RR-CAL
COOPERATION
State of California
Department of Fish and Game
Project W46R-3

CF&RES
R. Stanley
January 6, 1955

STUDY PLAN

Subject: Species - Seed Germination
Purshia tridentata

1. Introduction:

Laboratory germination tests using thiourea on bitterbrush seeds indicate that thiourea may inhibit or reduce fungal growth during germination. However, no tests have been conducted to determine whether or not there is a fungistatic action.

If thiourea does inhibit fungal growth, it may be detected by one of two methods:

1. Reduce the number of contaminating spores which survive the thiourea treatment and, therefore, fewer contaminants would appear on those seeds treated in a thiourea solution as compared to seeds soaked in water; and

2. Inhibit the growth of contaminants on the seed or in the media around the seed.

2. Purpose: To determine if thiourea has a fungistatic action.

3. Location: Berkeley, Forest Physiology Laboratory

4. Date of Work: January 1955

5. Design:

a. Seed lot: GB-57A

b. Method of selection: Random

c. Seed treatment: Two

1. Thiourea, 3 percent for five minutes

2. Distilled water for five minutes

d. Germination media: in petri dishes on sterile glucose-agar

e. Length of germination:

Minimum - 7 days

Maximum - 21 days

f. Temperature: $72^{\circ} \pm 2^{\circ}$ F (Room temperature)

g. Significance:

1. If thiourea does inhibit fungal growth, it may be detected in one of two methods:

   a. By reducing the number of contaminating spores which survive the thiourea treatment; therefore fewer contaminants would be expected on those seeds treated in a thiourea solution as compared to those soaked in water.

   b. By inhibiting the growth of the contaminants on the seed or in the soil around the seed.

2. Both factors will be check by the following procedure.

5. Method:

a. Prepare 25 petri plates as follows:

1. Add to 2-300 ml. distilled water in 500 ml. erhlenmeyer flasks 2% difco-agar and 4% glucose; stopper flasks and place in autoclave.

2. In addition, autoclave 150 ml. 3% thiourea and a 25 ml. graduate.

3. Under sterile conditions, pour approximately 25 ml. agar soln in each plate.

4. To 4 plates, add 4, 8, and 12 ml. thiourea solution, plates with added thiourea = 12(4x3)

5. Allow the plates to cool and dry overnight.

b. Treat 30 seeds in 3% thiourea 5 minutes and place on plain glucose-agar plates -- 10 seeds to each of 3 plates. Treat 30 seeds in distilled water and place on plates.

c. Record daily the amount of plate or seed covered by fungal growth. After 7 days, number of different types of fungal or bacterial contaminants.

d. After at least 7 days, transfer 1 isolation from each different contaminant to each of 4 plates containing different concentrations of thiourea (0, 4, 8, 12 ml.); replicate the entire series once.

e. Observe relative rates of growth of the inoculum on the plates kept at room temperature. Compare maximum growth attained at different concentrations of thiourea at the end of the experiment (minimum 7 days).

6. Responsibility:

R. Stanley -- design, counting and inoculating, final report preparation.

G. Ingoo -- preparation of plates, daily check of growth and recording of data.

7. Time schedule:

Preparation of study plan:	2 hours
Preparation of petri dishes:	3 hours
Treating and setting out seeds:	1 hour
Isolating and transferring contaminants:	3 hours
Recording and analysing results:	4 hours
Estimated Total	14 hours

8. Material and equipment:

Petri dishes, agar, glucose, binocular microscope, transfer needle. All materials are on hand at the Forest Physiology Laboratory or the California Forest and Range Experiment Station.

Attachment:

cc: RLH
ECW
RS
DOP - RLH (Unit file)
File

RR-CAL
COOPERATION
State of California
Department of Fish and Game
Project W46R-3

CF&RES
E. C. Nord
B. O. Pearson
January 14, 1955

JOB PLAN

Subject: Species - Germination
(Seed packets)

1. Purpose:

To determine effects of season, temperatures, and other site factors on germination of thiourea treated bitterbrush seeds.

2. Location of Work:

(a) Doyle

(b) Flukey Spring

(c) Wells Meadow

3. Design:

(a) Number of treatments: 2

thiourea

untreated

(b) Number of seed packets: 40 20 per treatment

(c) Number of seeds per packet: 20

4. Method of marking:

(a) Thiourea treated: Yellow stakes

At Doyle and Flukey Spring, individual seed packets have an attached metal washer

At Wells Meadow, individual packets in copper mesh screens.

(b) Untreated: white stakes

All areas: Individual packets in zinc mesh screens.

5. Depth of planting:

1 to 1-1/2 inches

6. Inspection of packets:

(a) Start: Receipt of this plan.

(b) Frequency: Weekly - at time other site records taken.

(c) Duration: To May 1 or as otherwise instructed.

7. Procedure:

Bitterbrush seeds mixed with screened soil have been enclosed in screen packets and placed in rows near the weather shelters. The individual packets are fastened to a guide wire which is attached to the white or yellow marking stakes.

Withdraw one seed packet from each row every week. Examine the seeds in each packet and record the number of seeds inspected (should be 20), the number of seeds which have germinated, and average length of roots (nearest 1/8 inch). Record data on weekly germination record sheet and mail with weather charts to Berkeley.

Also, transfer the data to the summary sheets - one for each treatment - and keep at the various experimental areas until completion of the work. Thus, should any records be lost, the information will still be available.

Weekly and summary forms are attached.

Enclosure

cc: A. L. Hormay
E. C. Nord
B. O. Pearson
R. L. Hubbard
J. Blaisdell
E. R. Schneegas
O. C. Nelson
File

RR-CAL
COOPERATION
State of California
Department of Fish and Game
Project W-6R-3

CF&RES
B. O. Pearson
February 21, 1955

STUDY PLAN NO. 9C

Subject: Site Preparation and Maintenance
Chemical (Dalapon)

Introduction:

See Annual Work Plan 1952, General Plan: Site Preparation, January 15, 1953; Line of Work Study Plan: Chemical Control of Plants, November 24, 1952; Study Plans 9 and 9A; Site Preparation and Maintenance, October 24 and November 15, 1953; and Quarterly Progress Report, October 1, 1954.

Preliminary tests with various chemicals made during 1953 and 1954 on browse reseeding sites show that Dalapon is effective in reducing cheatgrass and some annual weeds when sprayed during the early and vigorous growth stage of cheatgrass. Effective control of cheatgrass was obtained with 2 to 6 pounds of Dalapon per acre applied in late March 1954. Specific information, however, is needed to determine the minimum rates of chemical, quantity of solvent and dates of application which will effectively reduce the competing vegetation on the annual types of range in preparation for browse reseeding.

Objectives:

1. Determine the minimum rates of Dalapon to control the annual vegetation types, particularly cheatgrass.

2. Determine the most effective date of application of Dalapon to control cheatgrass.

3. Determine the effect of different solution rates of Dalapon on controlling cheatgrass.

Outline of study:

1. Sites: one	Casuse Mountain
2. Vegetation type: one	Cheatgrass - annual weed
3. Period of study: two years	1955 (application) and 1956
4. Season of application: spring	Determined by vegetative growth
5. Types of spray treatments: two	A. Chemical rates
	B. Solution rates

6.	Series of spray treatments: three	See Methods and Procedures
7.	Types of solution: one	Water
8.	Number of chemicals: one	Dalapon (Sodium salt 85% a,a,-dichloropropionate) active acid 74%
9.	Number of replications: two	Each treatment
10.	Size of sub-plots: 0.1 acre	20 feet x 218 feet
11.	Total number of sub-plots: thirty-eight	Chemical rates: 24 plus 4 checks Solution rates: 8 plus 2 checks
12.	Method of application: one	"Spray Rite" sprayer mounted on farm tractor
13.	Method of sampling: M&S #4	Annual grasses and forbs, supplemented with distribution index count
14.	Time of sampling: early summer	1955 and 1956 as cheatgrass leaf tips start curing on untreated plots
15.	Specific details of application:	See Table 1
16.	Diagram of field layout of plots:	See Table 1

Methods and procedure:

1. Timing of spray application

   a. Chemical rates:

      (1) Make the first application when most of the cheatgrass has germinated and emerged, and plants have from 3 to 4 leaves. Possibly during early March when the average maximum air temperatures for 15 days is about 50° F.

      (2) Make the second application before the seed stalks appear on the cheatgrass and when the mustard seedlings are in the late cotyledonous stage. Possibly during late March or early April when the average maximum air temperatures for 15 days is about 60° F.

      (3) Make the third application when the cheatgrass seed heads are in the mid-boot and the mustard seedlings are in the leaf stage. Possibly during mid-April when the average maximum air temperatures for 15 days is about 70° F.

