(B1)

BIOLOGICAL ASSESSMENT OF 1983 WESTERN SPRUCE BUDWORM SUPPRESSION PROJECT

by

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INTRODUCTION

The first indication of the current western spruce budworm (WSBW), *Choristoneura occidentalis* Freeman outbreak in eastern Oregon was 2,300 acres of defoliation noted during the annual aerial detection survey in 1980 (McConnell et al 1980). In 1981, 310,000 acres of defoliation were mapped during the annual survey of eastern Oregon, a 130-fold increase over that detected in 1980. This prompted Forest Pest Management, National Forest, and State personnel to conduct an environmental analysis of the situation. The analysis indicated that 200,000 acres qualified for direct treatment with insecticides. Because of budget constraints, only 178,000 acres were treated in 1982. The aerial detection survey in July of 1982 indicated that the area defoliated had increased to over 1.5 million acres. Another environmental analysis was made in 1982-1983. The Environmental Assessment, which resulted from the analysis, proposed insecticide treatment of approximately 1.4 million acres of WSBW-infested mixed-conifer type and pine type on the Umatilla, Ochoco, Wallowa-Whitman, and Malheur National Forests and adjacent BLM, State, and private lands. The principal host species involved were Douglas-fir, grand fir, and white fir. During June and July 1983, a total of 524,561 acres were treated--501,994 acres were treated with carbaryl, 10,095 with mexacarbate, and 12,472 with *Bacillus thuringiensis (B.t.)*.

The objective of this project was to reduce WSBW populations so that they remain at nondamaging levels throughout the current outbreak period. A 14-day post treatment count of 1.5 larvae per branch or less was the level that we felt could accomplish this objective. Meeting this target was expected to allow achievement of the objective of this project.

In addition to the operational project, three units were treated to compare *B.t.* and mexacarbate with the standard carbaryl treatment and an untreated check area under Pacific Northwest conditions.

PROJECT AREA

Seventeen entomological units (EU's)[1/] were treated in 1983 in eastern Oregon on or adjacent to portions of the Umatilla and Malheur National Forests and adjacent intermingled BLM, State, and private lands (see Figures 1 through 15). The EU's on the Umatilla National Forest ranged in elevation from 3200 to 6500 feet. The EU's on the Malheur National Forest had an elevational range of 3500 to 7000 feet. All EU's contained a mixture of mixed-conifer stands, pine stands, and open meadows.

1/ An area distinctly separated from other areas where treatment or lack of treatment will not have an effect on WSBW in other areas.

Each EU was divided into spray blocks to insure uniformity of insect and foliage development when released for treatment. Each spray block had a maximum elevational range of about 1000 feet and varied in size from 5 to 9380 acres.

SAMPLING DESIGN AND PROCEDURES

Larval Development and Density

Larval development plot locations were selected to represent differences in elevation and aspect within a particular block. If an elevation and/or aspect was not represented by a plot within a block, larval development information from the nearest plot at or near the same elevation and aspect was used. Larval samples from these plots were also counted to determine if levels were high enough to justify treatment.

A plot consisted of two open-grown Douglas-firs or true firs, the midcrowns of which could be reached with a 14-foot polepruner equipped with a catchbasket. Two midcrown (14-16 feet from ground level) 45 cm apical branches were collected from opposite sides of each tree on each collection date. When possible, sample collections were made only once from any tree at a plot site. Samples were placed into paper bags and transported to the laboratory where they were held in a walk-in cooler until they could be examined. All larvae from each branch were collected and examined for density, instar, and species determination. The threshold for treatment was at least 3.5 larvae/branch. When at least 50 percent of the WSBW larvae from development plots representing a spray block were in the 4th instar or later and the new buds had unfurled, the block was released for treatment.

Prespray and Postspray Treatment Larval Population

1. Operational Project

One or more larval population evaluation plots were established for each 1500 acres, with at least one plot per block. The proportion of plots to acres for each EU varied from 1:150 to 1:1200.

A plot consisted of five open-grown trees (Douglas-fir or true fir), the midcrowns of which could be reached with a 14-foot polepruner equipped with a catchbasket.

Since percent mortality was not being used to measure treatment effectiveness, prespray samples just prior to treatment were not taken on 14 of the EU's. Postspray samples were collected 14 days after treatment. They consisted of two 45 cm midcrown, apical branches (one each from opposite sides) from each of the plot trees. All larvae and pupae from each sample branch, as well as those that had fallen into the catchbasket, were counted and recorded in the field.

2. Evaluation of *B.t.* and Mexacarbate

Three EU's and a check area were used to evaluate these insecticides. Pogue 1 was treated with carbaryl, the standard; Pogue 2 was treated with mexacarbate, and Pogue 3 was treated with *B.t.* (Figure 2). The check plots were established in an untreated area around these units.

A plot consisted of five open-grown trees (Douglas-fir or true fir), the midcrown of which could be reached with a 14-foot polepruner equipped with a catchbasket. Prespray samples were collected just prior to treatment. One 45 cm midcrown, apical branch was collected from each plot tree during the prespray sampling period. Care was taken so that larvae from other branches were not knocked into the catchbasket and that all larvae from each sample branch, as well as the branch itself, were caught in the catchbasket. Each sample branch and all larvae within the catchbasket were put into a separate paper bag and labeled. Samples were transported to the laboratory and stored in a walk-in cooler until they could be examined.

Postspray samples were collected 14 and 21 days after treatment. The purpose of the 21 day sample was to measure possible delayed mortality from *B.t.* They consisted of two 45 cm midcrown, apical branches (one each from opposite sides) from each of the five previously sampled plot trees. When possible, branches were clipped from above those collected during prespray sampling to lessen the chance of larvae having been dislodged from the postspray sample branches during the prespray collection period. All larvae and pupae from each sample branch, as well as those that had fallen into the catchbasket, were counted and recorded in the field.

INSECTICIDE APPLICATION

During this project, three insecticides were used. Sevin 4-Oil® was used over most of the area, while Thuricide 32LV® and Zectran DB® were applied to smaller areas and compared with a standard carbaryl treatment and an untreated check area to evaluate these two formulations.

Sevin 4-Oil® was mixed with diesel oil at a volume-to-volume ratio of 1:1 and applied at a rate of 1/2 gallon per acre (1 pound active ingredient/acre). This mixture was applied with helicopters equipped with either Beecomist® or flat fan spray nozzles. Both spray systems were calibrated to release spray droplets with a mass median diameter (MMD) of 140μ with Beecomist® and 190μ with flat fan nozzles.

Thuricide 32LV® was mixed with water at a volume-to-volume ratio of 1:1 and applied at a rate of 3/4 of a gallon per acre (12 Billion International Units per acre). The spray system was equipped with flat fan nozzles and calibrated to release droplets with a volume median diameter (VMD) of 180μ.

Zectran DB® was mixed with diesel oil at a volume-to-volume ratio of 1:9 and applied at a rate of 1 gallon per acre (.125 pound active ingredient per acre). The spray system was equiped with Beecomist® nozzles and calibrated to release droplets with an MMD of 100-130μ .

The size of application helicopters used on the project varied from a Bell 214 with an application rate of 1400 acres per hour to a Hiller 12E, which had an application rate of 350 acres per hour.

RESULTS

Larval Development and Density

Larval development was earlier and more rapid on the lower elevation EU's than on those at generally higher elevations. All insect development blocks were relased for treatment within a span of 19 days on the Umatilla National Forest and surrounding lands, as compared to a 30-day span on the Malheur National Forest and surrounding lands. The greater development span on the Malheur National Forest was caused by greater elevational differences there and the slower insect and tree development at the higher, cooler elevations.

Prespray samples just prior to treatment were taken only in the four areas used to evaluate mexacarbate and *B.t.* All other areas considered for treatment were qualified for treatment by early larval density estimates when they were predominantly in the third and fourth instar. The threshold for treatment was 3.5 larvae/branch. The average early instar larval density sample and range for each EU is shown in Table 1.

Table 1. Mean Larval Density/Branch and Ranges by Unit

Unit	Mean Population Density Larvae/Branch	Range
Miller Prairie 2	31.7	3.5-110.5
Miller Prairie 1	31.7	1.0-103.8
Matlock	34.6	3.0-114.5
Putney	25.6	2.3-82.3
Rudio Mtn.	16.5	1.8-37.3
P.A.	19.7	1.5-67.8
Pogue Point 1	15.8	8.5-87.5
Pogue Point 2	20.0	1.8-58.3
Pogue Point 3	12.4	1.5-36.0
Logan North	26.3	0.8-110.0
Logan South	14.8	1.8-60.8
Logan South 2	12.7	0.5-48.8
Butte	37.5	3.0-79.0
Aldrich	19.1	0.0-84.3
King	16.7	1.0-35.3
Snow	17.2	6.3-37.3
Pearson	24.1	3.5-53.8

Prespray and Postspray Larval Population

1. Operational Project

The postspray larval sampling showed residual populations ranging from 0.3 larvae per branch on the P.A. Unit to 3.1 on the Pearson Unit.

As noted in Table 2, four of the 14 EU's did not meet the target.

Table 2. Postspray Average Larvae/Branch by Unit, the Ranges, and Acreages

Unit	Treatment	14-Day Postspray (Range)	Acreage
Miller Prairie 2	carbaryl	0.8 (0.0-4.6)	41,136
Miller Prairie 1	carbaryl	1.0 (0.0-5.8)	75,434
Putney Mtn.	carbaryl	1.5 (0.0-7.9)	33,642
Rudio Mtn.	carbaryl	1.5 (0.0-11.1)	20,577
P.A.	carbaryl	0.3 (0.0-2.6)	17,560
Logan South 1	carbaryl	0.7 (0.0-5.5)	58,528
Logan South 2	carbaryl	0.6 (0.0-3.6)	35,259
Butte	carbaryl	0.9 (0.0-3.9)	5,596
King	carbaryl	1.3 (0.1-6.1)	16,376
Snow	carbaryl	1.3 (0.0-7.4)	4,950
Aldrich	carbaryl	1.7 (0.0-9.1)*	88,577
Matlock	carbaryl	1.9 (0.0-12.6)*	61,174
Logan North	carbaryl	2.1 (0.0-8.3)*	8,010
Pearson	carbaryl	3.1 (0.0-14.8)*	20,436

*EU's not meeting the 1.5 larvae/branch target

2. Comparison of Carbaryl, Mexcarbate, and *B.t.*

None of the three small-scale evaluation units designated to compare carbaryl, mexacarbate, and *B.t.* met the Project target of an average of 1.5 larvae/branch or less.

