non-resistant clones with resistant pollen will continue for another year. This approach promises to increase the supply of MGR seed from the Badger Hill orchard for commercial outplanting.

A multi-year study plan will be begun with Dr. Pat Shea of PSW. It will investigate the importance of various seed and cone insects during the reproduction cycle in sugar pine at Badger Hill.

APPENDIX I

SEVEN YEAR GROWTH DATA FOR
SUGAR PINE BZ-3
SET 1 ORDERED BY
FAMILY AVERAGE

February 5, 1991

FAMILY	SZ	EL	1)	SL 61	MV 62	CG 63	FH 64	FAM AVG
			2)	52	40	26	42	
7446	525	44		194	153	150	256	188
7392	524	40		169	143	130	249	173
7402	524	43		184	147	132	229	173
7071	523	53		199	150	119	219	172
7010	524	47		180	148	124	228	170
7016	524	47		180	148	125	228	170
7324	525	38		171	140	141	225	169
7278	524	46		189	142	115	224	168
7011	524	47		176	145	114	230	166
7351	525	48		172	153	125	215	166
7232	524	47		188	135	119	220	166
7431	525	52		173	137	115	229	164
7480	525	41		155	137	126	237	164
7469	525	52		179	141	117	220	164
7464	525	56		173	133	113	237	164
7441	525	48		184	127	125	217	163
7305	525	45		168	133	122	216	160
7365	523	36		157	150	114	217	160
7444	525	51		171	134	117	219	160
7326	525	53		172	129	122	217	160
7252	523	53		158	132	111	235	159
7396	524	40		174	128	123	211	159
7448	525	54		166	137	107	221	158
7018	524	47		159	131	127	211	157
7481	525	44		171	131	121	203	157
7385	524	54		166	133	109	221	157
7023	524	47		163	134	107	220	156
7268	524	46		171	133	102	219	156
7098	523	53		169	141	114	200	156
7312	523	40		162	128	103	222	154
7445	525	49		151	130	128	206	154
7363	523	39		152	130	120	214	154
7471	525	55		149	132	119	211	153
7483	525	48		164	124	106	215	152
7320	525	46		162	129	113	196	150
7463	525	60		167	123	106	203	150
7298	524	46		153	129	106	209	149
7399	524	52		166	127	108	195	149
7267	524	46		166	120	107	198	148
7389	524	54		147	127	102	206	146
6751	522	50		165	117	100	198	145
7255	523	53		136	123	94	208	140
7397	524	37		145	117	92	196	138
6754	524	50		142	118	97	178	134
Plantation average				167	134	116	217	158

44 records selected.
1) Plantation number 2) Plantation elevation in 100's

TEN YEAR HEIGHT GROWTH DATA FOR
BREEDING ZONE TWO SET 4
ORDERED BY
FAMILY AVERAGE

FAMILY	BZ	SZ	NF	RD	EL	SUB	SL 06 52	IN 07 51	MV 08 40	CH 09 26	FH 10 42	FAM AVG
03130	2	524	11	54	30	2L	329	387	412	420	546	419
03148	2	523	11	56	37	2M	337	414	368	409	528	411
03134	2	523	11	52	46	2H	336	384	388	394	541	409
03510	2	524	11	54	33	2L	319	389	394	410	526	408
03259	2	525	11	53	32	2L	284	382	380	424	529	400
03275	2	523	11	52	37	2M	342	398	377	373	507	399
03517	2	524	11	54	28	2L	287	382	374	417	528	398
03052	2	524	11	54	30	2L	284	365	366	424	542	396
03129	2	523	11	52	35	2L	348	378	389	361	506	396
03016	2	525	17	54	41	2M	288	368	378	414	513	392
03514	2	524	11	54	25	2L	294	392	366	391	519	392
03518	2	524	11	54	25	2L	289	372	355	405	535	391
03217	2	525	17	53	40	2M	285	376	368	385	521	387
03011	2	524	11	54	40	2M	296	367	346	397	516	384
03038	2	524	11	54	35	2L	297	373	369	384	493	383
03236	2	525	17	54	53	2H	285	372	373	385	500	383
03254	2	525	17	54	49	2H	317	387	338	360	508	382
03468	2	525	17	54	50	2H	299	378	364	345	497	377
03086	2	524	11	54	36	2M	275	360	344	389	501	374
03280	2	523	11	52	37	2M	340	373	339	330	477	372
03377	2	523	11	56	40	2M	323	374	343	365	454	372
03028	2	525	17	53	35	2L	279	342	342	376	518	371
03132	2	523	11	56	44	2M	312	367	352	348	464	369
03235	2	525	17	54	48	2H	278	349	344	377	483	366
03473	2	525	17	55	46	2H	288	348	371	338	473	364
03222	2	525	17	55	46	2H	262	360	340	368	483	363
03269	2	523	11	56	41	2M	280	363	352	354	468	363
03020	2	525	17	55	42	2M	271	345	353	350	491	362
03128	2	524	11	54	35	2L	265	349	336	385	476	362
03287	2	523	11	51	52	2H	310	354	348	319	473	361
03288	2	523	11	51	49	2H	306	360	329	325	478	360
03074	2	525	17	54	42	2M	264	334	330	372	490	358
03281	2	523	11	52	49	2H	307	352	336	322	471	358
03292	2	523	11	51	45	2M	326	358	328	310	457	356
03283	2	523	11	52	41	2M	289	354	313	312	483	350
03381	2	524	11	54	51	2H	303	352	337	306	452	350
03139	2	525	11	53	49	2H	306	357	321	317	442	349
03290	2	523	11	52	45	2H	267	358	329	321	472	349
03294	2	523	11	51	49	2H	277	349	317	294	475	342
03301	2	523	11	56	37	2M	286	343	309	310	453	340
04216	2	524	6	51	54	2H	304	339	328	289	432	338
04223	2	523	6	51	55	2H	286	340	317	300	420	333
03233	2	525	17	54	55	2H	293	329	311	281	430	329
							298	364	351	359	490	373

43 records selected.