Table.1-Field Layout and Details of Application

CHEMICAL RATES (Plot ~~5F~~ 6 A)

Replicate	I													II										
Rate (Lbs/Acre)	1			2			-	4			6			-	1			2			-	4			6			-
Application Series	1	2	3	1	2	3	ck.	1	2	3	1	2	3	ck.	1	2	3	1	2	3	ck.	1	2	3	1	2	3	ck.
Sub-plot Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28

SOLUTION RATES (Plot ~~5G~~ 6 B)

Solution Rate (Gallons/Acre)	5					10				
Replicate	I		II			I		II		
Chemical Rate (Lbs/Acre)	2	4	2	4	ck.	2	4	2	4	ck.
Sub-plot Number	1	2	3	4	5	6	7	8	9	10

3 - Study Plan No. 9C by BOP - 2/21/55

b. Solution Rates:

This treatment series will be made at the same time as the second application of chemical rates

2. Equipment operation:

Operate the spray boom 24 inches above the ground for the 10 and 40 gallon applications and at 30 inches for the 5 gallon per acre application. For the solution rates of 40 gallons per acre, use TT 6503 jets; and for solution rates of 5 and 10 gallons per acre, use TT 65067 jets. Plug alternate nozzles for 5 gallon solution per acre. Calibrate actual solution rates prior to operation for a ground speed of approximately 2-1/2 miles per hour. Adjust pressure regulator to give more or less solution as determined by trial runs using water only on areas of equal size to the sub-plots.

3. Formulation procedures:

a. Chemical rates:

The following table shows the quantity of Dalapon (85 percent active ingredient) to add to ~~15~~ 13 gallons of water for each replicate treatment, 2 sub-plots, 0.1 acre each:

Rate per Acre in Pounds	Quantity of Dalapon to add to Solution	
	Grams	Ounces
1	200	7.0
2	400	14.1
4	800	28.2
6	1,200	42.3

This quantity of solution allows for 4 gallons to be applied to 3 each of the 2 test sub-plots, 2 gallons of waste and ~~5 gallons~~ to remain in the sprayer to maintain uniform spray distribution.

Use containers at Dry Lake Guard Station making sure they are clean. Prepare solutions for each series of treatments just prior to application by placing 10 gallons of water in container, mix in the prescribed amount of chemical, and add sufficient water to bring solution to 15 gallons.

b. Solution rates:

(1) Five gallon solution per acre

The following table shows the quantity of Dalapon to be added to the 5 gallon solution rate for each replicate treatment:

Rate per Acre in pounds	Quantity of Dalapon to add to Solution	
	Grams	Ounces
2	~~1,068~~ 1226	37.6
4	~~2,136~~ 2452	75.2

Place 5 gallons of water in the container, mix the prescribed amount of Dalapon and then add sufficient water to bring the total volume of the solution to 10 gallons. Label the containers. Mix thoroughly and apply. Save the remaining unused solution for the 10 gallon solution rate.

(2) Ten gallon solution per acre

To the solution remaining from the respective 5 gallon solution rate per acre, add equal amounts of water, mix thoroughly, and apply.

4. Marking and sampling plots:

Stake quadrats on all check sub-plots and on those sub-plots which show some effects from the treatment. Staking will be done at time of first vegetation inventory. Take records on density, composition, and distribution index of cheatgrass and weeds.

5. Reports

a. Office progress reports:

(1) Completion of spraying: July 1, 1955

(2). Completion of vegetation inventory, September 1, 1955. Compilation, tables, graphs, and analysis of results

b. Publication schedule: To be integrated with study plan.

6. Responsibility: Ben O. Pearson

7. Work Schedule:

	Project Personnel	Labor	Tractor
1955 -			
Layout	8	16	
First application (March)	6	6	6
Second application (April)	15	17	15
Third application (April)	6	6	6
Vegetation sampling (May or June)	64	76	-
Total	79	121	27
1956 -			
Vegetation sampling	44	44	-
Total 1955 and 1956	123	165	27

9. Materials and equipment:

Dalapon:	85 percent, 27 pounds (Furnished by cooperators)	
Pipe cap plugs - 1/4 inch:	10 each	
Steel stakes - 12 inch:	Approximately 600 each)	On hand
Fence posts, steel - 5 foot:	78 each)	

cc: A. L. Hormay
E. C. Nord
B. O. Pearson
R. L. Hubbard
File

RR
COOPERATION
State of California
Department of Fish and Game
Project W46R-3

CF&RES
B. O. Pearson
March 3, 1955

STUDY PROGRESS REPORT

Subject: Species, thiourea treatment of bitterbrush seed

Purpose

To prepare bitterbrush seed for spring planting

Accomplishment

Ninety-seven pounds of clean bitterbrush seed (62 pounds GB 66 and 35 pounds GB 57) and 30 pounds of bitterbrush fruit (GB 66) were treated with thiourea at the Western Utilization Research Branch of the United States Department of Agriculture *, February 28, 1955.

The solution was prepared by mixing 3 pounds of thiourea and 12½ gallons of tap water in a 20 gallon vat (3 percent solution).

The seed was immersed 5 minutes, drained off, and placed on screened bottom drying trays at approximately 1 quart of seed per square foot of tray surface, then placed in the dehydrator oven using only the fanning action for drying the seed. The seed appeared surface dry in 15 minutes and was hard at the end of the drying period (20 hours).

The fruit was immersed for 4 hours in the solution (penetration of solution to seed by visual inspection occurred in 3½ to 4 hours) then placed on drying trays and dried in the dehydrating oven with the seed.

* Use of the facilities at the Western Utilization Research Branch was made available to the project by the Business Manager, Sidney J. Adams, and use of equipment supervised by Ed Breitwieser, Chemical Engineer.

STATE California

PROJECT W46R-3

DATE April 1, 1955

QUARTERLY PROGRESS REPORT

SURVEYS AND INVESTIGATIONS

as required by

FEDERAL AID IN WILDLIFE RESTORATION ACT

1. Title of Project: Game Range Restoration

2. Supervisors: Ben Glading, Chief, and William P. Dasmann, Senior Game Biologist, Game Management Branch, California Department of Fish and Game

3. Leaders: M. W. Talbot and A. L. Hormay

   Assistants: E. C. Nord, R. L. Hubbard, and B. O. Pearson

4. Cooperating Agency: California Forest and Range Experiment Station

5. Summary report of progress during the quarter January 1 to March 31, 1955. This report is not for publication.

Purpose of Project

To develop cultural methods of re-establishing and extending native or introduced browse species suitable for food or cover for big game on deteriorated game ranges in California. The initial work of the project, started in July 1952, was directed to the critical deer winter range problems of the Eastside Region of the State.

These ranges extend about 600 miles southward into the State from the Oregon border. They lie largely in the snow belt. In heavy precipitation years, low growing vegetation on these ranges becomes covered with snow. Under these conditions the deer must depend mainly on shrubs and trees for forage. Unfortunately, desirable forage shrubs and trees have been greatly reduced by such factors as livestock and deer grazing, fire, and tent caterpillar depredation on most of the deer concentration areas. The only hope of getting adequate browse back on to many of these areas in the near future is through artificial reseeding. Special attention is being given to the study of bitterbrush at the outset because it is considered the most important game browse in the Eastside Region.

General Accomplishments During Last Quarter

1. Most of the quarter was spent in working up field data collected last season and preparing work plans for the coming season.

2. Compilation and analysis of data on rodent censuses carried out last fall were completed.

3. Rodent censuses, rodent poisoning, depth-of-planting seedings with bitterbrush and broad-scale drill seeding with bitterbrush on two wild-burn areas were carried out in March.

4. Initial studies on a method of testing the purity and germination percentage of bitterbrush seed and on the effect of various chemicals -- urea, sulfuric acid, glutathione, ammonium nitrate, petroleum ether, and BAL (2,3 dithiomercaptopropanol) -- on the dormancy of bitterbrush seed were completed.

5. Project personnel participated in the American Society of Range Management meeting in San Jose and the California Weed Control Conference in Santa Barbara in January.

The present report deals mainly with the results of last fall's rodent census work.

Results

Rodent censuses

Small-scale experimental results have shown that rodents destroy large numbers of seeds and seedlings of bitterbrush and it appears that rodent control may be necessary on practical large-scale plantings. The purpose of the rodent census work is to determine the number and kinds of rodents found on various sites and vegetation cover types. This information provides a basis for formulation of effective rodent control measures.

Last fall censuses were made in the undisturbed native vegetation cover on the three main experimental sites -- Flukey Spring, Doyle, and Wells Meadow -- and on two wild-burn areas -- Red Rock and Hallelujah Junction -- in Lassen County. The methods used were the same as those described in the July 1954 quarterly report.

Vegetation Cover on Census Sites

Main experimental area.--The vegetation composition on each of the three main experimental sites is shown in Table 1. The cover at Flukey Spring includes a little ponderosa pine, some juniper, considerable big sagebrush, perennial grasses and forbs, and some annuals. The Doyle site consists mainly of big sagebrush, cheatgrass, and other annuals. The Wells Meadow site supports mainly big sagebrush, Morman tea, and a light cover of perennials and annuals.

Wild-burn areas.--The vegetation on the Red Rock and Hallelujah Junction areas prior to burning consisted chiefly of sagebrush, juniper, and cheatgrass. The fires on both areas were very hot, destroying practically the entire cover. The former area burned in 1954 and the latter in 1953. At the time of the rodent census, the ground on both areas was bare of all vegetation except for a few small scattered islands of partly burned sagebrush and an occasional juniper.