Prespray and postspray larval densities are summarized in Table 3. Table 4 shows the relative population reduction by the three materials.

Table 3. Pre- and Postspray Average Larvae/Branch by Unit and the Ranges

Unit	Treatment	Prespray (Range)	14-Day Postspray (Range)	21-Day Postspray (Range)
Pogue Point 1	carbaryl	21.6 (9.8-44.8)	2.7 (0.1-11.5)	1.6 (0.1-6.2)
Pogue Point 2	mexacarbate	26.1 (7.6-46.6)	2.9 (0.1-7.6)	2.4 (0.1-9.7)
Pogue Point 3	B.t.	10.8 (1.8-34.0)	3.3 (0.5-9.1)	2.1 (0.4-6.3)
Check	untreated	13.1 (1.4-40.8)	6.9 (0.6-21.9)	4.9 (0.8-19.1)

Table 4. Percent Uncorrected Mortality (and Corrected Mortality[1/]) for the Pogue Point Units

Unit	14 days	21 days
Pogue Point 1	87 (76)	93 (81)
Pogue Point 2	89 (79)	91 (75)
Pogue Point 3	69 (42)	81 (48)
Check	47	63

1/ Abbott's formula used to correct treatment mortality for natural mortality.

DISCUSSION

Larval Development

Larval development was quite variable between the spray blocks in the southern treatment units with the release of blocks for treatment being spread over 30 days. These time spans were expected to be longer than those of the northern units (19 days) because of the greater elevational ranges of the southern units. However, they were not expected to be as long as they were. This was due in part to the cool and rainy weather experienced in the area during late June and July after the northern units had been treated.

Larval Population Density

Prior to 1983, the target density was expressed as larvae/100 buds. This was based on work by Carolin and Coulter 1972. In 1983, the target density was expressed as larvae/branch, and was also based on Carolin and Coulter (1972). By using larvae/branch, one does not have to count buds and eliminates questions concerning which buds to count. The result is the same, but the latter method speeds up lab and field work and reduces potential for error.

Postspray larval population densities for 10 of the 14 EU's in which only carbaryl was used were at or below the density threshold of 1.5 larvae/branch. Budworm populations in these areas are expected to remain at nondamaging levels throughout the current outbreak period.

Considerable variability existed between sample plots in most of the units. An analysis of the plots with $\leq$1.5 larvae/branch and plots with $>$1.5 larvae/branch showed that the average densities on plots with 1.5 or less larvae ranged from 0.2 to 0.8 larvae/branch. However, the average densities on the plots with more than 1.5 larvae ranged from 2 to 5 larvae/branch. These densities were similar to those of plots in untreated areas. This suggests that plot densities above the threshold level were due to problems in insecticide application and not poor insecticide efficacy.

Postspray larval densities in the remaining four units, while much reduced, did not meet the threshold of 1.5 larvae per branch. While it is not known what these populations will do throughout the remainder of the current outbreak, at least some resurgence may occur in the areas of poor treatment.

All treated areas will be monitored until budworm populations in surrounding untreated areas collapse. This monitoring will involve annual sampling within treated areas to estimate budworm population densities and/or host-tree defoliation intensities. This information will be augmented by that gained from the annual aerial forest insect detection survey.

Carbaryl, mexacarbate, and *B.t.* have been effective in the past in reducing western spruce budworm populations. However, postspray larval densities in all three evaluation areas in the Pogue Point Units, while much reduced, did not meet the threshold of 1.5 larvae per branch.

As with the operational portion of the project, the carbaryl and mexacarbate units had considerable variability between sample plots. The results suggest inadequate treatment.

Population reduction in the areas treated with carbaryl and mexacarbate were essentially the same. In the area treated with *B.t.*, the variation between plots was less, but the percent mortality was also lower. This could be due to a more uniform spray application, but reduced efficacy or delayed mortality which was not measured.

ACKNOWLEDGEMENTS

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LITERATURE CITED

Carolin, J. M. and W. K. Coulter. 1972. Sampling Population of Western Spruce Budworm and Predicting Defoliation on Douglas-fir in Eastern Oregon. USDA For. Serv. Res. Pap. PNW-149, 38 p. Pac. Northwest For. and Range Exp. Stn., Portland, OR.

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4/4/84
Date

Figure 1.

1983 WESTERN SPRUCE BUDWORM CONTROL PROJECT ENTOMOLOGICAL UNITS

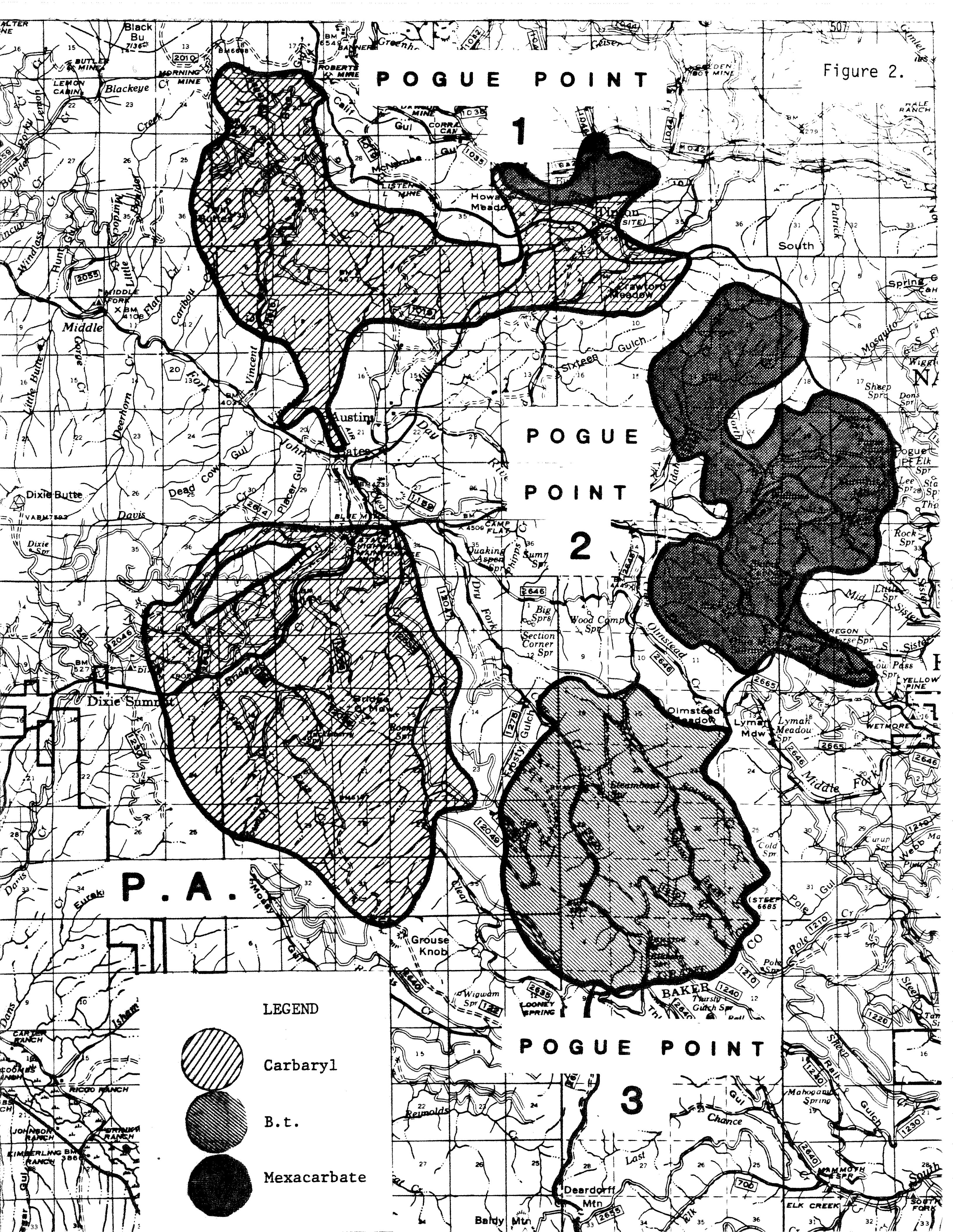
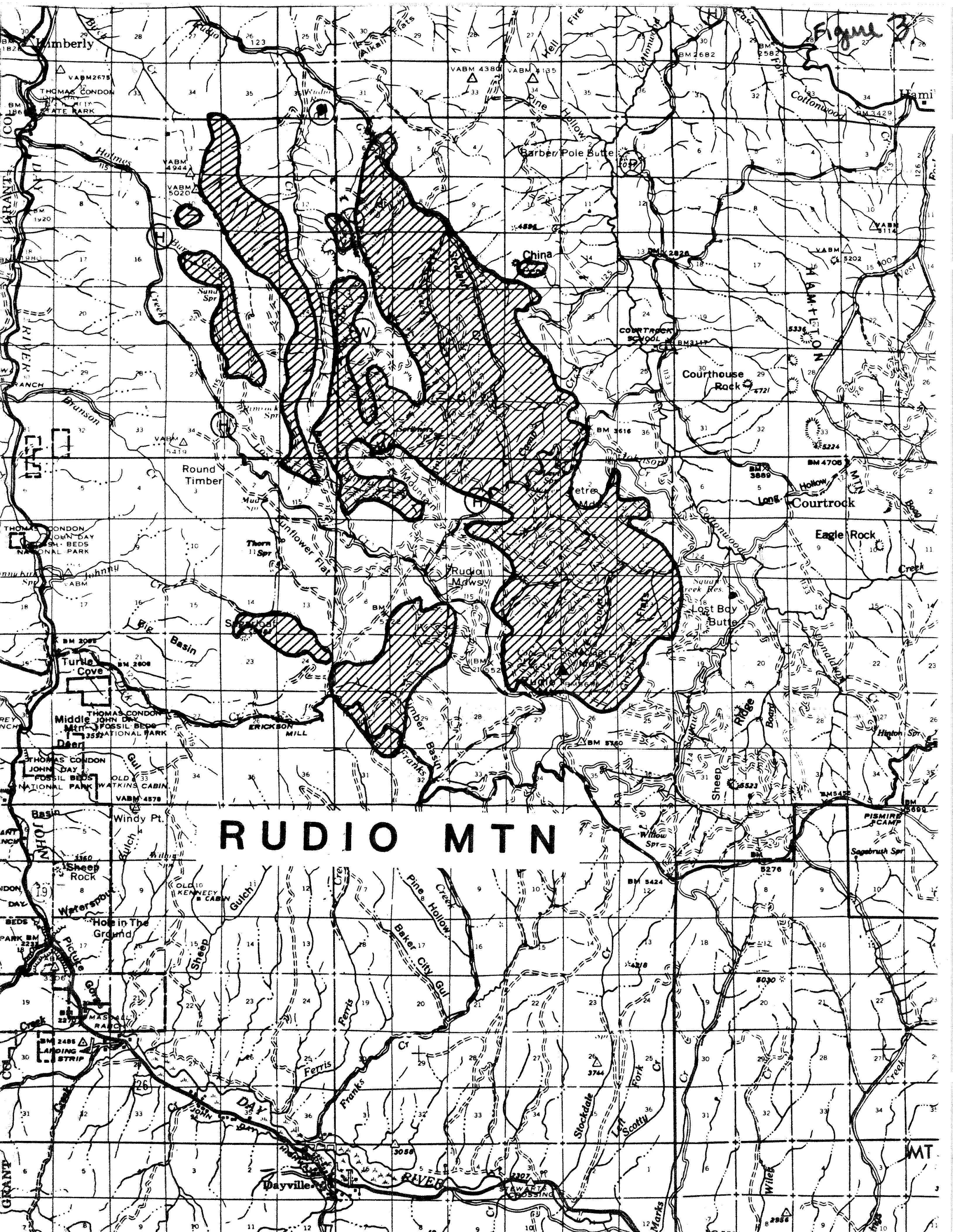