SEVEN YEAR GROWTH DATA FOR
BREEDING ZONE TWO
SET 6 ORDERED BY
FAMILY AVERAGE

FAMILY	BZ	SZ	NF	RD	EL	SUB	SL 06 52	IN 07 51	MV 08 40	CH 09 26	FH 10 42	FAM AVG
3513	2	524	11	54	27	2L	256	229	239	291	350	273
3296	2	523	11	56	43	2M	274	235	242	254	332	267
4209	2	524	6	51	38	2M	258	225	236	241	348	262
3158	2	524	11	54	35	2L	250	215	221	278	340	261
3267	2	523	11	56	37	2M	253	231	232	246	338	260
3016	2	525	17	54	41	2M	258	226	231	254	327	259
3264	2	524	11	54	40	2M	269	226	228	238	328	258
3092	2	524	11	54	38	2M	252	225	222	247	337	257
3015	2	525	17	54	42	2M	244	215	246	250	326	256
3508	2	524	11	54	28	2L	250	218	231	257	314	254
3519	2	524	11	54	62	2L	255	218	218	242	336	254
3214	2	523	11	56	44	2M	261	214	215	240	337	253
3131	2	523	11	56	42	2M	261	231	217	230	315	251
3137	2	523	11	56	43	2M	263	223	226	228	310	250
3127	2	523	11	52	35	2L	250	212	236	232	315	249
3025	2	525	17	55	36	2M	247	208	214	254	319	248
3265	2	523	11	56	28	2L	258	217	229	242	294	248
3100	2	524	11	54	36	2M	236	214	217	237	331	247
3271	2	523	11	52	36	2M	249	221	224	218	317	246
3291	2	523	11	56	43	2M	264	213	201	210	342	246
3078	2	524	11	54	32	2L	243	198	217	242	325	245
3273	2	523	11	52	36	2M	256	215	213	232	307	245
3153	2	524	11	54	31	2L	243	203	217	245	310	244
3266	2	524	11	54	44	2M	244	225	219	221	311	244
3216	2	525	17	53	45	2M	247	212	209	232	307	241
3143	2	523	11	56	40	2M	246	208	206	234	300	239
3155	2	523	11	56	44	2M	250	204	229	200	314	239
3070	2	524	11	54	36	2M	245	208	196	227	312	238
4205	2	523	6	51	48	2H	255	233	208	196	296	238
3286	2	523	11	52	45	2M	252	212	217	211	291	237
4221	2	523	6	51	51	2H	253	233	207	193	300	237
3376	2	523	11	52	40	2M	239	208	221	210	298	235
4207	2	523	6	51	44	2M	243	217	210	201	300	234
3021	2	525	17	55	47	2H	228	209	206	225	296	233
3152	2	524	11	54	31	2L	231	197	210	222	307	233
4224	2	523	6	51	49	2H	248	213	216	192	293	232
4230	2	524	6	51	41	2H	240	205	190	208	304	229
4204	2	522	6	51	47		238	215	198	185	297	227
3524	2	524	11	54	52	2H	247	205	199	202	277	226
4227	2	523	6	51	47	2H	243	212	204	184	285	226
4225	2	523	6	51	47	2H	233	209	187	185	281	219
3233	2	525	17	54	55	2H	233	200	197	186	271	217
4226	2	523	6	51	46	2H	229	196	185	191	274	215
4203	2	522	6	51	47	2H	225	201	186	165	250	205
4228	2	524	6	51	51	2H	211	205	184	171	252	205
							247	215	215	223	309	242

45 records selected.

SEVEN YEAR GROWTH DATA FOR
BREEDING ZONE TWO
SET 5 ORDERED BY
FAMILY AVERAGE

JAN 11 1991

FAMILY	BZ	SZ	NF	RD	EL	SUB	SL 06 52	IN 07 51	MV 08 40	CH 09 26	FH 10 42	FAM AVG
3268	2	523	11	56	36	2M	276	252	210	275	247	252
3151	2	524	11	54	30	2L	283	228	200	281	264	251
3426	2	523	11	52	38	2M	270	238	217	270	261	251
3126	2	524	11	54	38	2M	255	227	207	286	265	248
3019	2	525	17	55	42	2M	272	232	208	270	238	244
3092	2	524	11	54	38	2M	261	233	215	255	239	241
3511	2	524	11	54	33	2L	262	223	207	263	235	238
3211	2	525	17	53	40	2M	245	237	215	250	239	237
3114	2	524	11	54	48	2H	256	233	190	243	249	234
3297	2	523	11	56	42	2M	261	229	199	236	240	233
3146	2	525	11	53	37	2M	248	224	200	243	245	232
3257	2	525	17	54	39	2M	242	216	202	263	237	232
3272	2	523	11	52	36	2M	261	234	204	223	240	232
3154	2	524	11	54	30	2L	255	218	190	253	241	231
3057	2	524	11	54	35	2L	265	223	200	244	220	230
3270	2	523	11	52	36	2M	243	226	192	251	240	230
3251	2	525	17	55	53	2H	254	222	197	239	236	230
3332	2	525	11	53	43	2M	253	222	188	236	239	228
3135	2	523	11	56	48	2H	251	213	195	248	224	226
3302	2	523	11	56	41	2M	255	210	195	230	241	226
3144	2	524	11	54	38	2M	253	211	188	239	239	226
3153	2	524	11	54	31	2L	259	209	189	224	232	223
3166	2	523	11	56	40	2M	240	229	185	230	232	223
3266	2	524	11	54	44	2M	257	218	194	223	223	223
4217	2	524	6	51	40	2M	246	214	200	229	220	222
3149	2	523	11	56	37	2M	239	214	194	224	233	221
3015	2	525	17	54	42	2M	248	201	193	230	229	220
3027	2	525	17	55	42	2M	247	209	191	221	221	218
3056	2	524	11	54	39	2M	251	213	182	222	206	215
4219	2	524	6	51	37	2M	237	206	178	227	227	215
3145	2	525	11	53	40	2M	236	211	182	226	220	215
3519	2	524	11	54	62	2L	238	208	171	215	242	215
3155	2	523	11	56	44	2M	232	205	188	207	224	211
3375	2	523	11	52	46	2H	246	212	189	208	202	211
3147	2	523	11	56	43	2M	239	203	175	218	217	210
4211	2	524	6	51	48	2H	234	201	183	205	223	209
3127	2	523	11	52	35	2L	236	209	187	200	208	208
3299	2	523	11	56	34	2L	220	201	174	201	223	204
4222	2	523	6	51	48	2H	232	204	172	184	217	202
4220	2	523	6	51	45	2M	237	213	169	183	203	201
3382	2	525	17	55	53	2H	218	198	164	194	209	197
4235	2	524	6	51	52	2H	225	202	168	191	182	194
							249	217	192	232	230	224