Table 1. Vegetation composition on the three experimental areas

Species		Composition in Percent		
		Flukey		Wells
Common Name	Scientific Name	Spring	Doyle	Meadow
Shrubs and Trees				
Big sagebrush	Artemisia tridentata	30	30	20
Bitterbrush	Purshia tridentata	30	2	T
Yellow rabbitbrush	Chrysothamnus vicidiflorus	5		
Morman tea	Ephedra spp.			65
Sierra juniper	Juniperus occidentalis	5		
Desert peach	Prunus andersonii		1	5
Ponderosa pine	Pinus ponderosa	T		
Spineless horsebrush	Tetradymia canescens	1	—	—
	Totals	71	33	90
Forbs				
Mustard	Sisymbrium spp.	2		
Filaree	Erodium cicutarium		15	
Others		—	13	5
	Totals	2	28	5
Grasses and Sedges				
Cheatgrass	Bromus tectorum	5	35	
Idaho fescue	Festuca idahoensis	7		
Junegrass	Koeleria cristata	5		
Squirreltail	Sitanion hystrix	5		
Western needlegrass	Stipa occidentalis	3		
Bluebunch wheatgrass	Agropyron spicatum	1		
Sedge	Carex spp.	1		
Others		—	4	5
	Totals	27	39	5
Total Vegetation Density		.40	.25	.25

Fall Trapping Results

Main experimental areas.--The rodent catch on each of the three experimental areas is shown in Table 2. The highest catches were made at Flukey Spring where an average of 36 rodents were caught per trap day, a trap success of 71 percent. At Wells Meadow an average of 15 rodents were caught per day which gave a trap success of 30 percent. At Doyle only 4 rodents were caught per trap day giving a trap success of 7.3 percent, or one-tenth of what it was at Flukey Spring. Kangaroo rats and deer mice were the most common species caught on all three sites. A few chipmunks, pack rats, and shrew were trapped at Flukey Spring and some antelope ground squirrels and pocket mice were taken at the Doyle and Wells Meadow areas.

Wild-burn areas.--Trapping results on the burned areas are shown in Table 3. The take of rodents on the two areas which were quite similar averaged between 11 and 12 per day. The trap success was between 21.3 and 24 percent. The species taken consisted of deer mice and kangaroo rats only.

Kangaroo rat burrows were well distributed throughout the burn. The rats were apparently living within the burned area despite the fact vegetation was almost completely lacking and there was no apparent source of food on the ground. Deer mice were generally captured near the partially burned islands of sagebrush.

The largest population of rodents was found on the Flukey Spring area, the next largest at Wells Meadow, the next on the Hallelujah and Red Rock burns, and the smallest at Doyle. The comparatively high population of rodents on the burned areas was surprising.

The areas on which these censuses were made were poisoned with 1080 last fall and again this spring.[1/] Repeat censuses this spring and in the future will provide means of checking the effectiveness of the rodent control measures employed.

Work on the three main experimental areas and on the two burned areas will provide the first information obtained by the project on the effectiveness of conventional rodent control measures on the particular kinds of rodents found on the study areas. The work in the burned areas was designed also to provide information on the amount of bitterbrush seed taken by rodents on fairly large size planting and thus to give an indication of the importance of rodents in practical browse reseeding.

Spring Field Work

Spring field work got under way early in March. Rodent censuses were made on the principal experimental areas -- Flukey Spring, Doyle, and Wells Meadow -- and on the Red Rock and Hallelujah Junction burns. All of these areas were poisoned, after the rodent censuses were completed, by personnel from Modoc, Plumas, and Inyo National Forests and game-browse project under the supervision of John Ludeman of the Sacramento office of the U. S. Fish and Wildlife Service. Depth-of-planting seedings were made on the three main experimental areas. For the first time thiourea treated, rather than

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1/ Wells Meadow area was poisoned with strychnine in the spring.

Table 2. Rodent census at three experimental sites, Fall 1954

Rodent species	Date 10/4 N 1/	10/4 R 1/	10/4 T 1/	10/5 N	10/5 R	10/5 T	10/6 N	10/6 R	10/6 T	Total 3-Day Catch: New animals	Total 3-Day Catch: Compos. of animals trapped (percent)	Trap Success: 10/4 (Percent)	Trap Success: 10/5 (Percent)	Trap Success: 10/6 (Percent)	Trap Success: Average (Percent)
FLUKEY SPRING															
Deer mouse (Peromyscus spp.)	10	0	10	11	6	17	3	9	12	24	34	20	34	24	26.0
Kangaroo rat (Dipodomys spp.)	16	0	16	7	6	13	4	12	16	27	39	32	26	32	30.0
Chipmunk (Eutamias spp.)	2	0	2	8	1	9	6	3	9	16	23	4	18	18	13.3
Pack rat (Neotoma spp.)	1	0	1	0	0	0	1	0	1	2	3	2	0	2	1.3
Shrew (Sorex spp.)	1	0	1	0	0	0	0	0	0	1	1	2	0	0	0.7
Total	30	0	30	26	13	39	14	24	38	70	100	60	78	76	71.3
DOYLE															
Deer mouse	2	0	2	1	1	2	0	0	0	3	33	4	4	0	2.6
Kangaroo rat	2	0	2	0	0	0	2	1	3	4	45	4	0	6	3.3
Antelope ground squirrel (Citellus spp.)	1	0	1	0	0	0	0	0	0	1	11	2	0	0	0.7
Pocket mouse (Perognathus spp.)	1	0	1	0	0	0	0	0	0	1	11	2	0	0	0.7
Total	6	0	6	1	1	2	2	1	3	9	100	12	4	6	7.3
WELLS MEADOW															
Deer mouse	7	0	7	5	3	8	2	7	9	14	45	14	16	18	16.0
Kanagroo rat	6	0	6	2	1	3	4	3	7	12	39	12	6	14	10.6
Antelope ground squirrel	2	0	2	2	0	2	0	0	0	4	13	4	4	0	2.7
Pocket mouse	1	0	1	0	0	0	0	0	0	1	3	2	0	0	0.7
Total	16	0	16	9	4	13	6	10	16	31	100	32	26	32	30.0

1/ N = New animals trapped; R = Retrapped animals; T = Total new and retrapped animals.

Table 3. Rodent census on burn areas in Lassen County, Fall 1954

Rodent Species	Date 10/13 N 1/	10/13 R 1/	10/13 T 1/	10/14 N	10/14 R	10/14 T	10/15 N	10/15 R	10/15 T	Total 3-Day Catch: New animals	Total 3-Day Catch: Compos. of animals trapped (percent)	Trap Success 10/13	Trap Success 10/14	Trap Success 10/15	Trap Success Average
												. . . Percent . . .			
HALLELUJAH JUNCTION BURN 2/															
Deer mouse (Peromyscus spp.)	2	0	2	1	0	1	0	2	2	3	14	4	2	4	3.3
Kangaroo rat (Dipodomys spp.)	6	0	6	7	4	11	6	9	15	19	86	12	22	30	21.3
Total	8	0	8	8	4	12	6	11	17	22	100	16	24	34	24.6
RED ROCK BURN 3/															
Deer mouse	3	0	3	3	3	6	0	5	5	6	32	6	12	10	9.3
Kangaroo rat	5	0	5	5	2	7	3	4	7	13	68	10	14	14	12.7
Total	8	0	8	8	5	13	3	9	12	19	100	16	26	24	22.0

1/ N = New animals trapped; R = Retrapped animals; T = Total new and retrapped animals

2/ Burned summer of 1953.

3/ Burned summer of 1954.

stratified seeds, were used in these plantings. Thiourea has proved very effective in breaking dormancy and promoting germination of bitterbrush seed in the laboratory. Pilot plantings of thiourea treated bitterbrush seed were also made on more than 15 acres on the Red Rock and Hallelujah burns.

Meetings

Project personnel attended the eighth annual meeting of the American Society of Range Management at San Jose on January 25 to 28. Mr. M. W. Talbot presented a paper, jointly with A. L. Hormay, on the possibilities of improving game forage by artificial reseeding. E. C. Nord and B. O. Pearson represented the project at the Range Reseeding Equipment Committee meeting at San Jose on January 23 to 25. Nord was made chairman of a committee formed to suggest browse reseeding equipment needs to the main Range Reseeding Equipment Committee for their consideration and possible development. B. O. Pearson also took part in the California Weed Control Conference at Santa Barbara on January 26 and 27.

SUBMITTED BY

G. L. Hormay

Project Leader

APPROVED BY
CALIFORNIA DEPARTMENT OF FISH AND GAME

By _____
Chief, Game Management Branch

DATE _____

AHH

STATE California

PROJECT NO: W-6-R-4

FEDERAL AID IN WILDLIFE RESTORATION

PLANS, SPECIFICATIONS AND ESTIMATES

INVESTIGATIONS

DATE April 1, 1935

The Secretary of the Interior
Washington, D. C.

Sir:

The State of California by and through the Department of Fish and Game constituting the State Fish and Game Department, and pursuant to the Federal Aid in Wildlife Restoration Act (50 Stat. 917) and to the Rules and Regulations of the Secretary of the Interior made and published thereunder, does hereby submit this statement describing a wildlife investigations project and requests authorized financing thereof. Said project is proposed as a means of promoting efficient management of wildlife resources, and will be executed under the provisions of said Act and said Rules and Regulations.

1. Title of Project: Game Range Restoration

2. Supervisors: Ben Glading, Chief, and William P. Dasmann, Senior Game Biologist, Game Management Branch, California Department of Fish and Game.

3. Leaders: Chief, Division of Range Management Research, California Forest and Range Experiment Station, and A. L. Hormay, Range Conservationist, California Forest and Range Experiment Station.

   Assistants: E. C. Nord, E. C. Pearson, and R. L. Hubbard, Range Conservationists.