Figure 2.
POGUE POINT 1
POGUE POINT 2
POGUE POINT 3
P.A.
LEGEND
Carbaryl
B.t.
Mexacarbate



RUDIO MTN
Kimberly
Thomas Condon John Day State Park
Barber Pole Butte
China
Courtrock School
Courthouse Rock
Round Timber
Courtrock
Eagle Rock
Rudio Mdws
Lost Boy Butte
Turtle Cove
Middle Mtn
Erickson Mill
Thomas Condon John Day Fossil Beds National Park
Windy Pt.
Sheep Rock
Hole in The Ground
Picture Gorge
Dayville
Stewart Crossing
Pismire Camp
Sagebrush Spr
Hinton Spr
Sheep Ridge
Baker City Gul
Pine Hollow
Franks Cr
Ferris Cr
Stockdale
Scotty
Big Basin
Sunflower Flat
Hamilton Mtn
John Day River
Grant Co

Figure 3

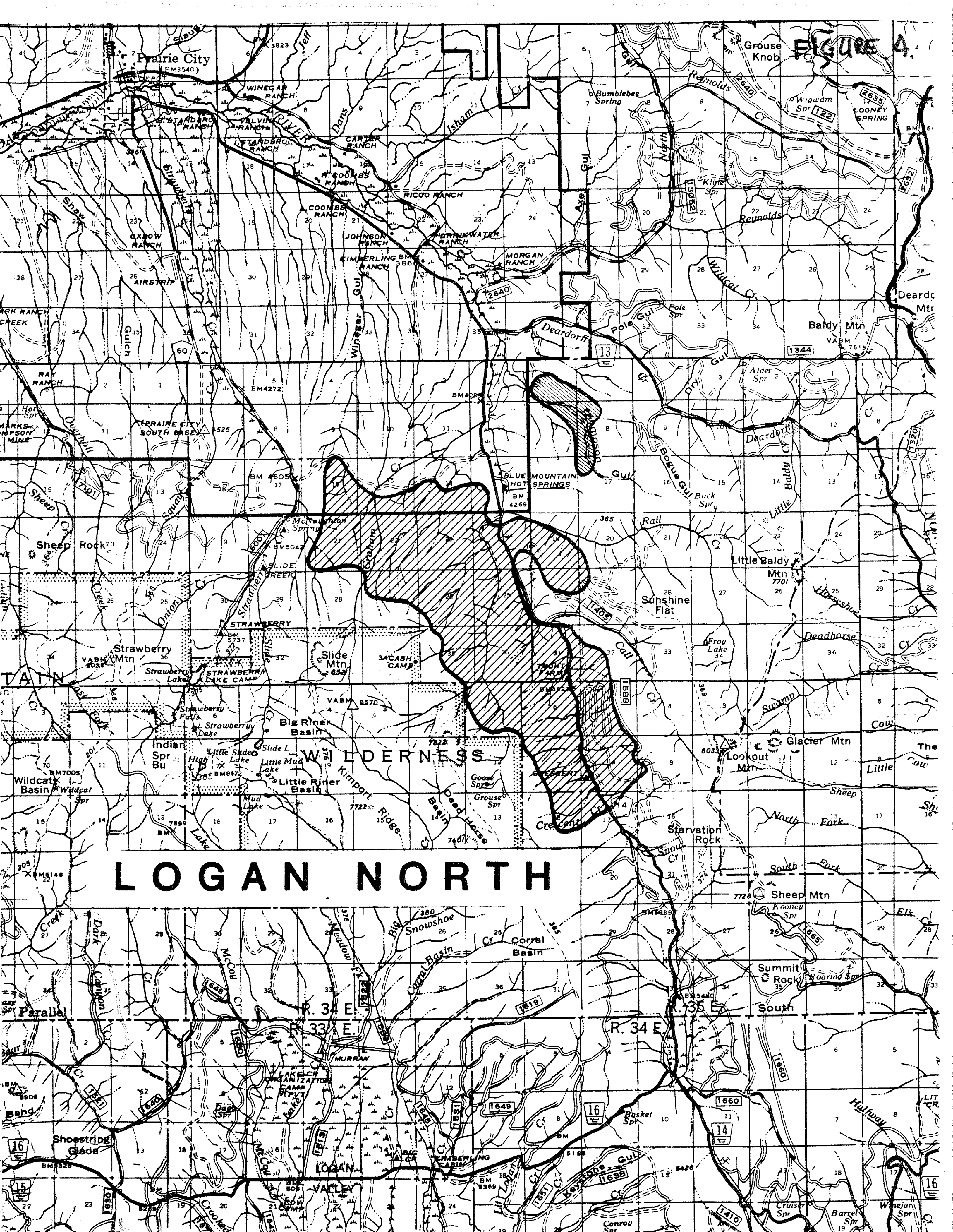
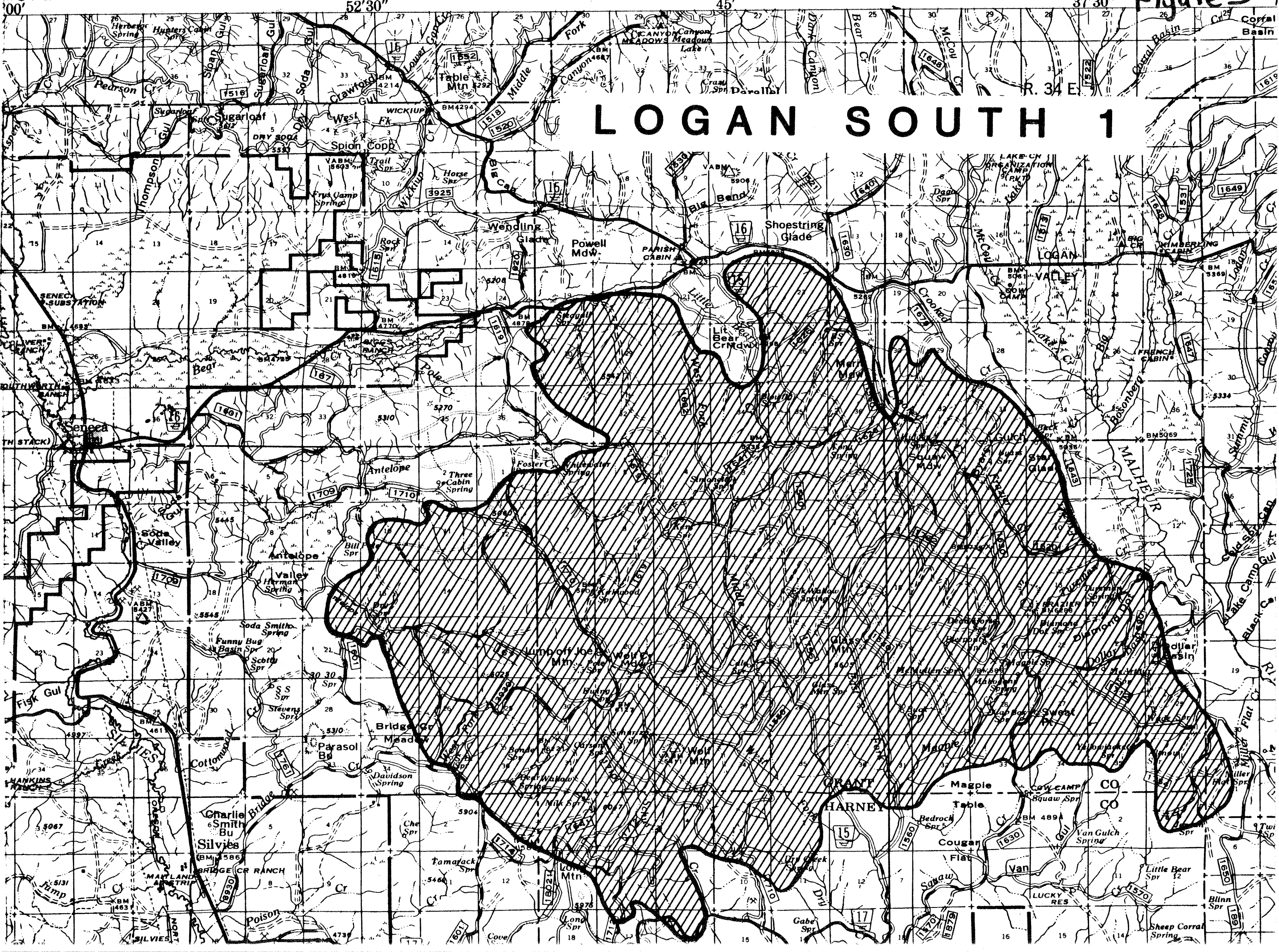