42 records selected.

TEN YEAR HEIGHT GROWTH DATA FOR
BREEDING ZONE TWO SET 4
ORDERED BY
SUBUNIT AND FAMILY AVERAGE

Jan 10 1991

SET A	SET B	SET C	SET AT	FAMILY	SZ	EL	SUB	SL 06 52'	IN 07 51'	MV 08 40'	CH 09 26'	FH 10 42'	FAM AVG	SPGR
4				03134	523	46	2H	336	384	388	394	541	409	.404
				03236	525	53	2H	285	372	373	385	500	383	.###
				03254	525	49	2H	317	387	338	360	508	382	.431
				03468	525	50	2H	299	378	364	345	497	377	.402
	1			03235	525	48	2H	278	349	344	377	483	366	.464
				03473	525	46	2H	288	348	371	338	473	364	.429
				03222	525	46	2H	262	360	340	368	483	363	.425
				03287	523	52	2H	310	354	348	319	473	361	.415
				03288	523	49	2H	306	360	329	325	478	360	.465
				03281	523	49	2H	307	352	336	322	471	358	.455
				03381	524	51	2H	303	352	337	306	452	350	.380
	30			03139	525	49	2H	306	357	321	317	442	349	.412
				03290	523	45	2H	267	358	329	321	472	349	.391
				03294	523	49	2H	277	349	317	294	475	342	.404
				04216	524	54	2H	304	339	328	289	432	338	.374
				04223	523	55	2H	286	340	317	300	420	333	.386
	1			03233	525	55	2H	293	329	311	281	430	329	.384
	30			03130	524	30	2L	329	387	412	420	546	419	.419
				03510	524	33	2L	319	389	394	410	526	408	.432
	30			03259	525	32	2L	284	382	380	424	529	400	.441
				03517	524	28	2L	287	382	374	417	528	398	.457
	20			03052	524	30	2L	284	365	366	424	542	396	.426
				03129	523	35	2L	348	378	389	361	506	396	.442
	40			03514	524	25	2L	294	392	366	391	519	392	.491
	40			03518	524	25	2L	289	372	355	405	535	391	.471
	40			03038	524	35	2L	297	373	369	384	493	383	.468
				03028	525	35	2L	279	342	342	376	518	371	.365
				03128	524	35	2L	265	349	336	385	476	362	.412
				03148	523	37	2M	337	414	368	409	528	411	.382
				03275	523	37	2M	342	398	377	373	507	399	.447
	2			03016	525	41	2M	288	368	378	414	513	392	.431
				03217	525	40	2M	285	376	368	385	521	387	.361
	40			03011	524	40	2M	296	367	346	397	516	384	.457
				03086	524	36	2M	275	360	344	389	501	374	.464
				03280	523	37	2M	340	373	339	330	477	372	.427
				03377	523	40	2M	323	374	343	365	454	372	.356
				03132	523	44	2M	312	367	352	348	464	369	.452
				03269	523	41	2M	280	363	352	354	468	363	.394
	30			03020	525	42	2M	271	345	353	350	491	362	.516
				03074	525	42	2M	264	334	330	372	490	358	.415
				03292	523	45	2M	326	358	328	310	457	356	.452
				03283	523	41	2M	289	354	313	312	483	350	.397
				03301	523	37	2M	286	343	309	310	453	340	.483
								298	364	351	359	490	373	

average

two digit set # are NSCTI sets

43 records selected.

APPENDIX II

APPENDIX II

Ponderosa Pine BZ-2

	PLA AVG (cm)	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 1							
year 3							
MV		Block Summary Reports					
CH		Block Summary Reports					
FH		Block Summary Reports					
across							
year 5							
MV	124	0.139	0.448	28	26	743	
CH	142	0.268	0.622	61	20	827	
FH	158	0.788	0.855	146	0	595	
across	141	0.367	0.854	74	16	713	6
year 7							
MV	203	0.151	0.485	65	0	1653	
CH	248	0.414	0.735	256	0	2220	
FH	286	0.867	0.858	410	74	1409	
across	246	0.433	0.858	214	0	34	1729
year 10							
MV	365	0.245	0.481	210	410	2812	
CH	446	1.01	0.83	1307	387	3506	
FH	521	1.16	0.846	1152	520	2313	
across	446	0.674	0.833	706	453	2840	189
year 12							
MV	452	Block Summary Reports					
CH	562	Block Summary Reports					
FH	678	Block Summary Reports					
across	564						