4. Purpose of Project: To develop cultural methods of re-establishing and extending native or introduced browse species suitable for food or cover on deteriorated game ranges in California. The work has been started in the Eastside Region of the State on deer winter ranges which extend a distance of about 500 miles from Oregon to

c.c. to Federal Agencies
" " AHH
" " ECN
" " File

the southern end of the Sierra Nevada mountains. These ranges are heavily deteriorated. They lie in a comparatively light snow belt, but in heavy precipitation years snow covers low growing forage and hinders the movement of the deer. Under these conditions shrubs become premium forage plants for deer because of their upstanding growth habit. Bitterbrush (Purshia tridentata) is the most important game browse in the region and is being given special attention in these studies.

5. Summary of Accomplishments During Fiscal Year 1955 (July 1, 1954 to June 30, 1955):

Background:

A successful browse reseeding program depends on a knowledge of a great many factors bearing on the species to be planted, the nature of the planting site, methods of preparing and seeding the site, and protecting the seeds and seedlings from harm. The present research is being directed to get information on these factors so that economical practices can be formulated for broad-scale reseeding. The relation of some of the study factors to practical reseeding steps is shown in Table 1.

Table 1. Factor information bearing on practical reseeding steps

Factors	Reseeding Steps			
	(1) Selection of planting stock	(2) Site and seedbed preparation	(3) Planting	(4) Protection of seed and seedlings
1. Species				
Grazing value	X			
Growth habit	X			X
Reproduction and seed germination	X	X	X	X
Adaptability to site	X			
2. Site				
Precipitation and temperature	X		X	
Soil character	X	X		
Soil moisture	X	X	X	
Native vegetation	X	X		
Biological factors - rodents, insects, etc.	X	X		X
3. Site and seedbed preparation				
Method and equipment	X	X	X	
Mechanical				
Chemical				
Fire				

Table 1. Factor information bearing on practical reseeding steps (Cont.)

Factors	Reseeding Steps			
	(1) Selection of planting stock	(2) Site and seedbed preparation	(3) Planting	(4) Protection of seed and seedlings
4. Planting				
Time	X	X	X	
Depth	X	X	X	
Rate	X	X	X	
Equipment	X		X	
5. Biological control measures				X

Results:

Factors found to be important to successful browse reseeding on the basis of studies to date are:

(a) Knowledge of seed germination.
(b) Evaluation of site--to determine suitability of the site for particular species.
(c) Site preparation--reducing vegetation that competes with browse plants for moisture.
(d) Time and depth of planting.
(e) Rodent control--to prevent destruction of browse seed and seedling.

Although the studies have been carried out almost entirely with bitterbrush, most of the findings apply in principal to other species.

Seed germination

The finding last year that thiourea was effective in breaking the dormancy of bitterbrush seed has made spring planting more a practical possibility. And spring planting rather than fall planting holds the main hope for artificial browse reseeding on a major portion of the deer winter range area in the Eastside region.

The first field planting of thiourea-treated bitterbrush seed was made last spring. The results were encouraging.

Additional plantings were made last fall and this spring and germination of these is in progress at the present time. These plantings are being watched particularly for the effect of

thiourea on both amount and speed of germination. Rapid spring germination is expected to increase seedling establishment and survival.

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Systematic measurements of various site factors--such as precipitation, air and soil temperatures, soil moisture, plant growth and development--were made on each of the three main experimental sites. These measurements are recurrent and provide the main basis for judging the adaptability of species to site and the seeding responses obtained on sites.

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The first two years' work shows clearly that existing vegetation on planting sites must be reduced before planting to insure maximum survival and growth of seedlings from artificial reseeding. At the end of the second year of growth, for example, mortality of bitterbrush seedlings growing under heavy competition ranged between 46 and 55 percent whereas under light competition mortality was only 20 to 22 percent. Plants under heavy competition grew only about 3 inches tall whereas those under light competition reached a height of about 14 inches.

Chemical spraying, burning, and mechanical clearing are being studied as a means of reducing plant competition. These methods materials can be used singly or in combination depending on the type of vegetation and other characteristics of the site.

Trials made with these three clearing "tools" to date have been of a preliminary nature. Burning in both spring and fall under certain conditions was found effective in controlling cheatgrass and big sagebrush. Of several chemicals tested, Dalapon, CMU, and IPC (C1) were effective on cheatgrass and other annuals. Both fall and spring discing reduced sagebrush, perennials, grasses and forbs, and eliminated enough annuals to permit the establishment of reasonably good stands of bitterbrush seedlings.

More detailed studies, particularly on burning and use of chemical sprays, are now in order.

Time and depth of planting

Preliminary hand plantings on three sites indicate that the most desirable depth of planting for bitterbrush is between 1 and 2 inches. With deeper planting the seedlings fail to emerge and with shallower plantings the germinating seeds are more likely to be killed by rapid drying out of the top soil. Depth of seedling

emergence and drying of the top soil appear to be related to soil texture and the precipitation pattern. A better understanding of these relationships will speed up completion of development of workable planting methods.

These plantings were made in both fall and spring to provide information on best time of planting. An intensified study in which a greater range of planting depths and more replications are being used than in earlier work and more consideration is being given to soil factors was started last fall and is scheduled to run 3 or 4 years.

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Rodents have taken from 48 to 87 percent of the bitterbrush seeds in some small-scale experimental plantings. This loss indicates the possible need for rodent control on large-scale plantings. During the summer censuses were made on several experimental areas to determine the kinds of rodents present. Moderate to high populations of kangaroo rats, pocket mice, white-footed deer mice, chipmunks, golden-mantle squirrels, and pack rats were found. This information is being used to formulate rodent control measures on planting sites.

Conventional rodent control methods were used on the three main experimental areas this past year to minimize interference of rodents with experimental results. In addition, the first check of the effect of rodents and rodent control measures on fairly large size bitterbrush planting was made on two wild burns in Lassen County. The rodents were poisoned with 1080 and strychnine under the supervision of the Fish and Wildlife Service. The results of these rodent control measures will become evident during the summer.

Pilot seedings of bitterbrush

The first attempt to seed bitterbrush on a fairly large scale since the game-browse project was started was made on the two wild burns in Lassen County. A total of 33 acres was planted. Three areas were drilled and 1 broadcast and rolled with a cultipacker. A portion of the area was poisoned for rodent control. The project was carried out cooperatively with the California Department of Fish and Game, U. S. Fish and Wildlife Service, Bureau of Land Management, and Plumas National Forest. These plantings are serving to bring out the status of present knowledge on bitterbrush reseeding. Similar seedings will be attempted almost every season from now on.

6. Work Plan for Fiscal Year 1956 (July 1, 1955 to June 30, 1956):

Species

A more concerted effort will be made this year to find additional suitable browse species for planting on Eastside game ranges, particularly on the drier areas below the bitterbrush zone where saltbushes, winter fat and similar species grow. Seed of promising species will be obtained for initial germination and planting trials.

Seed germination

In the laboratory germination studies will be continued with wedgeleaf ceanothus (Ceanothus cuneatus) and curl-leaf mahogany (Cercocarpus ledifolius) at about the same level as last year and initial tests, if needed, will be made of seed of any new species found.

Site factors

Systematic measurements of site factors like precipitation, temperature, soil moisture and plant growth and development will be continued on the three main experimental areas.

Depth and time of planting

Controlled small-scale hand plantings and larger scale drill plantings will be made in both spring and fall like last year to get information on depth and time of planting, particularly in relation to site characteristics.

Site and seedbed preparation

More intensive tests will be made of the use of fire and of chemical sprays, particularly Dalapon, IPC (Cl) and PCP for clearing sites of competing vegetation.

Rodent control and censuses

All experimental areas will be poisoned to control rodents and rodent censuses will be made to check the effectiveness of control. If present conventional control measures prove inadequate, cooperative work will be undertaken with the Denver Laboratory of the Fish and Wildlife Service to develop better methods.

Pilot planting

Both spring and fall pilot plantings of bitterbrush will be made in cooperation with administrative and other agencies.

7. The work outlined in paragraph 6 above will be carried out by the California Forest and Range Experiment Station through a cooperative agreement. A conformed copy of this agreement will be submitted when it has been duly executed. The following tabulation indicates the approximate manner in which the contractual budget item of paragraph 8 which follows is to be broken down.

Salaries

Division Chief	None	
A. L. Harmay	$ 1,073.75	
E. C. Herd	5,656.09	
B. O. Pearson	4,985.13	
R. L. Hubbard	4,724.08	
Stenographer	1,608.21	
Temp. tech. (GS-4, GS-6)	2,427.35	
Labor	2,000.00	
Total salaries and wages		$22,414.61

Service and Expense

Travel	3,400.00	
Automobile rental 1/	3,200.00	
Equipment rental (tractor) 2/	800.00	
Total service and expense		$ 7,400.00

Materials and Supplies

Stakes, posts, screen domes, etc.	1,000.00	
Chemicals	200.00	
Laboratory supplies	350.00	
Film and processing	200.00	
Communications, postage	200.00	
Seed collection	500.00	
Miscellaneous	300.00	
Total materials and supplies		$ 2,750.00
Total cooperative agreement		$32,564.61

1/ Includes auto rental from Forests and Experiment Station.
2/ Includes operator and tractor.