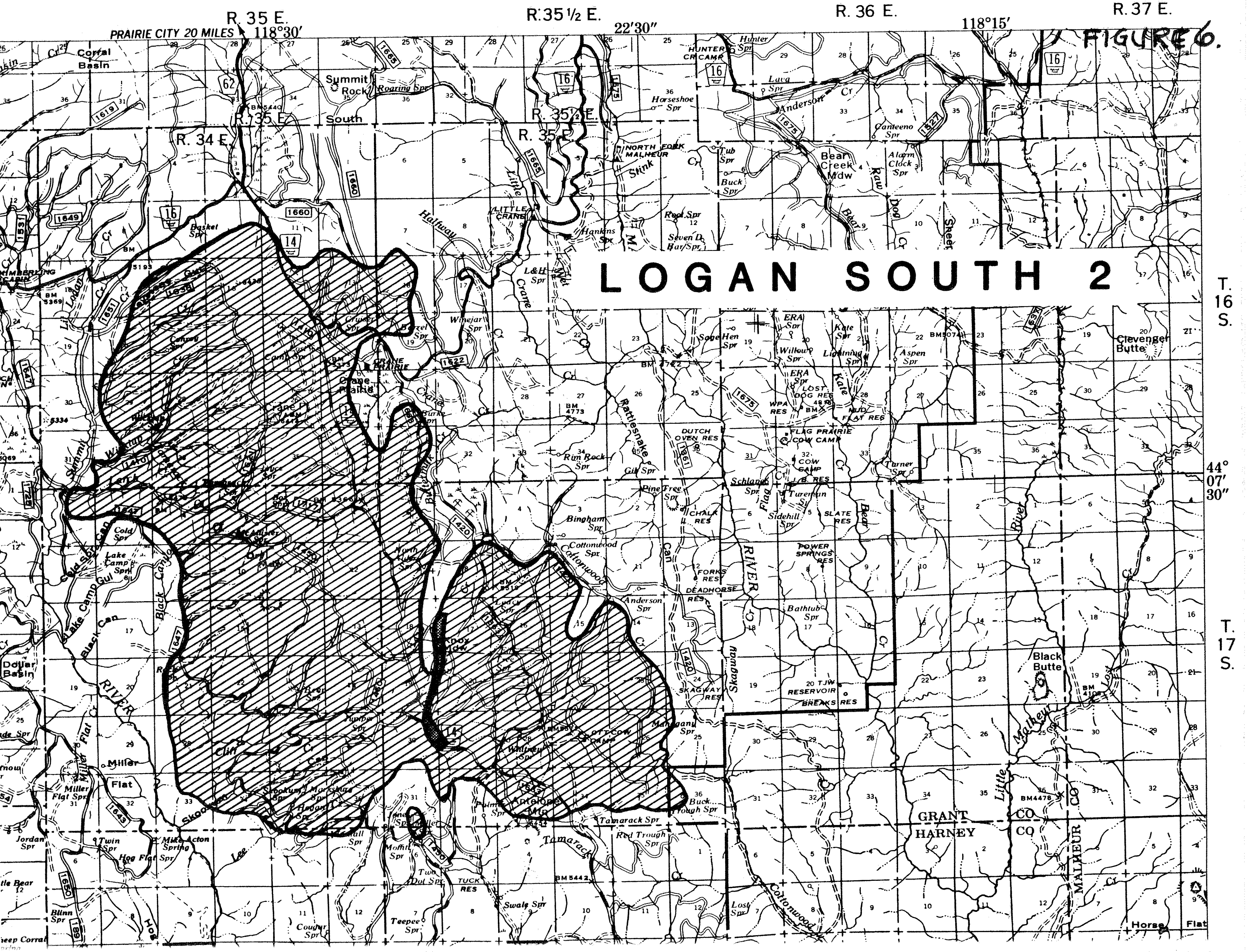
FIGURE 4.
LOGAN NORTH
Prairie City
Grouse Knob
WINEGAR RANCH
STANDBRO RANCH
VELVIN RANCH
CARTER RANCH
COOMBS RANCH
RICCO RANCH
JOHNSON RANCH
DRINKWATER RANCH
KIMBERLING RANCH
MORGAN RANCH
OXBOW RANCH
AIRSTRIP
Bumblebee Spring
Wigwam Spr
LOONEY SPRING
Kline Spr
Reynolds Cr
Wildcat Cr
Pole Gul
Pole Spr
Baldy Mtn
Deardorff Cr
Alder Spr
RAY RANCH
PRAIRIE CITY SOUTH BASE
BLUE MOUNTAIN HOT SPRINGS
Buck Spr
Rail Cr
Little Baldy Mtn
Sunshine Flat
Sheep Rock
McNaughton Spring
SLIDE CREEK
STRAWBERRY
Strawberry Mtn
Slide Mtn
CASH CAMP
Strawberry Lake
STRAWBERRY LAKE CAMP
Strawberry Falls
L. Strawberry Lake
Big River Basin
Indian Spr Bu
Slide L
Little Slide Lake
Little Mud Lake
Little River Basin
Mud Lake
WILDERNESS
Kimport Ridge
Dead Horse Basin
Goose Spr
Grouse Spr
Crescent Cr
Frog Lake
Deadhorse Cr
Swamp Cr
Glacier Mtn
Lookout Mtn
Starvation Rock
Snow Cr
Sheep Mtn
Kooney Spr
Elk Cr
Summit Rock
Roaring Spr
Wildcat Basin
Corral Basin
Big Snowshoe
Meadow Fk
McCoy Cr
Parallel
R. 34 E.
R. 33 E.
R. 35 E.
MURRAY
LAKE CR ORGANIZATION CAMP (PVT)
Shoestring Glade
Basket Spr
KIMBERLING CABIN
LOGAN VALLEY
COW CAMP
Keystone Gul
Conroy Spr
Cruiser Spr
Barrel Spr
Halfway

Figure 5



R. 31 E.
R. 32 E.
52'30"
R. 33 E.
45'
R. 34 E.
37'30"
LOGAN SOUTH 1
R. 34 E.
LOGAN VALLEY
MALHEUR
Seneca
Soda Valley
Antelope Valley
Silvies
Shoestring Glade
Powell Mdw
Wendling Glade
Big Bend
Jump-off Joe Mtn
Wolf Mtn
Glass Mtn
Magpie Table
Cougar Flat
GRANT
HARNEY
CO
CO
Middle Fork
West Fork
Bridge Cr Meadow
Parasol Bu
Charlie Smith Bu

FIGURE 6.


LOGAN SOUTH 2
R. 35 E.
R. 35 1/2 E.
R. 36 E.
R. 37 E.
R. 34 E.
118°30′
22′30″
118°15′
T. 16 S.
T. 17 S.
44° 07′ 30″
PRAIRIE CITY 20 MILES
Summit Rock
Corral Basin
Clevenger Butte
Black Butte
Crane Prairie
GRANT
HARNEY
MALHEUR CO
RIVER
Skagway
Cottonwood
Rattlesnake
Miller Flat
Dollar Basin