Ponderosa Pine BZ-2

	PLA AVG (cm)	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 2							
year 3							
MV		Block Summary Reports					
CH		Block Summary Reports					
FH		Block Summary Reports					
across							
year 5							
MV	128	0.549	0.79	134	0	844	
CH	150	0.749	0.8	250	132	954	
FH	158	1.04	0.893	245	0	697	
across	145	0.733	0.929	203	25	875	5
year 7							
MV	216	0.513	0.776	273	0	1855	
CH	261	0.936	0.844	762	285	2209	
FH	283	1.09	0.899	662	0	1763	
across	253	0.797	0.916	512	86	1926	46
year 10							
MV	385	0.756	0.783	878	122	3647	
CH	451	1.34	0.871	2595	1010	4115	
FH	507	1.31	0.877	1420	256	2667	
across	448	1.09	0.922	1503	465	3446	109
year 12							
MV	476	Block Summary Reports					
CH	567	Block Summary Reports					
FH	654	Block Summary Reports					
across	566						
SET 3							
year 3							
MV		Block Summary Reports					
CH		Block Summary Reports					
FH		Block Summary Reports					
across							
year 5							
MV	143	0.008	0.034	2	144	703	
FH	159	1.16	0.898	275	33	645	
year 7							
CH	251	0.152	0.428	89	267	1982	
FH	286	1.11	0.899	643	17	1666	
year 10							
CH	449	0.207	0.437	291	680	4646	
FH	522	1.3	0.88	1477	150	2922	

Ponderosa Pine BZ-2

	PLA AVG (cm)	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 4							
year 3							
SL		Block Summary Reports					
IN		Block Summary Reports					
MV		Block Summary Reports					
CH		Block Summary Reports					
FH		Block Summary Reports					
across							
year 5							
SL	100	0.237	0.693	30	12	462	
IN	136	0.412	0.843	46	0	403	
MV	133	0.273	0.772	43	0.12	589	
CH	136	0.201	0.646	58	66	1037	
FH	143	0.36	0.803	69	13	680	
across	130	0.225	0.881	39	16	634	10
year 7							
SL	248	0.182	0.505	44	39	888	
IN	218	0.419	0.849	110	0	944	
MV	192	0.378	0.833	158	0	1513	
CH	235	0.256	0.728	185	123	2587	
FH	234	0.518	0.864	271	45	1777	
across	225	0.261	0.88	115	40	1576	34
year 10							
SL	298	Meanranks					
IN	364	Meanranks					
MV	351	Meanranks					
CH	359	Meanranks					
FH	490	Meanranks					
across	373						
SET 5							
year 3							
SL		Block Summary Reports					
IN		Block Summary Reports					
MV		Block Summary Reports					
CH		Block Summary Reports					
FH		Block Summary Reports					
across							

Ponderosa Pine BZ-2

	PLA AVG (cm)	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
year 5							
SL		Block Summary Reports					
IN		Block Summary Reports					
MV		Block Summary Reports					
CH		Block Summary Reports					
FH		Block Summary Reports					
across							
year 7							
SL	249	0.441	0.811	154	40	1202	
IN	217	0.466	0.835	127	0	963	
MV	192	0.248	0.722	127	13	1907	
CH	232	0.77	0.882	566	41	2338	
FH	230	0.365	0.75	213	91	2043	
across	224	0.389	0.913	188	43	1668	39
SET 6							
year 3							
SL		Block Summary Reports					
IN		Block Summary Reports					
MV		Block Summary Reports					
CH		Block Summary Reports					
FH		Block Summary Reports					
across							
year 5							
SL	149	Block Summary Reports					
IN	127	Block Summary Reports					
MV	133	Block Summary Reports					
CH	124	Block Summary Reports					
FH	171	Block Summary Reports					
across	141						
year 7							
SL	247	Meanranks					
IN	215	Meanranks					
MV	215	Meanranks					
CH	223	Meanranks					
FH	309	Meanranks					
across	242						

PONDEROSA PINE BZ-3

	PLA AVG (cm)	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 1							
year 3							
BH		Block Summary Reports					
AS		Block Summary Reports					
HS		Block Summary Reports					
CR	58	Block Summary Reports					
BR		Block Summary Reports					
across							
year 5							
BH	137	0.329	0.648	78	45	823	
AS	128	0.416	0.715	104	0	897	
HS	136	0.235	0.545	58	0	925	
CR	143	0.287	0.616	117	0	1515	
BR	88	0.462	0.169	33	33	709	
across	126	0.254	0.856	66	0	964	11
year 7							
BH	224	0.37	0.68	207	99	1933	
AS	209	0.315	0.649	193	0	2256	
HS	248	0.209	0.51	103	0	1873	
CR	262	0.362	0.675	321	0	3223	
BR	156	0.16	0.445	84	105	1916	
across	220	0.264	0.853	161	29	2228	21
year 10							
BH	395	0.577	0.678	725	1205	3100	
AS	350	0.74	0.778	999	148	4254	
HS	447	0.615	0.431	455	801	2967	
CR	476	0.395	0.615	716	624	5918	
BR	302	0.112	0.284	143	810	4141	
across	394	0.33	0.838	439	732	4070	77
year 12							
BH		Block Summary Reports					
AS		Block Summary Reports					
HS		Block Summary Reports					
CR	598	Block Summary Reports					
BR		Block Summary Reports					
across							