8. Estimated expenditures July 1, 1955 to June 30, 1956:

Service and expense

Contractual services with the California Forest and Range Experiment Station	$32,564.61	
Pro-rata administrative charges	400.00	
Total service and expense		$32,964.61

Property and equipment

1 camera, 4 x 5 Press type, f4.5 lens, 135 mm	200.00	
1 camera case	20.00	
1 meter, exposure	25.00	
1 utility or garden cart, 2-wheel	15.00	
miscellaneous	40.00	
Total property and equipment		300.00
Total all functions		$33,264.61
Contingency		200.00
Total		$33,464.61

Assurance is given that the foregoing information concerning the project herein described is presented to the best ability of the State Fish and Game Department, and all applicable provisions of the State laws have been fully complied with.

Respectfully submitted,

CALIFORNIA DEPARTMENT OF FISH AND GAME

By _____
Chief, Game Management Branch

Approved: Date _____

_____
Regional Director

Approved: Date _____
SECRETARY,
DEPARTMENT OF THE INTERIOR

By _____
Director, Fish and Wildlife Service

Flannery

RR
COOPERATION
State of California
Department of Fish and Game
Project W-6R-3

CF&RES
E. C. Nord
April 20, 1955

Subject: Field Progress Report for
March and April 1955

A brief resume is given for the work in progress during March and April 1955. The principal accomplishments and general observations made this spring are as follows:

1. Rodent census:

The first series of rodent census was made on all planting sites during March and the second series was completed on all areas except at Flukey Spring during April. Recent snows have delayed the census at Flukey Spring.

2. Rodent poisoning:

All planting areas were poisoned for rodents during March. John Ludeman supervised and directed all poisoning operations at Wells Meadow, Doyle, and Red Rock - Hallelujah Junction areas. Poisoning at Flukey Spring was carried out entirely by project personnel. Strychnine treated wheat was used at Wells Meadow and 1080 crushed oat bait was used on all other areas. The U. S. Fish and Wildlife Service furnished all bait used to control the rodents.

3. Experimental plantings:

a. Depth of planting:

Plantings were made on the following dates:

Wells Meadow	March 9
Doyle	March 22
Flukey Spring	March 28

Satisfactory soil moisture was present on all sites at time of planting, however, rapid drying was occuring at the shallower depths, particularly at 1/2 to 1 inch depths. Additional rains fell on the Doyle and Flukey Spring plantings within 10 days after the seedings were completed.

b. Thiourea plantings:

These plantings were made on the following dates:

Wells Meadow	March 3
Doyle	March 10
Flukey Spring	March 21

Stratified seeds were planted at the same time as the thiourea treated seeds. Seeds used in all experimental plantings were from the 1954 collection at Milford (GB Lot 57A). Germination tests were made on each treatment at time of planting.

4. Trial field plantings:

Field plantings were made at Hallelujah Junction, Red Rock, and the Mears burn areas. These plantings were made as follows:

Area	Acres	Date of Planting	Rate of Seeding Lbs/Acre	Rodent Control	Seedbed Preparation
Hallelujah Junction	5.6	3-21-55	6.7	1080 crushed oats	Wild burn 1953
Red Rock	5.0	3-22-55	6.7	1080 crushed oats	Wild burn 1954
Red Rock	5.0	3-22-55	6.7	None	Wild burn 1954
Mears Burn	1.5	4- 6-55	8.0	1080 crushed oats	Plowed fall, harrowed spring
Mears Burn	1.8	4- 6-55	8.0	None	Plowed fall, harrowed spring

All seeds were treated with thiourea, air dried, mixed with rice hulls and seeded at 1/2 to 1 1/2 inch depth. Conventional double-disc grain drills were used on all plantings. Press wheels attached to the seeder were used on the Hallelujah Junction - Red Rock seedings. The Mears burn seedings were rolled with an empty metal drum in lieu of press wheels on the available seeder.

Seedbed conditions at planting time were very satisfactory on all areas. Good soil tilth and moisture existed both at planting time and up to the last observation -- April 15th.

The Red Rock - Hallelujah Junction plantings were made with seed furnished by the California Department of Fish and Game and the California Forest and Range Experiment Station (GB 66). Mears area was from the 1954 collection of the project (GB 57A).

5. General observations:

a. Seedling emergence:

The first emergence on any site occurred at Wells Meadow about March 8 from seeds planted last fall under screen domes at 1/2 inch depth. The earliest observed emergence on the respective planting sites is as follows:

Wells Meadow	March 8
Doyle	March 12
Flukey Spring	April 8
Red Rock pilot planting	April 7
Hallelujah Junction	None to April 16

The emergence at Flukey Spring was about 2 weeks later this year than it was in 1954. By April 8 last year, most of the seedlings had emerged.

b. Mortality of seedlings from thiourea treated seeds:

The preliminary showing of seedlings from thiourea treated fall planted seeds is not too encouraging. Relatively few seedlings have emerged or survived thus far from these plantings. In contrast, many of the untreated seeds planted under similar conditions have emerged and are still surviving at both Wells Meadow and Doyle. In one planting, both the thiourea treated seeds and untreated seeds emerged in early March at Wells Meadow. An examination in early April disclosed that all the seedlings from the thiourea treated seeds had succumbed while the seedlings from untreated seeds were still living and growing.

Judging from the root development on seeds buried in packets over winter, there was a different form on those treated with thiourea than on the untreated seeds. The treated seeds had roots which had elongated about 2 inches and then branched, forming a rosette of roots. The untreated seeds did not display this branching. These effects will be checked more fully at the Flukey Spring and Doyle areas.

c. Rodent controls:

It is too early to determine results of rodent poisoning on most of the areas. Retrappings show that some rodents

are found on all sites. However, only 2 kangaroo rats have been taken at Wells Meadow and none at the other poisoned areas. Several kangaroo rats, both animals captured last fall and again this spring, were taken on the non-poisoned area at Red Rock. Hubbard reports possible rodent "mining" of 2 caged spots at Wells Meadow. There was noticeable rodent digging or activity on the non-poisoned area at Red Rock. This was not apparent on the other poisoned areas.

d. Frost heaving:

Considerable frost heaving occurred to the 1 year old seedlings in the Flukey Spring area. It is estimated that about 1/2 of the seedlings at Mears Pilot Plot were "heaved" out of the ground during the winter. Heaving was also found on the seedlings growing in the Flukey Spring controlled burn and drill plantings on the cultivated plots inside the exclosure. No observed heaving was found on the non-cultivated or on the Casuse Mountain burn plots. Similarly, heaving was not noted on the cone plots inside the exclosure.

e. Grazing:

Seedlings on the Mears Pilot Plot have been grazed during the winter. This grazing is probably from deer; the degree of use is not too severe and most of the plants will probably survive.

Both cattle as well as deer were present on the plantings at Red Rock and Hallelujah Junction. Hubbard reported seeing 27 cattle on one of these plantings in April while he was making the rodent census. Cattle and deer tracks are noticeable on all the planted areas.

Fencing to protect some of these areas from sheep is planned. The Bureau of Land Management has offered to furnish materials and the California Department of Fish and Game has planned to construct the fence. When it will be accomplished is not known.

f. Seedling mortality:

Some seedlings which emerged this spring have been injured or killed due to either insects or other unknown causes. The cotyledons have been removed or "nipped" soon after they emerged. This suggests that insects may be the cause since the plants were protected from rodents. Some plants died soon after emergence.

Inasmuch as bitterbrush seedlings have been reported by Peterson 1/ to be quite susceptible to damping off, it may be a possible cause of some of the early seedling mortality which has occurred on some of our plantings.

6. Current work:

The final rodent census at Flukey Spring will be made as soon as weather conditions permit. This may be completed by the end of April.

Chemical spraying of plots at Casuse Mountain will be made when cheatgrass growth is favorable for spraying. Delayed growth has delayed the initial application. All plots have been laid out and materials and equipment assembled for this work.

Sampling of emergence on the Red Rock - Hallelujah Junction pilot plots will be made when seedling emergence is further along. It is contemplated using a 3 foot belt transect.

Compilation work is proceeding on data collected in the field. This includes site factor records, rodent census and early emergence of experimental plantings made last fall and this spring.

1/ Peterson, R. A. Comparative effect of Seed Treatments Upon Seedling Emergence in 7 Browse Species. Ecology 34(4): 778-85.

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cc: A. L. Hormay
E. C. Nord
File

FR-CAL
COOPERATION
State of California
Department of Fish and Game
Project W-6R-3

CFARES
May 2, 1955

PROGRESS REPORT

April, 1955

Accomplishments:

1. Three drill plantings of bitterbrush were made on the Flukey Spring experimental area with thiourea treated seeds. Areas ranging in size from 1/2 to 1-1/2 acres were seeded. Two of the seedings were made on cultivated seedbeds and one on a controlled burn area. The plots were treated with 1080 to control rodents. Rodent censuses were made before and after seeding to determine the effectiveness of rodent poisoning.

2. Rodent censuses were made on all sites planted last fall and this spring.

3. Project personnel participated in the California Forest and Range Experiment Station investigative meetings April 25 to 27. M. W. Talbot summarized the progress made on game habitat improvement and A. L. Hormay discussed dormancy in bitterbrush seed as related to browse reseeding.

4. M. W. Talbot and E. C. Nord of the Station and William P. Dasmann and Henry Hjersman of the California Department of Fish and Game made a trip over some of the southern and eastern reaches of the Eastside deer winter range area. Significant information was obtained on site variations, varieties of bitterbrush -- especially sprouting forms -- and species in addition to bitterbrush that may be suitable for planting on Eastside ranges.

5. M. W. Talbot, co-leader of the project and Associate Director of the Station, retired April 30. Jay R. Bentley is acting Division Chief until the new Division Chief arrives about July 1.