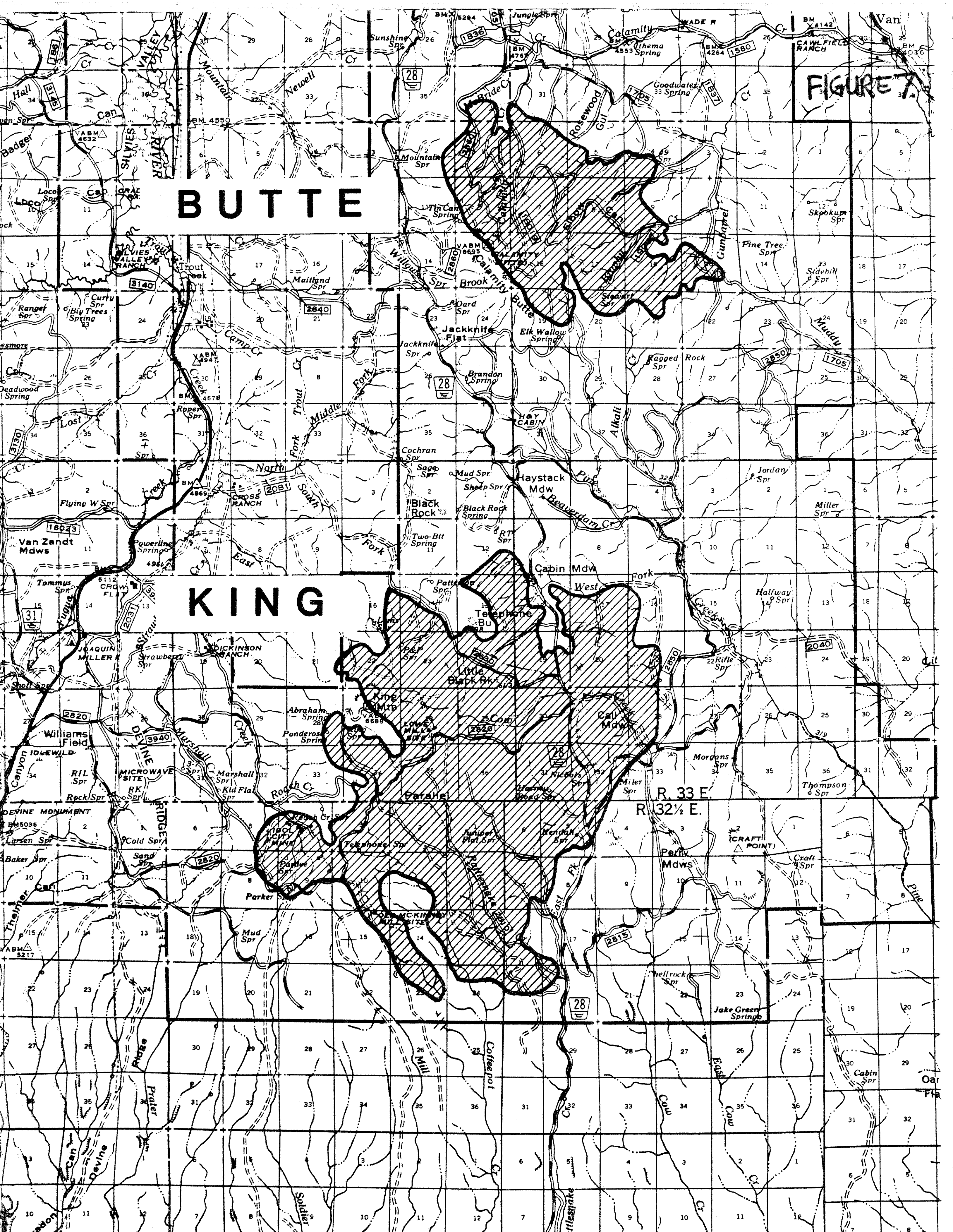
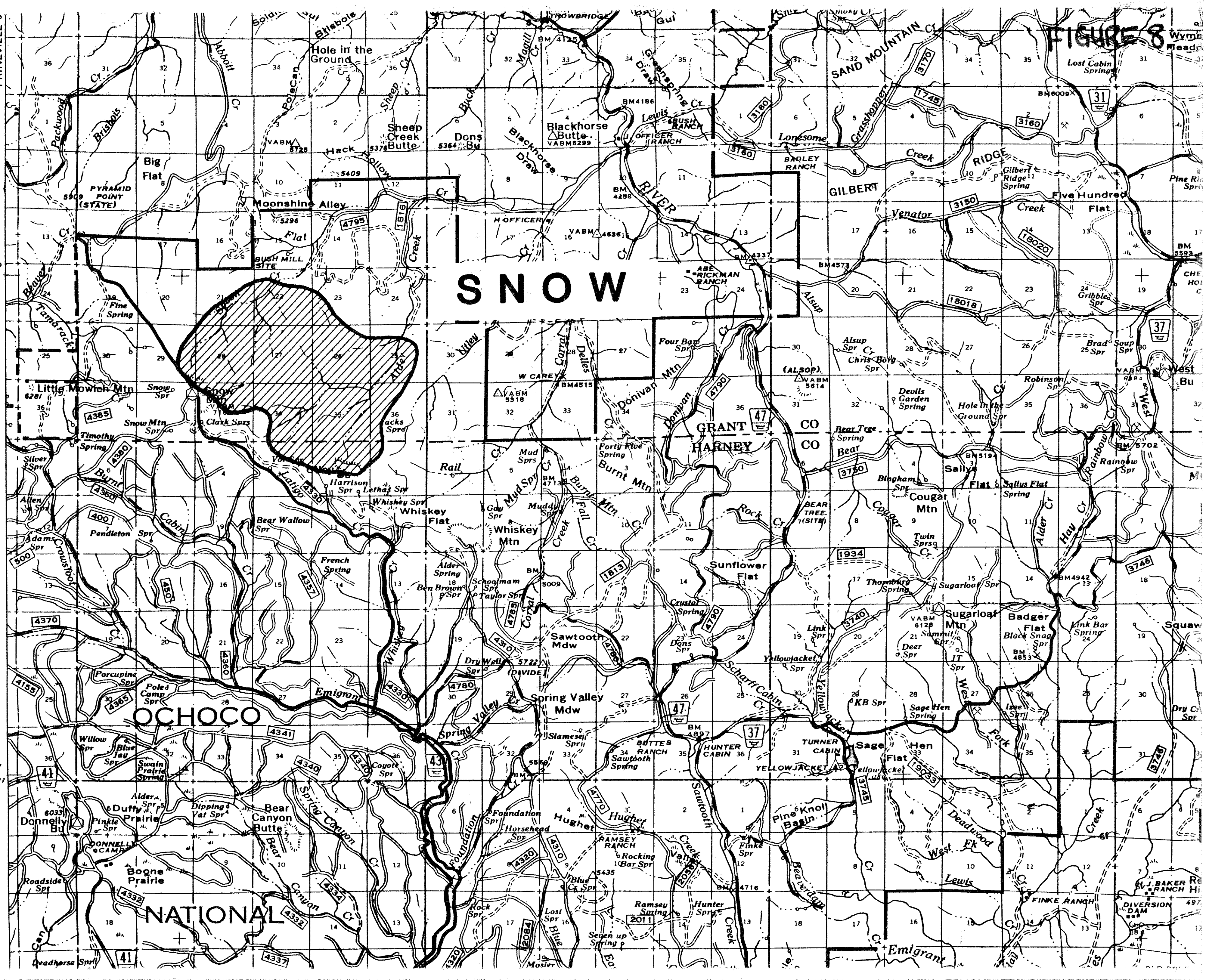

BUTTE
KING
R. 33 E.
R. 32½ E.
Calamity Butte
Jackknife Flat
Haystack Mdw
Black Rock
Cabin Mdw
Telephone Bu
Little Black Rk
King Mtn
Call Mdw
Parallel
Perry Mdws
Williams Field
Van Zandt Mdws
Trout Creek
Silvies River
Devine Ridge
Idlewild
Joaquin Miller
Crow Flat
Dickinson Ranch
Cross Ranch
Cawlfield Ranch
Calamity
Sunshine Spr
Mountain Spr
Tin Can Spring
Maitland Spr
Brandon Spring
Elk Wallow Spring
Ragged Rock Spr
Pine Tree Spr
Goodwater Spring
Thema Spring
Jordan Spr
Miller Spr
Halfway Spr
Rifle Spr
Morgans Spr
Thompson Spr
Craft Spr
Jake Green Spring
Cabin Spr
Idol City Mine
Parker Spr
Pardee Spr
Telephone Spr
Juniper Flat Spr
Kendall Spr
Nichols Spr
Abraham Spring
Ponderosa Spring
Lower Mills Site
McKinney Mill Site
Mud Spr
Two-Bit Spring
Cochran Spr
Sage Spr
Mud Spr
Sheep Spr
Black Rock Spring
Patterson Spr
P&P Spr
Strawberry Spr
Marshall Spr
Kid Flat Spr
Microwave Site
Devine Monument
Cold Spr
Sand Spr
Baker Spr
Larsen Spr
Rock Spr
RK Spr
RIL Spr
Shell Spr
Tommus Spr
Powerline Spring
Flying W Spr
Roper Spr
Curry Spr
Big Trees Spring
Ranger Spr
Deadwood Spring
Loco Spr
Skookum Spr
Sidehill Spr
Stewart Spr
Craft Point
Rosewood Gul
Gunbarrel
Beaverdam Cr
Alkali Cr
Muddy
Mill Cr
Coffeepot Cr
Rattlesnake Cr
Prater
Soldier
Devine Can
Thelmer Can
Cow Cr
East Cow Cr
Camp Cr
Willow Spr Brook
Roach Cr
Marshall Cr
Fugue
Lost Cr
Newell Cr
Mountain Cr
Hall Can
Badger

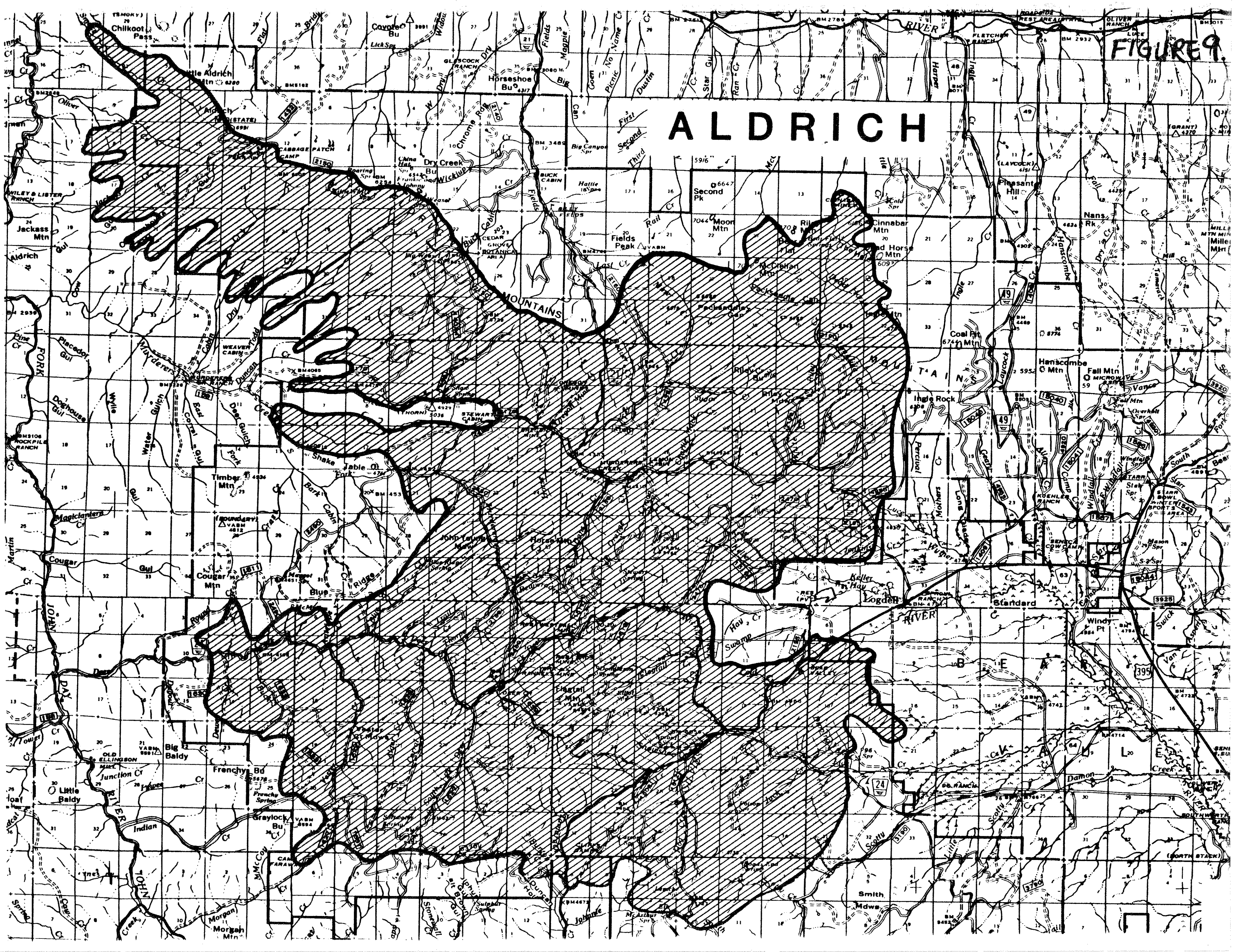
FIGURE 7.



