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THE BRUSH PROBLEM
ON CALIFORNIA LIVESTOCK RANGES

1960

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COVER PHOTO: An on-the-ground discussion of range improvement by rancher and a range specialist in El Dorado County.

ACKNOWLEDGMENT

This bulletin is a product of the combined efforts of many persons interested in range improvement and the brush problems on California livestock ranges. John Callaghan, formerly Chief Deputy State Forester, California Division of Forestry, prepared the basic outline. James Davis, with assistance from Thomas Honeycutt, both of the California Division of Forestry, added detail to that outline, giving the bulletin essentially its present form and substance. Various drafts were reviewed by the Subcommittee on Range Improvement Publications of the Range Improvement Advisory Committee to the State Board of Forestry; many suggestions for improvement of the work came from that subcommittee, and especially from its chairman, Dr. R. Merton Love. George Craig, of Western Lumber Manufacturers, Inc., made a major contribution in his thorough revision of the text as it neared its final stage. Finally, the Editorial Committee of the State Board of Forestry, under chairmanship of Kenneth Walker, made a number of suggestions which added to the correctness and value of the bulletin in presenting the facts of progress and problems in improving our brush range lands.

For the unstinted effort of all those persons who participated in this venture at some point, we hereby express our appreciation.

F. H. Raymond, State Forester
California Division of Forestry

THE BRUSH PROBLEM ON CALIFORNIA LIVESTOCK RANGES

FOREWORD

The foothill range lands of California occupy about 30 percent of the State's total area, and produce some 80 percent of our range forage crop each year. They are an important livestock producing area, where sheep and cattle can be raised economically and efficiently.

California has within her borders a market for all the meat and other animal products we can produce. The purchaser of meat that is produced locally does not have to pay transportation costs over long distances—which means cheaper food for him.

But California's range lands are not as productive as they might be. Unpalatable brush occupies many acres that could be good grazing land (see cover).

Ranchers have been making efforts to control brush on the foothill ranges. Public agencies have been assisting them with research to test better methods of brush clearing, growing forage plants, and managing livestock on the range.

This booklet is designed to inform the intelligent inquirer—from any walk of life—what is being done toward improving our brush range lands, and to explain some of the problems that still face ranchers and public agencies.

CHAPTER I

BRUSH—A PROBLEM ON CALIFORNIA LIVESTOCK RANGES

CALIFORNIA WILD LANDS

California's vast foothill and mountain lands covered with forest, brush, and grass are among the important foundations of the State's tremendous economic wealth. These lands provide timber for a large wood-using industry, and cover and food for wildlife. They serve as areas of recreation for California residents as well as for millions of tourists. They form watersheds to catch and release slowly a supply of life-sustaining water for man's use. They also provide forage, at least part of the year, for the State's important livestock industry.

THE RANGE RESOURCE OF CALIFORNIA

California has had a sizeable livestock industry for nearly two centuries. The Spanish pioneers of 1769 found a land that offered great opportunities for the production of cattle and sheep.

Today about 37 million acres are grazed in California each year. The sale of livestock and livestock products account for over 38 percent of the agricultural income of the State. California is one of the leading producers of livestock, and within the past few years has become a leader in the field of livestock feeding operations.

Although livestock are produced throughout the State from irrigated pastures in the central valley, the deserts of the southeastern part of the State, and the mountain ranges, the foothill region is by far the most important range livestock area (Fig. 1). The foothill ranges are important for at least two reasons: they are suited for economical production of feeder livestock; and they are favorably located with respect to local markets.

THE FOOTHILL RANGE AREA

California's noncultivated or wild lands include approximately 24 million acres of land classed as brush or woodland having little value for commercial purposes. In general these brush areas are located in both the Coast Ranges and the Sierra Nevada-Cascade Mountains forming a zone between the valley floors and the lower limits of commercial timber.

Far from being uniform, they include the sloping plains and rolling foothills bordering the valleys and extend upward to steep mountain topography. Elevations vary from near sea level to about 8,000 feet. Soils are exceedingly diverse, and total annual precipitation varies from

FIG. 1. The foothill ranges are the most important livestock producing region in California. A foothill ranch near Shingle Springs, El Dorado County.

less than 10 inches to more than 40 inches in the upper reaches of the brush zone.

As would be suspected from such differences in topography, soils, and climate, there is also great variation in kinds of brush. The brush varies all the way from semi-open groves of oaks, growing on rolling foothills to dense stands of chaparral covering steep mountain slopes (Figs. 2 and 3).

The grazing capacity of the foothill ranges has decreased during the period of their use by domestic animals, probably as much as 25 to 50 percent. This decline has been brought about by a number of causes; chief among them has been a change to less desirable forage species and the invasion of shrubby vegetation into grass areas.