6. Mr. Robert Stanley, graduate student at the University of California, who has been working part-time on the game-browse project during the last year assisting in seed germination studies resigned April 10. Stanley will remain with the Station where he has accepted an appointment as a collaborator in plant biochemistry with Dr. N. T. Mirov.

A. L. Hormay

cc: ECN
ALH ✓
BOP
RLH
File

ALH !

6-29-55

STATE California

PROJECT NO. W-46-R-4

Contract #14-19-008-6758

FEDERAL AID IN WILDLIFE RESTORATION

PLANS, SPECIFICATIONS AND ESTIMATES

INVESTIGATIONS

DATE May 12, 1955

The Secretary of the Interior
Washington, D. C.

Sir:

The State of California by and through the Department of Fish and Game constituting the State Fish and Game Department, and pursuant to the Federal Aid in Wildlife Restoration Act (50 Stat. 917) and to the Rules and Regulations of the Secretary of the Interior made and published thereunder, does hereby submit this statement describing a wildlife investigations project and requests authorized financing thereof. Said project is proposed as a means of promoting efficient management of wildlife resources, and will be executed under the provisions of said Act and said Rules and Regulations.

1. Title of Project: Game Range Restoration

2. Supervisors: Ben Glading, Chief, and William P. Deamann, Senior Game Biologist, Game Management Branch, California Department of Fish and Game.

3. Leaders: Joseph E. Woolfolk, Chief, Division of Range Management Research, California Forest and Range Experiment Station, and A. L. Herman, Range Conservationist, California Forest and Range Experiment Station.

   Assistants: E. C. Nord, B. C. Pearson, and R. L. Hubbard, Range conservationists.

4. Purpose of Project: To develop cultural methods of re-establishing and extending native or introduced browse species suitable for food or cover on deteriorated game ranges in California. The work has been started in the Eastside region of the State on deer winter ranges which extend a distance of about 500 miles from Oregon to

the southern end of the Sierra Nevada mountains. These ranges are heavily deteriorated. They lie in a comparatively light snow belt, but in heavy precipitation years snow covers low growing forage and hinders the movement of the deer. Under these conditions shrubs become premium forage plants for deer because of their upstanding growth habit. Bitterbrush (Purshia tridentata) is the most important game browse in the region and is being given special attention in these studies.

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Adaptability to site	X			
2. Site				
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Soil character	X	X		
Soil moisture	X	X	X	
Native vegetation	X	X		
Biological factors - rodents, insects, etc.	X	X		X

Factors	Receeding Steps			
	(1) Selection of planting stock	(2) Site and seedbed preparation	(3) Planting	(4) Protection of seed and seedlings
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Method and equipment	X	X	X	
Mechanical				
Chemical				
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Depth	X	X	X	
Rate	X	X	X	
Equipment	X		X	
5. Biological control measures				X

Results:

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- strains
- sprouting

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Total Materials and supplies		2,750.00
Total cooperative agreement		$ 32,564.00

1/ Includes auto rental from Forests and Experiment Station $ 3870 3.00 FY '57
2/ Includes operator and tractor

8. Estimated expenditures July 1, 1955 to June 30, 1956:

Service and Expense		
Contractual services with the California Forest and Range Experiment Station	$ 32,564.00	
Pro-rata administrative charges	466.00	
Total Service and Expense		$ 33,030.00
Property and Equipment		
1 Meter, exposure	25.00	
Miscellaneous property and equipment	100.00	
Total Property and Equipment		125.00
Total All Functions		$ 33,179.00
Contingency		21.00
Total		$ 33,200.00

30,500

Assurance is given that the foregoing information concerning the project herein described is presented to the best ability of the State Fish and Game Department, and all applicable provisions of the State laws have been fully complied with.

Respectfully submitted:

CALIFORNIA DEPARTMENT OF FISH AND GAME

By Ben Glading
Chief, Game Management Branch

Approved: Date May 25, 1955

J. T. Barnaby
Acting Regional Director

SECRETARY OF THE INTERIOR

Approved: Date June 2, 1955

By O. Lloyd Meehan
Acting Director, Fish and Wildlife Service

BR-CAL
COOPERATION
State of California
Department of Fish and Game
Project W6R-3

CFSREX
June 3, 1955

PROGRESS REPORT

May, 1955

Accomplishments:

1. Thirty-two plots on the Casuse Mountain area were sprayed with Dalapon to determine the most effective date of application and the minimum rates of chemicals and solution required to control annual species, particularly cheatgrass, on browse planting sites.

2. Measurements were made of over-winter survival of seedlings and of new germination from last fall and this spring seedings on all experimental areas. Bitterbrush seedling emergence as well as other plant growth was considerably delayed in most areas due to the lateness of the season. Summarization of these data was started during the month.

3. On May 16 and 17, project personnel together with California Department of Fish and Game representatives showed members of the Utah Big Game Committee the experimental browse reseeding work in progress on the Doyle and Flukey Spring area.

4. Insect damage to bitterbrush seedlings has been observed on the experimental plots in the past. Edwin Clark and Carl Reiner of the University of California, Department of Biological Control, and Robert Cope of the Entomology Division of the California Forest and Range Experiment Station together with project personnel examined the plantings on the Flukey Spring and Casuse Mountain areas for insect damage. Cut worms, leaf miners, and wire worms appeared to be responsible for killing or injuring seedlings in the early growth stages.

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cc: ALH
ECN
BOP
RLH
File

STATE California

PROJECT W46R-3

DATE July 5, 1955

QUARTERLY PROGRESS REPORT

SURVEYS AND INVESTIGATIONS

as required by

FEDERAL AID IN WILDLIFE RESTORATION ACT

1. Title of Project: Game Range Restoration

2. Supervisors: Ben Glading, Chief, and William P. Dasmann, Senior Game Biologist, Game Management Branch, California Department of Fish and Game

3. Leaders: E. J. Woolfolk and A. L. Hormay

   Assistants: E. C. Nord, R. L. Hubbard, and B. O. Pearson

4. Cooperating Agency: California Forest and Range Experiment Station

5. Summary report of progress during the quarter April 1 to June 30, 1955. This report is not for publication.

Purpose

The primary objective of this project is to develop cultural methods of re-establishing and extending native or introduced browse species suitable for food or cover on deteriorated game ranges in California. The work has been started in the Eastside Region of the State on deer winter ranges which extend a distance of about 500 miles from Oregon to the southern end of the Sierra Nevada mountains. These ranges are heavily deteriorated. They lie in a comparatively light snow belt, but in heavy precipitation years snow covers low growing forage and hinders the movement of the deer. Under these conditions shrubs become premium forage plants for deer because of their upstanding growth habit. Bitterbrush (Purshia tridentata) is the most important game browse in the region and is being given special attention in these studies.

General Accomplishments During Last Quarter

1. Measurements were made of bitterbrush seedling emergence from plantings made last fall and this spring on the three main experimental areas. Also survival records were made on older plantings.

2. Thirty-two plots on the Casuse Mountain area were sprayed with Dalapon to determine the most effective dates and rates of application for control of annual species, particularly cheatgrass, on browse planting sites.

3. Three drill plantings ranging from 1/2 to 1 1/2 acres in size were made with thiourea treated bitterbrush seeds.

4. Project personnel participated in a game-range tour and in the 1955 annual conference of the Western Association of Game and Fish Commissioners.

The present report deals mainly with seedling emergence from last fall's depth-of-planting tests, frost heaving of seedlings, and a quick method of testing bitterbrush seed viability.

Personnel

M. W. Talbot, Associate Director of the California Forest and Range Experiment Station, Chief of Range Research Division and one of the leaders of the Game-Browse project, retired from the Service on April 30. E. J. Woolfolk who has been named to succeed Mr. Talbot comes to the California Station from the Southeastern Forest Experiment Stateon at Ashville, North Carolina where he has been in charge of range research since February 1954. He served in a similar capacity at Missoula, Montana from 1949 to 1954. Mr. Woolfolk has more than 20 years of research experience on livestock and game problems in the Rocky Mountain and Great Plains areas. He grew up on a Wyoming livestock ranch and attended the Universities of Montana and Minnesota.

Robert Stanley, a graduate student at the University of California and part-time worker on the game-browse project during the last year assisting in seed germination studies, resigned April 10. However, he will remain with the California Forest and Range Experiment Station where he has accepted an appointment as a collaborator in plant physiology with Dr. N. T. Mirov.

Genaro Ingco, senior in forestry at the University of California who also has been assisting in seed germination studies on the project on a part time basis, resigned the latter part of June to accept an appointment with the U. S. Forest Service on the Sequoia National Forest.

Results

Fall Depth-of-planting Results

The results of depth-of-planting tests with bitterbrush seeds last fall differ in two ways from comparable plantings made in previous years. First: the precent emergence was much greater. Second: the best emergence was obtained from shallower depths than in previous years.

The most striking difference in seedling emergence between 1954 and 1955 occurred at Wells Meadow. Of the total seeds planted last fall, 68 percent emerged from one inch depth (table 1). This emergence rate was nearly three times greater than that obtained from any planting depth in 1954. At Doyle and Flukey Spring the highest emergence was 56.8 and 44.0 percent, respectively, or more than one and a half times greater than the best emergence in 1954.