PRINEVILLE 9
T. 18 S.
44° 00′
T. 19 S.
52′ 30″
T. 20
SNOW
OCHOCO
NATIONAL
SAND MOUNTAIN
GILBERT
RIDGE
RIVER
GRANT CO
HARNEY CO
Hole in the Ground
Big Flat
Moonshine Alley
Little Mowich Mtn
Whiskey Flat
Whiskey Mtn
Burnt Mtn
Donivan Mtn
Sunflower Flat
Cougar Mtn
Sugarloaf Mtn
Badger Flat
Spring Valley Mdw
Sawtooth Mdw
Sage Hen Flat
Bear Canyon Butte
Duffy Prairie
Boone Prairie
Blackhorse Butte
Sheep Creek Butte
Five Hundred Flat

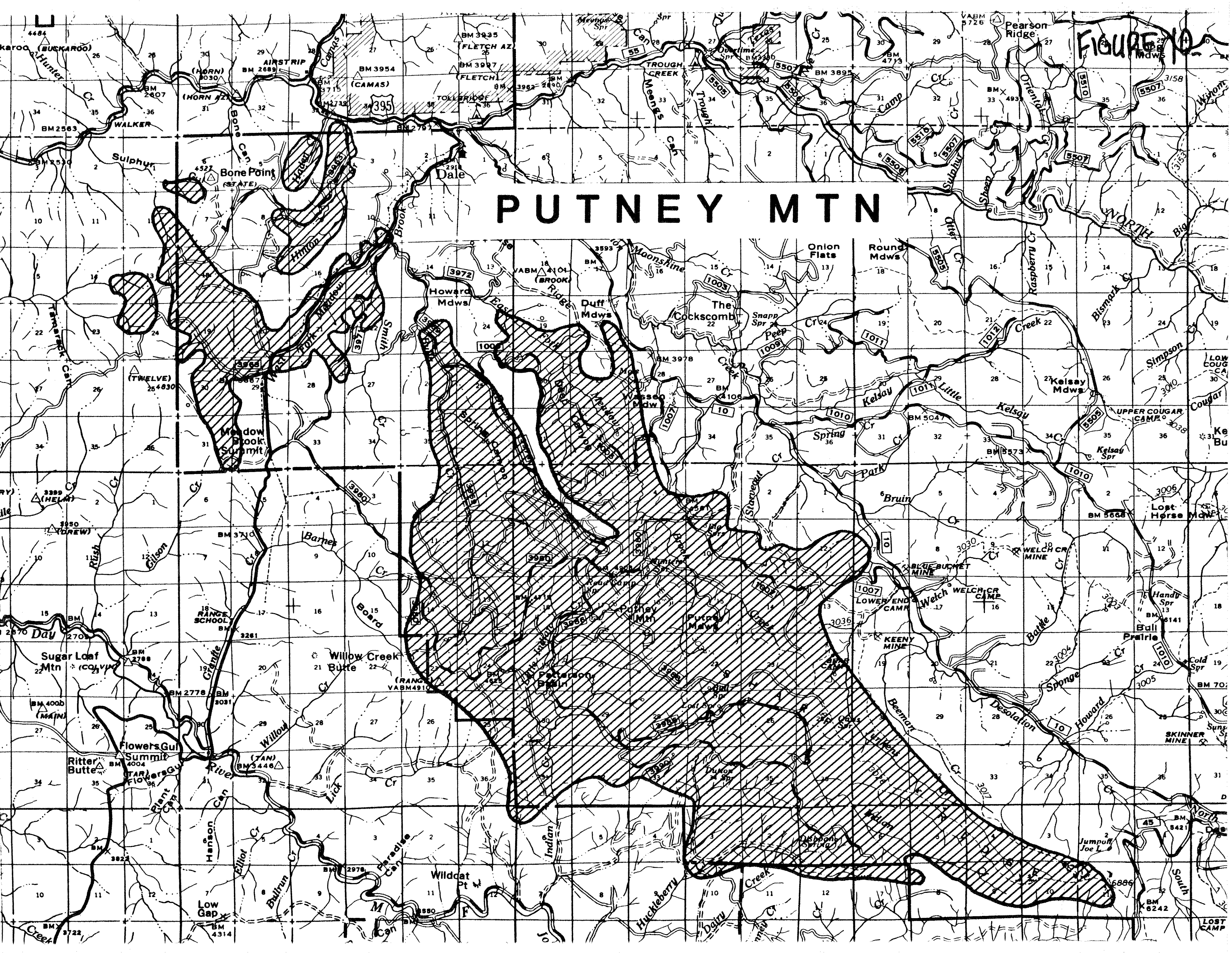
FIGURE 8

FIGURE 9.



ALDRICH
MOUNTAINS
Chilkoot Pass
Little Aldrich Mtn
Aldrich
Jackass Mtn
Second Pk
Moon Mtn
Fields Peak
Cinnabar Mtn
Coal Pit Mtn
Hanscombe Mtn
Fall Mtn
Ingle Rock
Pleasant Hill
Nans Rk
Timber Mtn
Cougar Mtn
Big Baldy
Little Baldy
Frenchy Bu
Graylock Bu
Morgan Mtn
Smith Mdws
Windy Pt
Standard
Logden
Horseshoe Bu
Coyote Bu
Dry Creek Bu
JOHN DAY RIVER
FORK
BEAR VALLEY

FIGURE 10



PUTNEY MTN
Dale
Bone Point
Howard Mdws
Duff Mdws
The Cockscomb
Onion Flats
Round Mdws
Kelsay Mdws
Pearson Ridge
Putney Mtn
Putney Mdws
Patterson Basin
Willow Creek Butte
Sugar Loaf Mtn
Ritter Butte
Flowers Gul Summit
Meadow Brook Summit
Wildcat Pt
Low Gap
Lost Horse Mdw
Bull Prairie
UPPER COUGAR CAMP
LOWER END CAMP
WELCH CR CAMP
WELCH CR MINE
BLUE BUCKET MINE
KEENY MINE
SKINNER MINE
RANGE SCHOOL
TROUGH CREEK
AIRSTRIP
Jumpoff Joe L
395