PONDEROSA PINE BZ-3

	PLA AVG (cm)	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 2							
year 3							
BH		Block Summary Reports					
AS		Block Summary Reports					
HS		Block Summary Reports					
CR	64	Block Summary Reports					
BR		Block Summary Reports					
across							
year 5							
BH	164	0.701	0.831	211	12	981	
AS	135	0.293	0.651	91	0	1152	
HS	140	0.225	0.499	45	73	674	
CR	159	0.232	0.555	73	46	1141	
BR	87	0.332	0.653	52	20	557	
across	137	0.278	0.85	75	19	968	21
year 7							
BH	280	0.858	0.859	652	30	2355	
AS	221	0.326	0.661	237	0	2671	
HS	258	0.156	0.415	79	82	1853	
CR	292	0.21	0.535	206	0	3711	
BR	151	0.28	0.601	132	116	1641	
across	240	0.271	0.824	183	0	2439	84
year 10							
BH	485	1.054	0.842	1852	399	4782	
AS	364	0.5	0.673	778	599	4851	
HS	474	0.246	0.454	276	427	3792	
CR	519	0.068	0.207	124	482	6651	
BR	302	0.228	0.442	226	818	2920	
across	429	0.352	0.837	512	556	4604	142
year 12							
BH		Block Summary Reports					
AS		Block Summary Reports					
HS		Block Summary Reports					
CR	633	Block Summary Reports					
BR		Block Summary Reports					
across							

PONDEROSA PINE BZ-3

	PLA AVG (cm)	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 4							
year 3							
BH		Block Summary Reports					
AS		Block Summary Reports					
CR	82	Block Summary Reports					
BR		Block Summary Reports					
across							
year 5							
BH	148	0.762	0.919	168	0	714	
AS	76	0.041	0.273	6	15	591	!5 blks
CR	184	0.092	0.526	28	37	1129	
BR	85	0.331	0.717	63	0	693	!7 blks
across	123						rerun
year 7							
BH	239	0.742	0.916	441	0	1935	
AS	118	0.095	0.352	37	44	1461	!5 blks
CR	286	0.092	0.47	68	157	2743	
BR	162	0.281	0.547	163	0	2161	!4 blks
across	201						rerun
year 10							
BH	388	Meanranks					
AS	255	Meanranks					
CR	442	Meanranks					
BR	319	Meanranks					
across	351						

PONDEROSA PINE BZ-3

	PLA AVG	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 5							
year 3							
BH		Block Summary Reports					
AS		Block Summary Reports					
CR	67	Block Summary Reports					
BR		Block Summary Reports					
across							
year 5							
BH		Block Summary Reports					
AS		Block Summary Reports					
CR	158	Block Summary Reports					
BR		Block Summary Reports					
across							
year 7							
BH	197	0.465	0.799	174	58	1261	
AS	212	0.439	0.812	181	0	1467	
CR	271	0.336	0.783	197	14	2135	
BR	217	0.25	0.7	175	35	2587	
across	224	0.331	0.912	174	19	1891	12

PONDEROSA PINE BZ-3

	PLA AVG	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 6							
year 3							
BH		Block Summary Reports					
AS		Block Summary Reports					
CR		Block Summary Reports					
BR		Block Summary Reports					
across							
year 5							
BH	139	Block Summary Reports					
AS	158	Block Summary Reports					
CR	192	Block Summary Reports					
BR	130	Block Summary Reports					
MV	152	Two Blocks					
across							
year 7							
BH	228	0.339	0.765	167	0	1802	
AS	280	0.495	0.866	287	2	2036	
CR	297	0.492	0.863	268	13	1897	
BR	236	0.286	0.732	186	112	2300	
across	260	0.32	0.93	76	7	851	17

PONDEROSA PINE BZ-21

	PLA AVG (cm)	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 1							
year 7							
BU	220	0.341	0.812	155	0	1666	
WI	181	0.61	0.9	199	0	1101	
DI	223	0.218	0.714	136	0	2353	
FT	203	0.372	0.798	219	0	2133	
across	207	0.297	0.892	367	0	1789	30
SET 2							
year 7							
BU	214	0.44	0.82	219	0	1762	
WI	181	0.71	0.89	258	0	1196	
DI	222	0.39	0.74	208	151	1771	
AL	254	0.89	0.91	748	0	2616	
across	218	0.5	0.89	275	3	1845	86
SET 3							
year 7							
BU	225	0.45	0.79	196	8	1532	
FF	331	0.8	0.87	675	47	2657	
FT	221	0.14	0.51	98	0	2801	
AL	272	0.68	0.86	505	9	2472	
across	262	0.47	0.9	322	14	2345	56
SET 4							
year 7							
WI	195	0.45	0.86	176	0	1383	
FF	327	0.43	0.85	460	0	3778	
FT	230	0.2	0.72	144	0	2686	
AL	258	0.32	0.8	266	0	3109	
across	253	0.33	0.95	246	0	2742	19

PONDEROSA PINE BZ-30

	PLA AVG	H^2 I	H^2 F	v(f)	v(fb)	v(e)	v(fp)
SET 1							
year 7 LM		0.384	0.779	236	7	2216	
SET 2							
year 7 LM		0.494	0.826	0.306	0	2169	
SET 3							
year 7 LM		0.539	0.827	301	38	1895	