Good emergence was obtained from planting depths ranging from 0.5 to 1.0 inches at the Flukey Spring and Doyle areas and from 0.5 to 2.0 inches at the Wells Meadow area. Results to date indicate that the probable extreme limit of seedling emergence is about 3.0 inches. This year emergence was not obtained from depths greater than 1.5 inches at Flukey Spring, 2.0 inches at Doyle and 3.0 inches at Wells Meadow. No seedlings were obtained from seeds planted on the soil surface on any site.

The range of depths which have given the best emergence from fall plantings for the last three years is shown in table 2.

The difference in seedling emergence from 1954 to 1955 apparently is largely a result of variation in growing conditions from one season to the next. The lower emergence in 1954 than in 1955 probably was caused by greater soil moisture fluctuations at the seed level at germination time. The results at Wells Meadow appear to bear this out. Measurements on this site show there were wider fluctuations in soil moisture at the 1.5 inch depth during the month preceding emergence in 1954 than in 1955.

Some of the difference in emergence between the two years is explained in the quality of the seeds planted. The seed planted in the fall of 1953 had 75 percent viability and in 1954, 85 percent. Also the seeds used in 1953 were moistened during cleaning. This may have caused an increase in fungus growth on the seeds in the soil and reduced germination and seedling emergence.

Spring planting results have not been summarized yet. They will be given in a later report.

Table 1. Emergence of bitterbrush seedlings in 1954 and 1955 from seed planted at specified depths, fall planting on cultivated areas.

Experimental Area	Emergence Year	Emergence where depth of planting (inches) was - 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
		Percent 1/								
Flukey Spring	1955	0.0	44.0	37.8	8.4	0.0	0.0	0.0	0.0	0.0
	1954	--2/	14.0	28.0	21.0	4.0	0.0	0.0	--	--
Doyle	1955	0.0	44.0	56.8	16.4	0.6	0.0	0.0	0.0	0.0
	1954	--	23.0	36.0	12.0	3.0	4.0	0.0	--	--
Wells Meadow	1955	0.0	64.4	68.0	62.0	35.6	14.2	1.2	0.0	0.0
	1954	--	4.0	20.0	23.0	20.0	8.0	3.0	--	--

1/ Based on 100 seeds per depth class in 1954 and 500 seeds in 1955.
2/ No comparable plantings in 1954.

* * * * *

Table 2 Fall planting depths giving best bitterbrush seedling emergence - 1953-55.

Experimental Area	Year Planted 1952	1953	1954
	Inches		
Flukey Spring	2.0	0.5 - 1.5	0.5 - 1.0
Doyle	1.0 - 2.0	0.5 - 1.5	0.5 - 1.0
Wells Meadow	2.0	1.0 - 2.0	0.5 - 2.0

Frost Heaving of Bitterbrush Seedlings

Frost heaving of bitterbrush seedlings starting the second year of growth was observed this spring at the Flukey Spring Experimental area. Mortality ranged up to 31 percent on some sites. The heaved plants had been thrust up and the roots broken off below the ground surface. In early March many of the plants were still in place with 2 to 4 inches of the tap root exposed. The foliage on most of the heaved plants was still succulent indicating that heaving had occurred during late winter. There was no heaving of 2 and 3-year old seedlings on any site.

Mortality due to frost heaving apparently was not related to seed bed preparation or size of plant (table 3). Rather the differences in mortality seems related to soil differences.

All sizes of one-year old seedlings were heaved. Many of them were even larger than the 2 and 3-year old seedlings that were not heaved. The reason for this difference is not clear. Further observations are needed in order to gain a more complete understanding of conditions causing heaving.

Table 3 Mortality of one-year old bitterbrush seedlings from frost heaving, Flukey Spring, winter 1954-55.

Site	Site Preparation	Seedlings Fall 1954	Seedlings Spring 1955	Mortality	Average Height of Plants (Fall 1954)
		Number		Percent	Inches
Flukey Spring	Cultivated	271	231	15	1.3
	Native vegetation	14	12	14	0.9
Mears' Burn	Cultivated	142	101	29	2.5 1/
	Native vegetation	96	66	31	1.5 1/

1/ Estimated height.

Quick Testing of Bitterbrush Seed Viability

The viability of bitterbrush seed can be determined in about 8 days by excising and germinating the embryos. In a study made this year it was found that four hundred or more seeds replicated in lots of 100 are needed to determine viability within about 5 percent. Practically all viable embryos germinate within 8 days.

The steps used in making the test are as follows:

1. Soak the seeds in water for about 4 hours. Use sufficient seeds to obtain 400 or more good, excised embryos.

2. Separate the soaked seeds into nearly equal sub-samples -- 4 or more. These are tested and analyzed separately. Each sub-sample should contain sufficient seeds to give 100 good embryos for germinating.

3. Excise the embryos by cutting the seeds through the widest portion. The embryo can be forced out of the seed coat by squeezing the root end of the seed (the tip) gently between the fingers. Record and discard

the seeds in which the embryos have not formed or are obviously not good. Care should be exercised in removing the seed coat to prevent damaging the small end of the embryo where the radicle is located.

4. Germinate the embryos on moist filter paper in Petri dishes at temperatures between 60°F and 70°F.

5. Record the number of embryos that germinate daily. The embryos that develop a half-inch of healthy root can be considered viable. A healthy root is smooth, white and opaque, whereas, an unhealthy one is usually grayish or brown in color and somewhat translucent.

The percent viability of a sub-sample of seeds is the product of the percentage of seeds with good embryos and the percentage of embryos that germinate.

Chemical Spraying with Dalapon (Na salt a,a-diachloropropionic acid)

Preliminary tests with Dalapon during 1953 and 1954 show that this chemical is an effective herbicide on cheatgrass and short-lived annuals when applied at rates from 2 to 6 pounds per acre during the early and vigorous growth stages of cheatgrass. Further work was carried out this year with this chemical to determine the best date of application and formulation to control cheatgrass on browse planting sites. The chemical was applied on three different dates at rates from 1 to 6 pounds in 5, 10 and 40 gallons of solution per acre.

Meetings

Project personnel joined with the California Department of Fish and Game and members of the Utah Big Game Committee in looking over some of the deer problem areas in northeastern California on May 16 and 17. The group saw the game-browse restoration experiments underway on the Doyle and Flukey Spring areas in Lassen and Modoc Counties.

A. L. Hormay and E. C. Nord attended the 1955 annual conference of the Western Association of Game and Fish Commissioners at Moran, Wyoming on June 16 to 18. Phases of game-range restoration work in the Western states were reviewed during this conference.

SUBMITTED BY

E. C. Nord

Project Leader

APPROVED BY
CALIFORNIA DEPARTMENT OF FISH AND GAME

By _____

Chief, Game Management Branch

STATE California

PROJECT W46R-4

DATE October 4, 1955

QUARTERLY PROGRESS REPORT

SURVEYS AND INVESTIGATIONS

as required by

FEDERAL AID IN WILDLIFE RESTORATION ACT

1. Title of Project: Game Range Restoration

2. Supervisors: Ben Glading, Chief, and William P. Dasmann, Senior Game Biologist, Game Management Branch, California Department of Fish and Game

3. Leaders: E. J. Woolfolk and A. L. Hormay
   Assistants: E. C. Nord, R. L. Hubbard, B. O. Pearson, R. F. Wagle, and J. Whitacre

4. Cooperating Agency: California Forest and Range Experiment Station

5. Summary report of progress during the quarter July 1 to September 30, 1955.

This report is not for publication.

Purpose

The primary objective of this project is to develop cultural methods of re-establishing and extending native or introduced browse species suitable for food or cover on deteriorated game ranges in California. The work has been started in the Eastside Region of the State on deer winter ranges which extend a distance of about 500 miles from Oregon to the southern end of the Sierra Nevada mountains. These ranges are heavily deteriorated. They lie in a comparatively light snow belt, but in heavy precipitation years snow covers low growing forage and hinders the movement of the deer. Under these conditions shrubs become premium forage plants for deer because of their upstanding growth habit. Bitterbrush (Purshia tridentata) is the most important game browse in the region and is being given special attention in these studies.

General Accomplishments During Last Quarter

1. Fall 1954 and spring 1955 pilot plantings in Modoc and Lassen counties produced bitterbrush seedling stands averaging up to more than 9,000 seedlings per acre.

2. Seedling emergence from spring planting in depth-of-planting tests was later and much lower than from comparable fall plantings.

3. A new project initiated by the California Forest and Range Experiment Station provides for the cooperative study of the sprouting habit of bitterbrush by the University of California School of Forestry at Berkeley.

4. Project personnel met in August with representatives of the California and Nevada Departments of Fish and Game and the Toiyabe National Forest to get a first hand look at deterioration on the East Walker deer-winter range resulting from the invasion and increasing density of pinion pine.

5. During September project personnel served as supervisory overhead on forest fires which occurred on the Trinity, Klamath, and Los Padres National Forests.

6. Bitterbrush fruit was harvested during July and August for future field and laboratory tests.

The present report deals mainly with seedling establishment on large scale pilot plantings and seedling emergence from spring depth-of-planting tests.

Personnel

Robert F. Wagle joined the project on September 1 on a part-time basis to assist with morphological studies of bitterbrush. Wagle has a B. S. F. from the University of Minnesota and an M. F. from the University of Washington.

James E. Whitacre of San Diego, a junior in the School of Forestry at Berkeley, was appointed to the project on September 19 on a part-time basis to assist with germination studies and the compilation of research data. Whitacre holds a B. A. degree in political science from the University of California at Los Angeles.