FIGURE 11

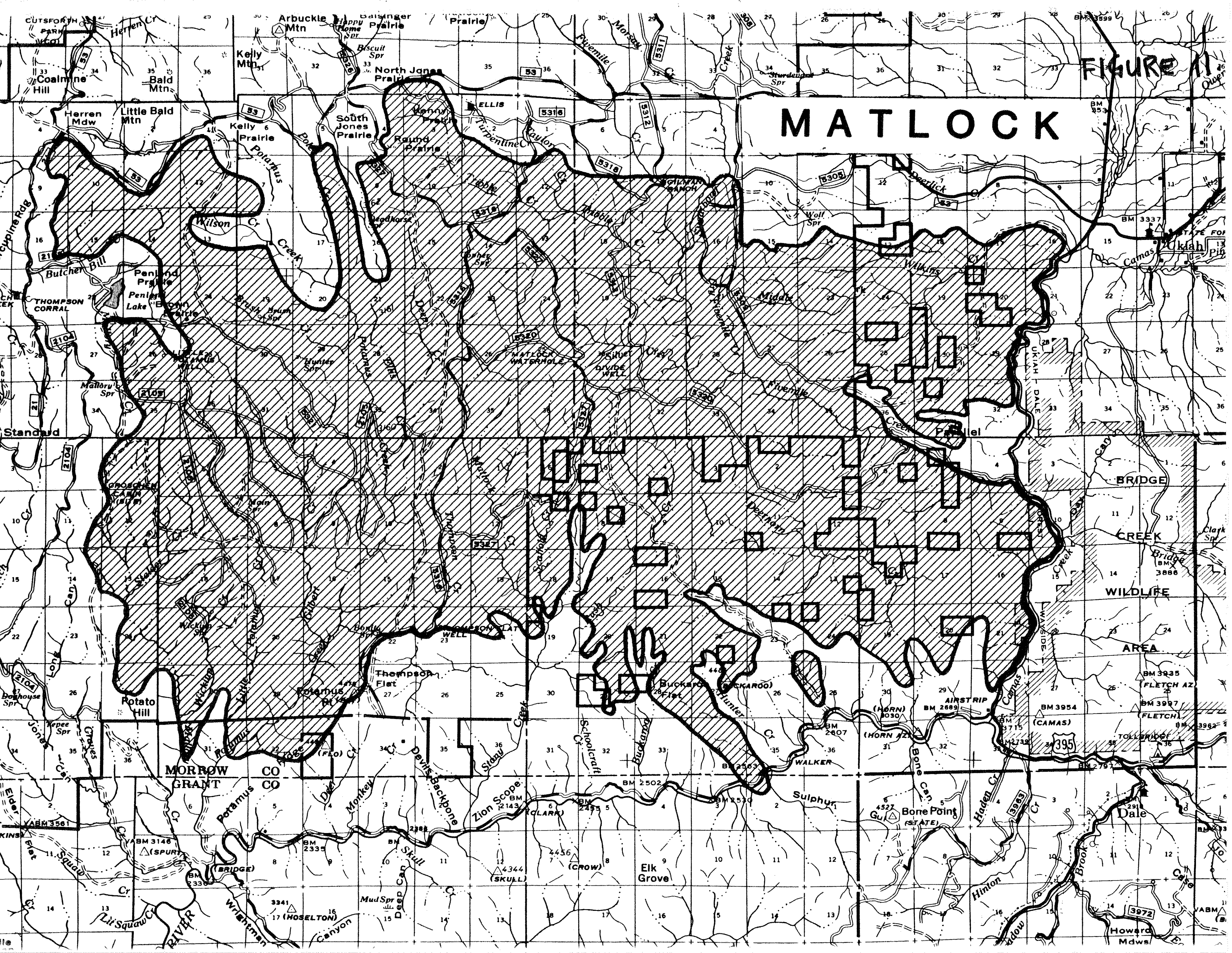

MATLOCK
MORROW CO
GRANT CO
BRIDGE CREEK WILDLIFE AREA
Ukiah
Dale
Potato Hill
Standard
Elk Grove
Bone Point
Thompson Flat
Buckaroo Flat
Penland Prairie
Penland Lake
Kelly Prairie
Round Prairie
South Jones Prairie
North Jones Prairie
Devils Backbone
Zion Scope
Potamus Cr
Wilson Creek
Fivemile Creek
Matlock Waterhole
Divide Well
Little Bald Mtn
Kelly Mtn
Arbuckle Mtn
Herren Mdw
Coalmine Hill
Thompson Corral
Sulphur
Howard Mdws

FIGURE 12

MILLER PRAIRIE 1 (N)

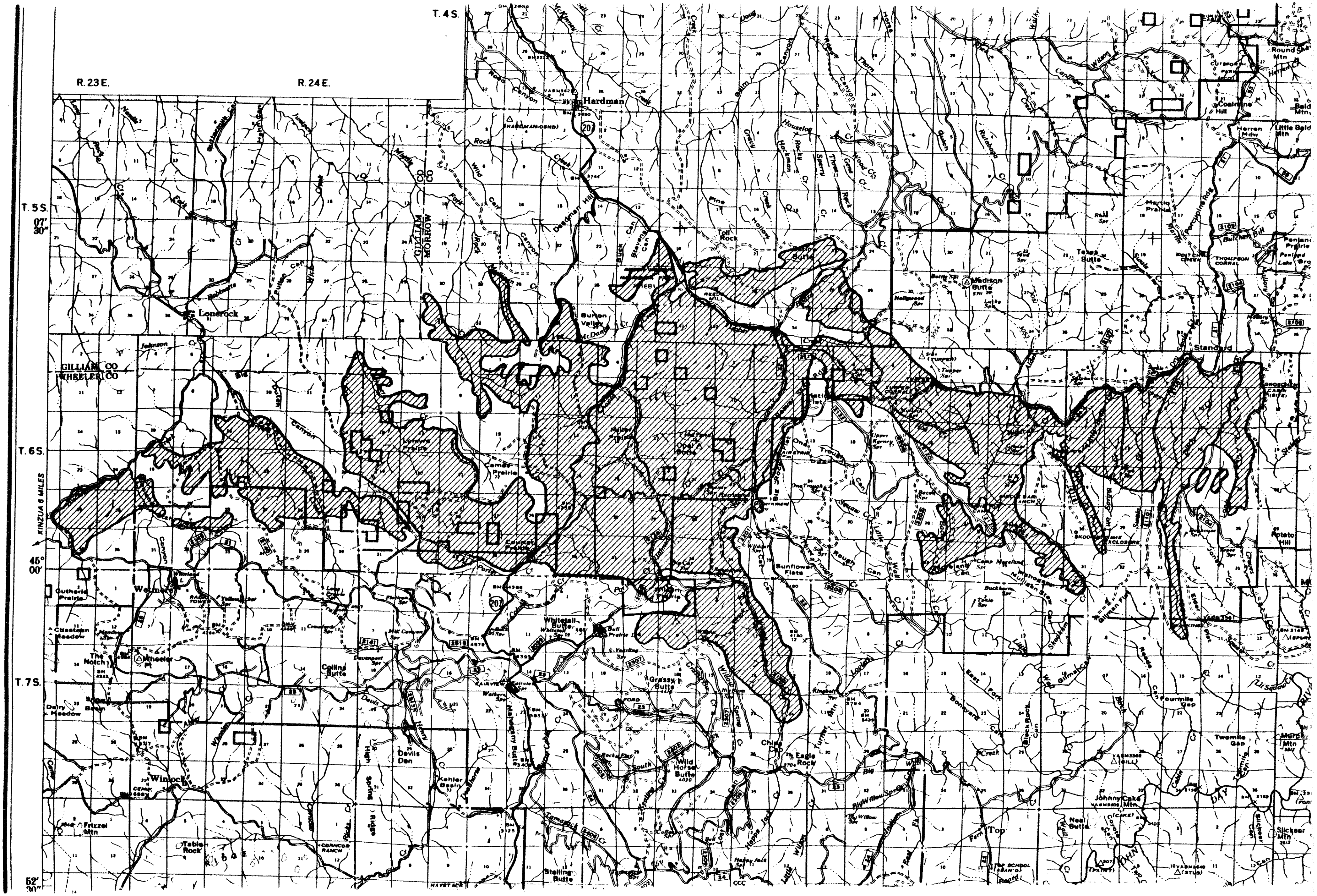


FIGURE 13

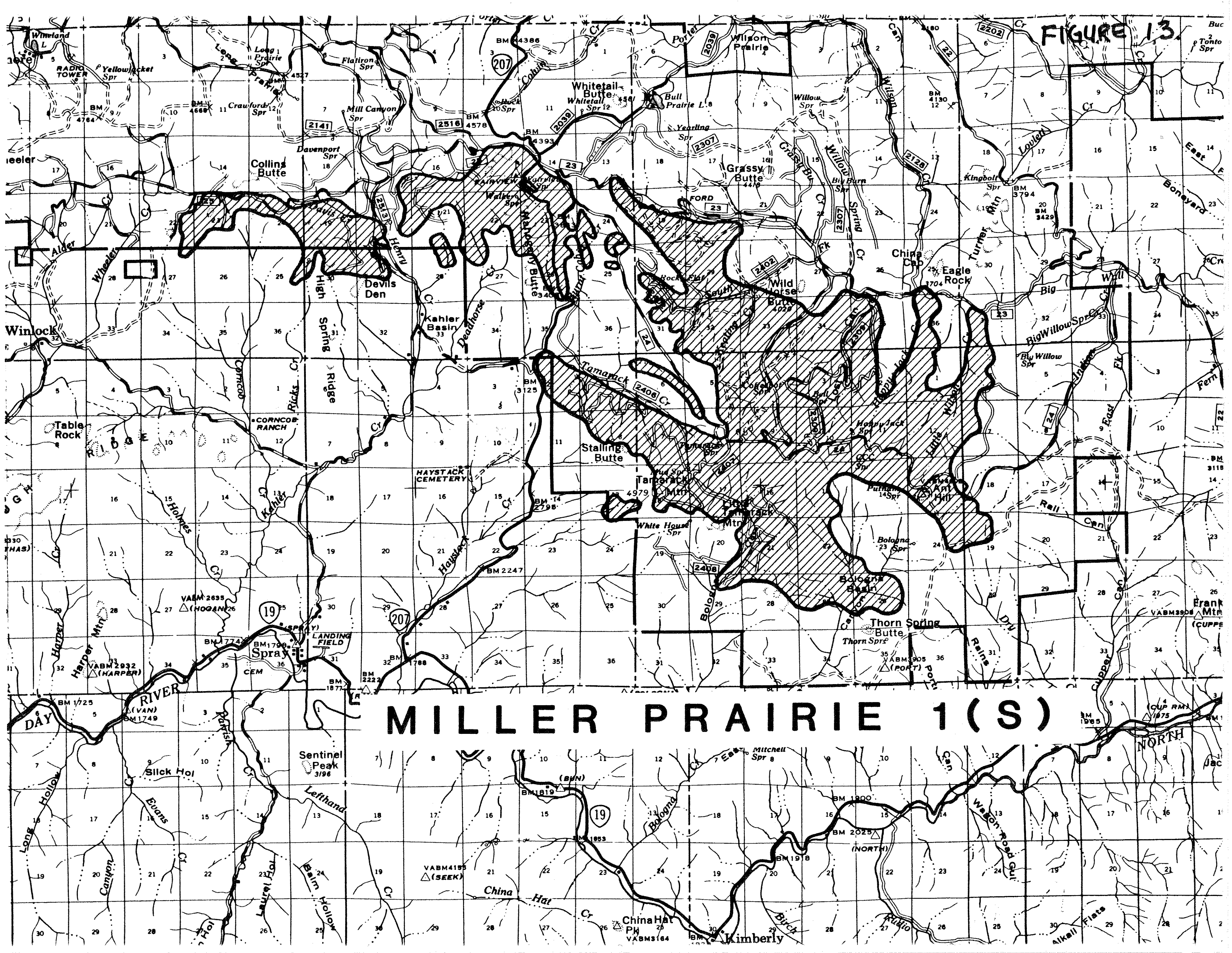

MILLER PRAIRIE 1(S)
Wilson Prairie
Whitetail Butte
Bull Prairie L.
Collins Butte
Grassy Butte
Wild Horse Butte
China Cap
Eagle Rock
Turner Mtn
Mahogany Butte
Devils Den
High Spring Ridge
Kahler Basin
Stalling Butte
Tamarack Mtn
Bologna Basin
Thorn Spring Butte
Table Rock
Winlock
Haystack Cemetery
Corncob Ranch
Spray
Landing Field
Sentinel Peak
Day River
Kimberly
China Hat Pk
Frank Mtn

FIGURE 14.