APPENDIX III

NURSERY MEASUREMENTS SUMMARY REPORT
PP BZ4 SET3 BLKS 1A,1B,2A
SITES BM, MK, NY, PE

FAMILY	MEAN HT(mm)	% CV	MEAN DIA(mm)	% CV	HT * (DIA)^2	RANK
5X7	243	10	3.9	13	3696	2
9X8	215	8	3.6	9	2786	21
GEN	201	9	3.5	12	2462	36
LOC	221	14	3.5	16	2707	25
3106	205	7	3.7	10	2806	20
3107	228	6	3.6	9	2955	14
3113	236	12	3.5	13	2891	17
3180	198	12	3.4	11	2289	42
3182	229	11	3.7	12	3135	8
3189	241	9	3.8	11	3480	4
3194	194	13	3.5	10	2377	39
3199	192	13	3.3	11	2091	46
3206	205	9	3.6	8	2657	28
3224	204	9	3.3	14	2222	44
3319	266	10	3.7	10	3642	3
3335	235	9	3.6	13	3046	11
3363	221	12	3.6	13	2864	18
3421	184	13	3.3	15	2004	47
3433	197	11	3.5	13	2413	38
3436	212	15	3.6	9	2748	22
3444	244	12	3.5	14	2989	12
3456	230	9	3.6	10	2981	13
3458	249	9	3.9	8	3787	1
3483	214	12	3.4	13	2474	35
3493	209	9	3.6	12	2709	24
3494	209	8	3.5	10	2560	30
3503	272	8	3.5	12	3332	5
3529	225	10	3.6	9	2916	16
3530	222	11	3.4	14	2566	29
3531	220	10	3.4	13	2543	32
3535	209	12	3.4	13	2416	37
3542	206	13	3.1	15	1980	48
3554	203	8	3.4	14	2347	41
3557	250	7	3.5	13	3063	10
3558	246	6	3.1	12	2364	40
3559	207	11	3.7	13	2834	19
3572	231	6	3.4	14	2670	26
3582	215	8	3.8	12	3105	9
3585	234	6	3.3	13	2548	31
3600	239	8	3.7	14	3272	6
3603	205	10	3.3	13	2232	43
3604	205	10	3.2	11	2099	45
3607	190	9	3.1	12	1826	49
3608	217	8	3.4	15	2509	33
3614	230	7	3.3	9	2505	34
3617	210	14	3.6	8	2722	23
3623	228	9	3.6	15	2955	15
3627	230	11	3.4	10	2659	27
3631	238	5	3.7	10	3258	7

NURSERY MEASUREMENTS SUMMARY REPORT
PP BZ4 SET3 BLK 6B.MK

FAMILY	MEAN HT(mm)	% CV	MEAN DIA(mm)	% CV	HT * (DIA)^2	RANK
5X7	225	3	3.4	0	2601	11
9X8	178	18	3.9	2	2707	9
GEN	188	6	3.3	4	2047	27
LOC	210	3	3.4	4	2428	12
3106	180	4	3.1	5	1730	40
3107	208	5	3.8	4	3004	4
3113	210	24	3.6	10	2722	8
3180	200	4	3.0	5	1800	37
3182	218	5	3.9	4	3316	3
3189	205	3	3.8	6	2960	5
3194	148	31	3.0	14	1332	48
3199	210	30	3.1	9	2018	30
3206	193	17	3.4	19	2231	17
3224	170	8	3.2	9	1741	38
3319	213	2	3.1	5	2047	26
3335	180	27	3.4	12	2081	23
3363	225	13	3.6	2	2916	6
3421	188	2	3.2	0	1925	32
3433	160	0	2.8	5	1254	49
3436	190	7	3.4	17	2196	19
3444	193	9	3.1	0	1855	33
3456	210	3	3.3	2	2287	16
3458	210	3	4.0	7	3360	2
3483	160	4	3.2	4	1638	43
3493	190	11	3.3	9	2069	25
3494	180	4	3.1	7	1730	39
3503	230	3	4.1	9	3866	1
3529	175	4	3.4	15	2023	29
3530	190	4	3.3	9	2069	24
3531	203	5	3.0	9	1827	35
3535	158	2	3.4	11	1826	36
3542	190	7	3.2	18	1946	31
3554	185	11	3.0	5	1665	42
3557	208	9	3.6	2	2696	10
3558	195	0	2.8	5	1529	45
3559	180	8	3.4	4	2081	22
3572	205	10	3.2	18	2099	21
3582	175	0	3.7	15	2396	13
3585	190	0	3.0	7	1710	41
3600	178	2	3.6	8	2307	15
3603	223	2	3.6	0	2890	7
3604	183	10	3.4	8	2115	20
3607	180	8	2.9	5	1514	46
3608	145	0	3.1	9	1393	47
3614	203	5	3.0	9	1827	34
3617	178	10	3.0	9	1602	44
3623	215	7	3.2	4	2202	18
3627	198	20	3.2	0	2028	28
3631	200	0	3.4	15	2312	14

NURSERY MEASUREMENTS SUMMARY REPORT
PP BZ4 SET3 BLK 8C.MK

FAMILY	MEAN HT(mm)	% CV	MEAN DIA(mm)	% CV	HT * (DIA)^2	RANK
5X7	180	12	3.5	6	2205	13
9X8	238	19	3.6	2	3084	2
3106	90	71	1.6	5	230	47
3107	163	20	3.0	5	1467	41
3113	195	15	3.9	0	2966	3
3180	160	9	3.3	13	1742	32
3182	203	5	3.4	2	2347	8
3189	198	16	3.4	4	2289	11
3194	143	7	3.4	21	1653	34
3199	168	2	3.0	5	1512	40
3206	193	2	3.3	11	2102	19
3224	148	12	3.3	15	1612	36
3319	218	8	3.4	2	2520	5
3335	178	13	3.4	11	2058	20
3363	198	2	3.7	19	2711	4
3421	210	7	3.1	2	2018	21
3433	180	0	3.6	4	2333	9
3436	198	2	3.1	12	1903	24
3444	218	28	3.3	9	2374	7
3456	203	9	3.3	0	2211	12
3458	190	15	3.5	6	2328	10
3483	173	6	3.3	15	1884	26
3493	168	6	3.3	9	1830	28
3494	158	2	3.1	21	1518	39
3503	238	7	3.6	4	3084	1
3529	189	20	3.4	11	2185	14
3530	173	14	3.4	19	2000	22
3531	205	10	3.5	4	2511	6
3535	165	0	2.9	10	1388	42
3542	150	5	2.9	5	1261	44
3554	163	2	2.9	10	1371	43
3557	200	4	3.0	0	1800	31
3558	190	4	3.2	0	1946	23
3559	168	6	3.3	11	1830	27
3572	168	6	3.2	9	1720	33
3582	163	11	3.4	23	1884	25
3585	188	6	3.1	2	1807	30
3600	183	2	3.4	8	2115	18
3603	165	0	3.1	2	1586	37
3604	153	2	2.8	0	1200	45
3607	178	2	3.2	0	1823	29
3608	183	21	2.9	26	1539	38
3614	180	8	3.0	5	1620	35
3617	140	5	2.9	2	1177	46
3623	173	10	3.5	4	2119	17
3627	173	2	3.5	6	2119	16
3631	188	17	3.4	2	2173	15