Pilot Seedings of Bitterbrush

Pilot seedings of bitterbrush made on four different sides: Casuse Mountain and Flukey Spring in Modoc county and Red Rock and Hallelujah Junction in Lassen county, in the fall of 1954 and the spring of 1955 have demonstrated the feasibility of establishing bitterbrush on large scale deer winter ranges. The best stands were obtained from spring seedings on the Mear's burn in Modoc county where more than 9,000 seedlings per acre were obtained on cultivated seed beds. Satisfactory stands also resulted from plantings on the Casuse Mountain area in the heart of the Interstate deer-winter range. Fall seedings produced from 3,350 to 5,600 seedlings per acre. Fair to poor stands resulted from seeding without soil preparation on wild burned areas in Lassen county.

From 0.3 to 8.6 percent of the viable seeds planted produced seedlings in these trials. A statistical check of emergence shows no significant differences between the fall and spring plantings. Poisoning of the areas with 1080 prior to seeding gave variable and inconclusive results based on numbers of seedlings established.

All seedings were made with standard fluted-feed grain drills equipped with double disk openers. Rice hulls were mixed with the seed as a carrier to facilitate planting and give uniform seed distribution. Thiourea treated seed was used in all the spring plantings and the seedbeds were lightly firmed after planting. Depth of seeding was about 1 and 1 1/2 inches, respectively, for fall and spring planting.

Fluke: Spring

Two spring plantings 1 1/2 to 2 acres in size on the Mear's burn produced 8,350 and 9,260 seedlings per acre respectively. These stands represent establishment of 7.8 and 8.6 percent of the viable seed planted. Outside of small plot seedings within experimental exclosures these are the best stands of bitterbrush obtained thus far from any seeding.

The areas seeded were disk-plowed in the fall and harrowed just before planting in the spring. High quality seed was used. Soil preparation gave good tilth, reduced plant competition and permitted early planting to take advantage of moisture stored in the soil.

Casuse Mountain

Four areas, 30 feet by 100 feet, spring seeded in the heart of the Interstate deer-winter range produced bitterbrush seedling stands ranging from 3,350 to 5,600 seedlings per acre. The average stand, 4,800 seedlings per acre, represents 4.5 percent of the viable seed planted.

There was a 36 percent loss of seedlings from all causes between early May and late July. Much of this loss is believed due to insects, mostly cutworms and leaf miners, which were active during the early stages of seedling development.

Red Rock-Hallelujah Junction

Several 5 to 15 acre seedings on wild burns in the big sagebrush type produced up to 1,290 seedlings per acre (Table 1). The best stand, 1,290 seedlings per acre, was obtained from spring drilling on the Red Rock burn. Very poor stands resulted from both fall and spring seeding at Hallelujah Junction.

Not more than 3 percent of the viable seed planted developed into established seedlings on these areas. The low establishment was probably due to seed quality, 52 percent viability, and to sheet erosion in early summer. In mid-June heavy rains caused considerable soil movement which no doubt destroyed many young seedlings.

Table 1.--Bitterbrush seedling stands from pilot plantings in Lassen county

Location	Method of seeding	Time of seeding: Average number of seedlings per acre: Fall 1954	Spring 1955
Red Rock (burned 1954)	Drilled	340	125
	Drilled 1/	1,060	1,290
	Broadcast-rolled	850	--
Hallelujah Junction (burned 1953)	Drilled	435	180

1/ No rodent controls used. All other seedings poisoned with 1080 prior to seeding.

These plantings show that bitterbrush stands can be established by large scale field methods over a relatively wide range of conditions. Even under heavy rodent populations (April 1955 Quarterly Progress Report) satisfactory seedling establishment was obtained.

Spring 1955 Depth-of-planting Results

Results from spring 1955 planting thiourea treated bitterbrush seed at various depths differ in three ways from comparable fall 1954 plantings of untreated seed. First, the percent emergence was much lower; second, the seedlings emerged at a later date and third, at the Flukey Spring area, some emergence occurred from deeper depths.

The best emergence from spring planting, between 16.4 to 20.4 percent on the three areas, was from the 0.5- to 1.0-inch depths (Table 2). Highest emergence from fall planting, also from the 0.5- and 1.0-inch levels, ranged from 44.0 to 68.0 percent, or more than twice as high. Since this was the first year the thiourea treatment was used in the depth-of-planting tests, the data from previous years spring plantings cannot be used for comparison.

At the Flukey Spring area, emergence from spring planting occurred at the 0.5- to 2.5-inch depths. Fall planted seed did not emerge from depths greater than 1 1/2 inches. At the other areas there was no difference in the range of depths from which emergence occurred, between the fall and spring plantings.

On all areas spring planted seed emerged 2 to 3 weeks later than did the seed planted the preceding fall (Table 3). There was some overlap, but generally the spring planted seed began to emerge at about the time emergence was tapering off from the fall planted seed.

Table 2.--Emergence of bitterbrush seedlings from seed planted at specified depth 1/ fall 1954 and spring 1955

Experimental area and time of planting	Emergence where depth of planting (inches) was							
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	Percent							
Flukey Spring								
Fall 1954	44.0	37.8	8.4	0.0	0.0	0.0	0.0	0.0
Spring 1955	16.2	17.4	9.0	5.8	0.2	0.0	0.0	0.0
Doyle								
Fall 1954	44.0	56.8	16.4	0.6	0.0	0.0	0.0	0.0
Spring 1955	8.4	16.4	4.8	0.2	0.0	0.0	0.0	0.0
Wells Meadow								
Fall 1954	64.4	68.0	62.0	35.6	14.2	1.2	0.0	0.0
Spring 1955	20.4	16.0	5.4	5.4	1.4	0.4	0.0	0.0

1/ Based on 500 seeds per depth class

Table 3.--Time of bitterbrush seedling emergence from fall and spring plantings (percent of total emerged seedlings)

Dates of emergence	Flukey Spring	
	Planted 10/22/54	Planted 3/28/55
April 8, 1955	35.6	0.0
April 8 to 22, 1955	49.4	3.7
April 22 to May 2, 1955	8.4	21.6
May 2 to 10, 1955	6.0	39.6
May 10 to 17, 1955	0.4	10.2
May 17 to 19, 1955	0.2	6.1
May 19 to June 1, 1955	0.0	18.0
June 1 to 20, 1955	0.0	0.8
June 20 to July 7, 1955	0.0	0.0

Dates of emergence	Doyle	
	Planted 11/9/54	Planted 3/22/55
March 24, 1955	46.3	0.0
March 24 to 29, 1955	30.5	0.0
March 29 to April 14, 1955	18.2	0.0
April 14 to 17, 1955	3.1	41.6
April 17 to May 4, 1955	1.9	53.7
May 4 to June 22, 1955	0.0	4.7
June 22 to July 12, 1955	0.0	0.0

Dates of emergence	Wells Meadow	
	Planted 11/5/54	Planted 3/9/55
March 10, 1955	9.5	0.0
March 10 to 19, 1955	59.5	0.0
March 19 to 27, 1955	19.9	0.0
March 27 to April 8, 1955	7.2	9.8
April 8 to 23, 1955	0.9	13.9
April 23 to 30, 1955	2.4	2.0
April 30 to May 8, 1955	0.2	0.0
May 8 to 18, 1955	0.0	60.4
May 18 to 27, 1955	0.1	6.1
May 27 to June 4, 1955	0.1	4.9
June 4 to 11, 1955	0.0	2.9

Laboratory tests of thiourea treated seed showed 85 percent germination within 6 days (April 1954 Quarterly Progress Report). However, these tests were conducted under saturated moisture conditions, temperatures or length of day on thiourea treated seed. Any of these factors or perhaps others, may be the reason for the discrepancies between laboratory and field results.

Cooperative Aid Study

A fund of $1,000 has been made available by the California Forest and Range Experiment Station for research on the sprouting habits of bitterbrush. The study will be a cooperative aid project with the University of California School of Forestry at Berkeley, designed to determine whether sprouting in bitterbrush is a genetic characteristic or an effect of environmental factors.

Seed Collection

About 350 pounds of bitterbrush fruit were collected this year mostly on the Modoc National Forest. Several smaller collections were made by cooperators and project personnel over a wide range of site conditions.

Other special lots of seed received by the station this year are as follows:

1.	Bitterbrush (two species)	Gene Gerdes	Calif. Fish and Game
		Richard Weaver	Calif. Fish and Game
		Donald F. Hervey	Colorado A&M College
		Walter F. Mueggler	Intermountain Forest & Range Expt. Sta.
2.	Cliffrose	Richard Weaver	
3.	Curlleaf Mountain-mahogany	Donald F. Hervey	
4.	Ceanothus glorious	W. C. Malloch	Berkeley, Calif.
5.	Ceanothus griseus	W. C. Malloch	
6.	Ceanothus impressus	W. C. Malloch	
7.	Ceanothus papillosus	W. C. Malloch	
8.	Fourwing saltbush	Donald F. Hervey	
9.	Hopsage	Gene Gerdes	
10.	Koa haole	Bryce York	Northrup-King & Co. Bakersfield, Calif..

SUBMITTED BY
E. J. WOOLFOLK, Project Leader

By Famor C. Nord
Famor C. Nord

APPROVED BY
CALIFORNIA DEPARTMENT OF FISH AND GAME

By _____
Chief, Game Management Branch