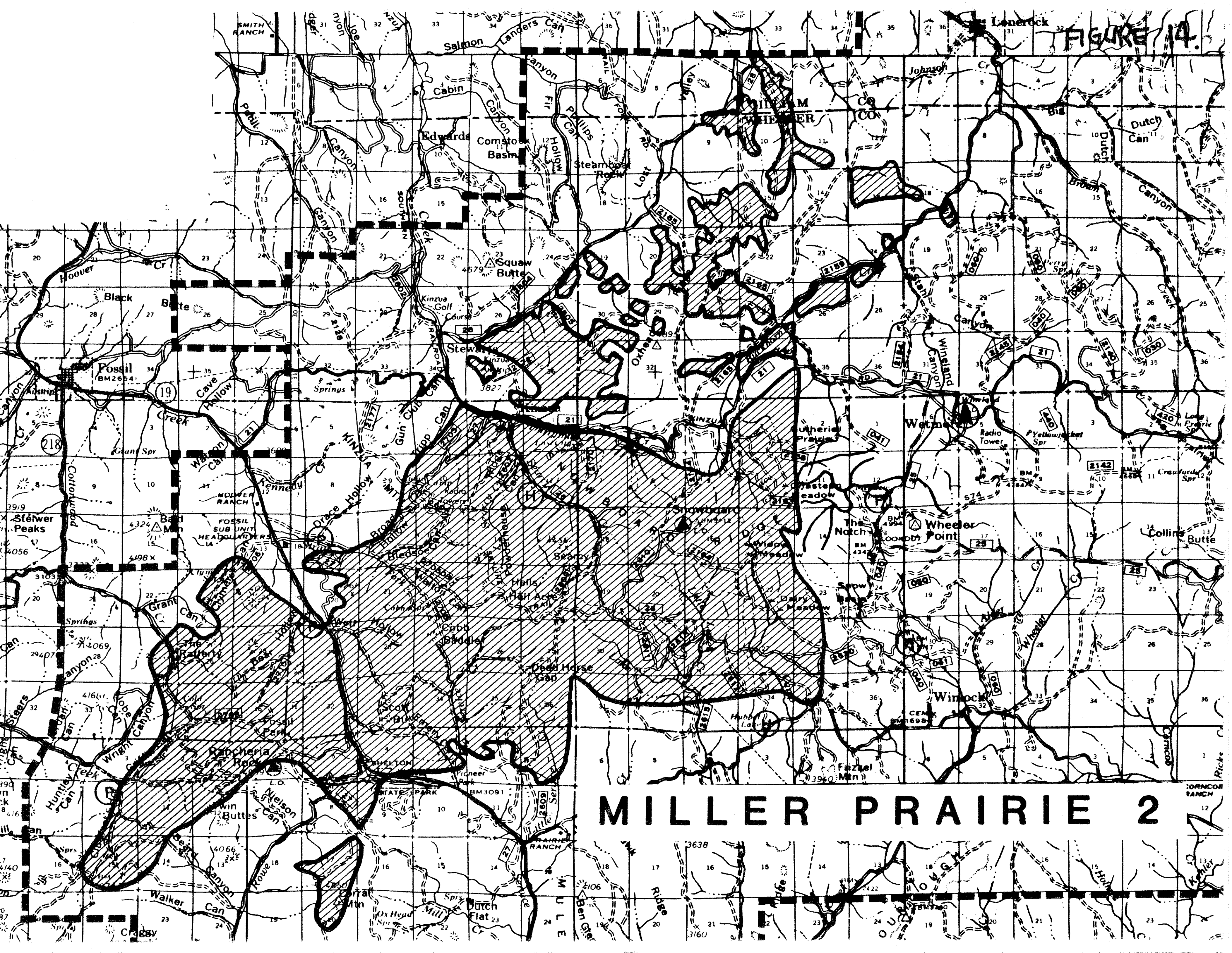
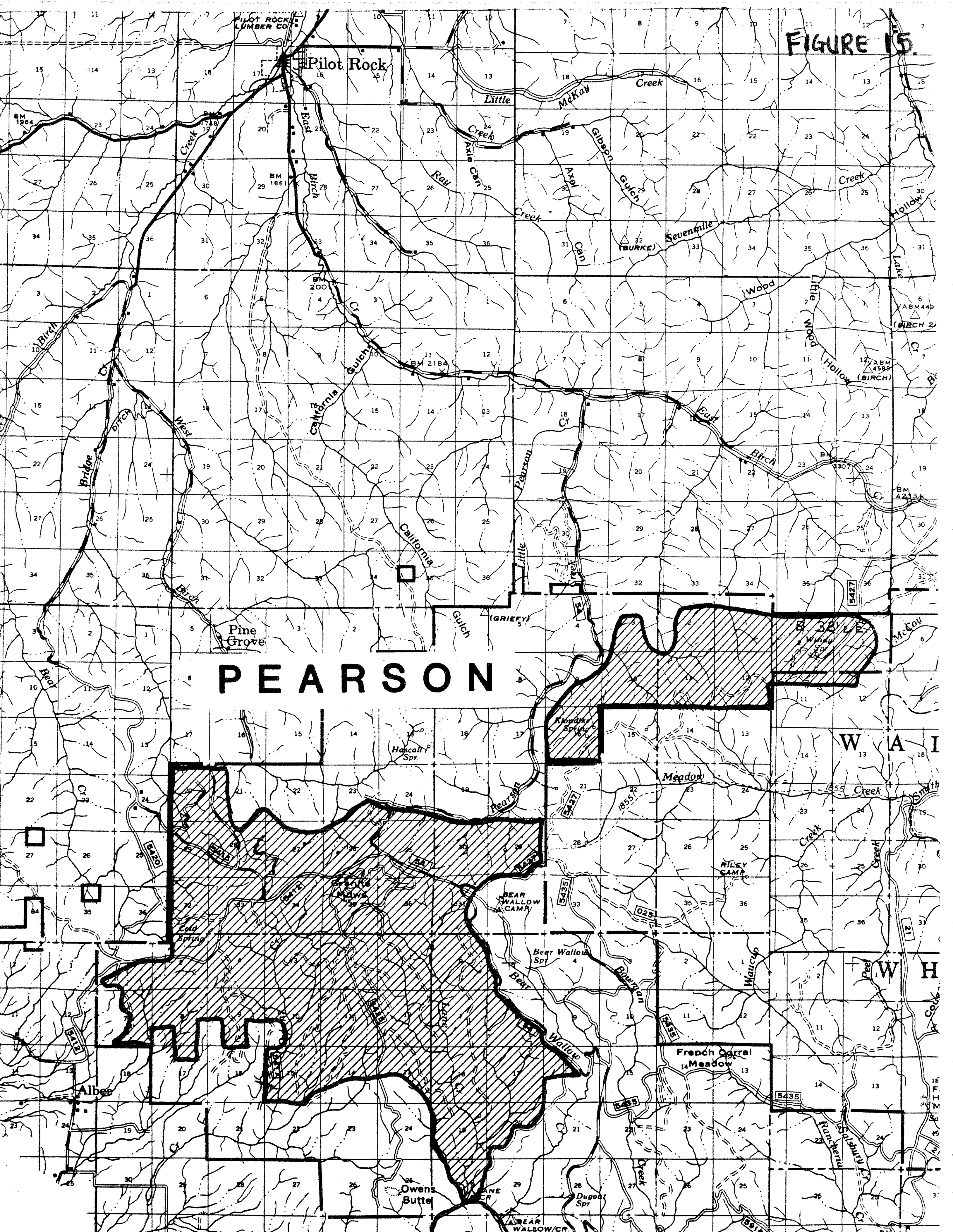

MILLER PRAIRIE 2
Lonerock
Fossil
Wetmore
Wineland Canyon
Kinzua
Stewart
Squaw Butte
Black Butte
Edwards
Comstock Basin
Steamboat Rock
Cabin Canyon
Phillips Can
Fir Hollow
Lost
Salmon
Landers Can
Johnson Cr
Big
Dutch Can
Brown Canyon
Wheeler Point
The Notch
Collins Butte
Winlock
Fizzel Mtn
Hubbell Lake
Dead Horse Gap
Cobb Saddle
Halls Half Acre
Searcy
Bledsoe
Scott Butte
Rancheria Rock
Fossil Park
The Rafferty
Wright Canyon
Grant Can
Twin Buttes
Nielson Can
Corral Mtn
Dutch Flat
Walker Can
Huntley Can
Craggy
Cottonwood
Stelwer Peaks
Bald Mtn
Hoover Cr
Cave Hollow
Kennedy
Gun Club Can
Kinzua Golf Course
Radio Tower
Yellowjacket Spr
Crawfords Spr
Long Prairie Spr
Dairy Meadow
Widow Meadow
Ben Gier
Ridge
Mule
Pioneer Park
State Park
Shelton
Rowe
Fossil Sub-Unit Headquarters
Moover Ranch
Smith Ranch
Corncob Ranch
Ricks
Snowboard
Sutherland Prairie
Oxhead
Wilson
Mill Cr
Ox Head
Beard Canyon
Kinzua Mt
Railroad
Southern
Grant Spr
Springs
Wheeler
Can
Creek
Canyon

FIGURE 15.



PILOT ROCK LUMBER CO
Pilot Rock
PEARSON
Pine Grove
Albee
Owens Butte
Little McKay Creek
Gibson Gulch
Sevenmile Creek
Ray Creek
Axle Can
East Birch Cr
California Gulch
Pearson Cr
Little Pearson Creek
West Birch
Bridge Cr
Birch Cr
Bear Cr
Wood Hollow
Little Wood Hollow
Lake Hollow
McCoy
Winom Spr
Klondike Spring
Hascall Spr
Meadow Creek
Bear Wallow Camp
Bear Wallow Spr
Bear Wallow Cr
Bowman Creek
Waucup
Riley Camp
French Corral Meadow
Granite Mdws
Cold Spring
Rancheria Cr
Salsbury Cr
Dugout Spr
Lane Cr
(BURKE)
(BIRCH)
(BIRCH 2)
(GRIEFY)
R. 32 E.
W A
W H