NURSERY MEASUREMENTS SUMMARY REPORT
PP BZ4 SET4 BLKS 1A, 1B, 2B
SITES BM, MK, NY, PE

FAMILY	MEAN HT(mm)	% CV	MEAN DIA(mm)	% CV	HT * (DIA)^2	RANK
5X7	218	9	3.7	7	2984	9
9X8	218	7	3.7	10	2984	8
LOC	180	14	3.4	10	2081	37
3059	178	12	3.4	10	2058	40
3068	244	12	3.6	14	3162	5
3115	230	11	3.9	7	3498	1
3184	213	12	3.6	9	2760	13
3186	240	10	3.7	7	3286	2
3192	208	11	3.4	11	2404	25
3196	216	9	3.3	16	2352	29
3197	170	11	3.3	17	1851	48
3198	192	15	3.0	15	1728	49
3203	171	14	3.3	14	1862	47
3209	203	8	3.6	5	2631	17
3228	180	14	3.5	13	2205	33
3320	204	12	3.8	11	2946	11
3357	216	14	3.7	11	2957	10
3432	238	15	3.5	12	2916	12
3448	205	11	3.5	14	2511	23
3449	226	8	3.8	12	3263	3
3451	183	17	3.6	9	2372	27
3453	204	11	3.6	10	2644	16
3462	193	17	3.5	12	2364	28
3477	244	11	3.6	11	3162	6
3485	206	8	3.5	19	2524	22
3497	198	12	3.6	14	2566	18
3499	191	8	3.3	14	2080	38
3504	233	12	3.7	11	3190	4
3533	209	10	3.8	12	3018	7
3534	219	8	3.5	9	2683	14
3537	214	10	3.4	13	2474	24
3538	190	7	3.4	13	2196	34
3552	196	12	3.6	14	2540	21
3553	200	14	3.4	15	2312	31
3560	185	12	3.6	15	2398	26
3561	185	9	3.2	15	1894	45
3562	175	18	3.4	16	2023	42
3575	190	9	3.3	9	2069	39
3583	191	12	3.5	13	2340	30
3597	205	10	3.3	16	2232	32
3602	187	9	3.3	10	2036	41
3606	171	18	3.5	10	2095	36
3610	205	12	3.6	9	2657	15
3611	180	17	3.3	13	1960	44
3615	198	13	3.6	15	2566	19
3619	162	13	3.4	13	1873	46
3626	195	10	3.3	11	2124	35
3628	221	9	3.4	11	2555	20
G534	197	13	3.2	14	2017	43

NURSERY MEASUREMENTS SUMMARY REPORT
PP BZ4 SET4 BLK 6B.MK

FAMILY	MEAN HT(mm)	% CV	MEAN DIA(mm)	% CV	HT * (DIA)^2	RANK
5X7	245	0	4.3	7	4530	1
9X8	183	17	3.6	4	2372	22
LOC	190	0	3.6	2	2462	18
3059	133	29	3.4	2	1537	45
3068	208	5	3.6	2	2696	14
3115	210	0	4.0	18	3360	2
3184	230	0	3.7	0	3149	6
3186	208	15	3.3	9	2265	26
3192	240	21	3.6	2	3110	7
3196	188	13	3.8	7	2715	13
3197	145	10	3.4	8	1676	40
3198	168	15	3.1	14	1614	42
3203	165	0	3.8	4	2383	20
3209	190	4	3.6	4	2462	19
3228	158	2	3.4	12	1826	39
3320	195	4	3.1	0	1874	38
3357	208	5	3.9	7	3164	5
3432	140	15	4.3	3	2589	17
3448	175	4	3.3	9	1906	37
3449	198	9	4.0	11	3168	4
3451	170	0	3.5	6	2083	31
3453	188	17	3.9	2	2859	11
3462	190	11	3.5	4	2328	24
3477	213	2	3.7	8	2916	10
3485	230	3	3.8	13	3321	3
3497	178	6	3.5	4	2181	29
3499	180	24	3.6	10	2333	23
3504	210	3	3.6	2	2722	12
3533	193	13	3.9	17	2936	9
3534	190	4	3.3	4	2069	33
3537	183	6	3.6	6	2372	21
3538	170	8	3.7	15	2327	25
3552	165	0	3.4	2	1907	36
3553	160	22	3.5	14	1960	35
3560	193	13	3.4	15	2231	27
3561	138	13	3.4	2	1595	43
3562	153	21	3.3	17	1666	41
3575	140	0	3.0	7	1260	49
3583	200	14	3.6	0	2592	16
3597	173	2	3.5	6	2119	30
3602	150	9	3.2	4	1536	46
3606	135	0	3.4	2	1561	44
3610	185	8	3.8	11	2671	15
3611	170	4	3.0	5	1530	47
3615	200	7	3.9	15	3042	8
3619	110	6	3.5	6	1348	48
3626	175	0	3.4	10	2023	34
3628	203	2	3.2	13	2079	32
G534	193	2	3.4	4	2231	28

NURSERY MEASUREMENTS SUMMARY REPORT
PP BZ4 SET4 BLK 8C.MK

FAMILY	MEAN HT(mm)	% CV	MEAN DIA(mm)	% CV	HT * (DIA)^2	RANK
5X7	165	17	3.4	2	1907	15
9X8	188	21	2.9	12	1581	25
3059	123	14	2.6	8	831	48
3068	175	4	3.5	12	2144	7
3115	185	11	3.8	7	2671	2
3184	185	0	3.3	4	2015	11
3186	165	0	3.4	6	1907	16
3192	175	8	3.0	7	1575	27
3196	195	11	3.3	11	2124	8
3197	128	3	2.9	5	1076	41
3198	155	9	2.5	8	969	45
3203	153	7	2.9	0	1287	36
3209	155	9	3.0	7	1395	32
3228	145	10	3.2	4	1485	30
3320	175	4	3.1	12	1682	23
3357	205	7	3.9	16	3118	1
3432	178	18	3.1	11	1711	21
3448	160	13	3.4	2	1850	18
3449	183	21	3.4	10	2115	9
3451	145	15	3.1	11	1393	34
3453	195	11	3.4	2	2254	4
3462	193	2	3.0	9	1737	19
3477	200	35	3.4	15	2312	3
3485	170	4	3.6	14	2203	6
3497	148	2	3.6	2	1918	14
3499	163	15	3.0	7	1467	31
3504	198	2	3.1	7	1903	17
3533	168	6	3.4	2	1942	13
3534	203	26	3.3	17	2211	5
3537	133	29	3.1	5	1278	37
3538	160	0	3.1	5	1538	28
3552	185	8	3.0	0	1665	24
3553	155	36	3.3	2	1688	22
3560	148	7	3.0	9	1332	35
3561	125	11	2.6	11	845	47
3562	155	6	3.0	3	1395	33
3575	130	16	2.8	5	1019	43
3583	143	7	2.6	14	967	46
3597	180	12	3.3	15	1960	12
3602	145	15	2.9	5	1219	39
3603	123	3	3.1	14	1182	40
3610	158	16	3.1	2	1518	29
3611	140	30	3.0	7	1260	38
3615	145	10	3.3	9	1579	26
3619	118	9	2.9	2	992	44
3626	180	4	3.1	2	1730	20
3628	158	16	2.6	8	1068	42
G534	175	0	3.4	4	2023	10

APPENDIX IV

CENTRAL ZONE TREE IMPROVEMENT

COOPERATORS AND DISTRICTS WITHIN BREEDING ZONES

BZ	Cooperators	Districts
PP-2	North Sierra Co-op Pacific Gas & Electric Sierra Pacific Soper-Wheeler Louisiana Pacific Diamond International Fruit Growers Supply	Almanor (Lassen) Greenville, La Porte, Oroville, Quincy (Plumas) Downieville, Foresthill, Nevada City (Tahoe)
PP-3	Central Sierra Co-op Fiberboard Fruit Growers Supply Georgia Pacific Michigan-California Lumber Calif. Dept. of Forestry	Amador, Georgetown, Pacific, Placerville (Eldorado) Calaveras, Groveland, Mi-Wok, Summit (Stanislaus) Mariposa, Minarets (Sierra)
PP-4		Kings River, Pineridge (Sierra) Greenhorn, Hot Springs, Hume Lake, Tule River (Sequoia)
WF-1	North Sierra Co-op Louisiana Pacific Calif. Dept. of Forestry	Almanor (Lassen) Greenville, La Porte, Oroville, Quincy (Plumas) Downieville, Foresthill, Nevada City (Tahoe)
WF-2	Central Sierra Co-op Fiberboard Fruit Growers Supply Michigan-California Lumber Georgia Pacific Calif. Dept. of Forestry	Amador, Georgetown, Pacific, Placerville (Eldorado) Calaveras, Groveland, Mi-Wok, Summit (Stanislaus)
WF-3	Sequoia-Kings Canyon Nat. Park Southern California Edison Mountain Home State Forest	Kings River, Mariposa, Minarets, Pineridge (Sierra) Greenhorn, Hot Springs, Hume Lake, Tule River (Sequoia)
DF-7	North Sierra Co-op Sierra Pacific Soper-Wheeler Louisiana Pacific Fruit Growers Supply Pacific Gas & Electric Roseburg Resource Co. Diamond International	Greenville, La Porte, Oroville, Quincy (Plumas) Downieville, Foresthill, Nevada City (Tahoe) Amador, Georgetown, Pacific, Placerville (Eldorado)

BZ	Cooperators	Districts
SP-3	North Sierra Co-op Diamond International Fruit Growers Supply Louisiana Pacific Pacific Gas & Electric Soper-Wheeler	Almanor (Lassen) Greenville, La Porte, Milford, Oroville, Quincy (Plumas) Downieville, Foresthill, Nevada City (Tahoe)
SP-4	Central Sierra Co-op Pacific Gas & Electric Michigan-California Lumber Fiberboard Georgia Pacific Fruit Growers Supply Bureau of Land Management	Amador, Georgetown, Pacific, Placerville (Eldorado) Calaveras, Groveland, Mi-Wok, Summit (Stanislaus)
SP-5	Sequoia-Kings Canyon Nat. Park Southern California Edison Mountain Home State Forest	Kings River, Mariposa, Minarets, Pineridge (Sierra) Greenhorn, Hot Springs, Hume Lake, Tule River (Sequoia)

APPENDIX V

Distribution of ponderosa pine by elevation unit (100's)

	seed zone	Elevation 25	30	35	40	45	50	55	60	65	70	75	Total
	522						4	1	1				6
BZ	523		1	1	24	23	22	4	1				76
2	524	2	14	15	18	5	4	10		1			69
	525			8	11	23	18	12	1				73
	526		5	11	16	15	22	11					80
BZ	531			3	11	11	22	16	3				90
3	532			2	17	29	13	10					71
	533			3	8	14	19	16	15				75
BZ	534				3	4	5	9	17	18			56
4	540					4	2	12	20	24	4	1	67
	Total	2	20	43	108	128	131	101	58	43	4	1	663