Brush not only crowds out desirable forage plants, making less feed available for livestock, but it also makes ranch operation much more difficult (Fig. 3).

FIG. 2. Groves of oaks similar to this occupy many acres of California's foothill range.

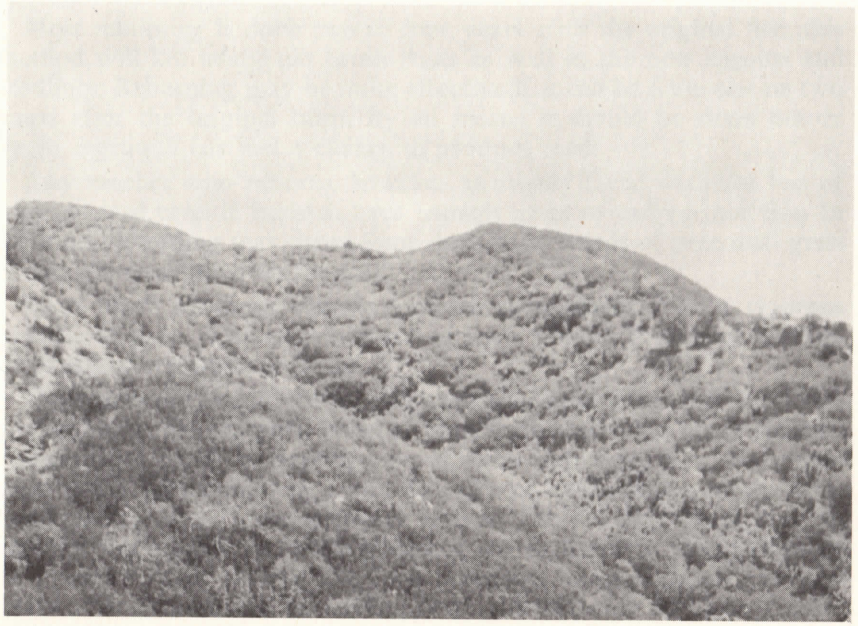

FIG. 3. Dense stands of chaparral are a problem on many of the foothill ranges.

CHAPTER II

INCREASING FORAGE PRODUCTION ON FOOTHILL RANGES

THE NEED AND THE OPPORTUNITY

The State's rapid growth in population has meant an increased demand for both food and range land suitable for other uses. Much brushland could be converted to more productive range on selected sites (Fig. 4).

Some brush ranges produce almost no forage for either wildlife or domestic animals. Information obtained from field studies has shown an annual beef production of only about 10 pounds or less per acre on unimproved ranges, while adjacent areas cleared of shrubs and seeded to forage plants produced more than 30 pounds.

However, not all brush-covered land is suitable for livestock production. Some areas are too steep and rugged for livestock use. Furthermore, some soils are too poor to make brush removal economical. In some areas the chaparral cover provides the only protection available for invaluable watersheds.

FIG. 4. This land was covered by brush; now it is productive range.

A FIVE-STEP PROGRAM

Forage production can be increased on suitable brush ranges by a combination of treatment of the range and management of the livestock. Ranchers who have made a lasting and financial success of their brushland conversion list five important steps:

1. Site selection;
2. Brush removal;
3. Revegetation;
4. Grazing management;
5. Follow-up action.

The methods actually used and the intensity of their application on any one property depend on a number of factors, including the rancher's personal opinions, his available cash, and the natural resources at his disposal.

CONSIDERATION IN SITE SELECTION

There are many thousands of acres of land now in brush that once were in woodland grass. Most of this can be returned to its original condition. There are additional thousands of acres that are natural brushland that can be made into productive range. However, there are also thousands of acres of brush that due to steep slopes, poor soil, or unfavorable climate are not suited for conversion in light of present knowledge. Some brushland soils may best be converted to other uses such as timber, orchards, or cultivated crops.

Soil, topography, and brush type are the most important factors in determining when brush can be removed successfully from a particular area. Dense tall stands of brush indicate a fertile soil but not necessarily one that will grow grass. Grassy openings and grass clumps growing in and around the brush plants are good indicators of conversion potential.

The state-financed soil-vegetation survey provides site-selection aids in some areas (Fig. 5). The survey is a co-operative project between the California Division of Forestry, the University of California, the Pacific Southwest Forest and Range Experiment Station, and the Soil Conservation Service. It produces maps and reports of the soils and natural vegetation of the foothills and rough mountainous land. These are available to the public at the cost of printing. Other soil survey information may be available also.

In connection with the soil-vegetation survey, the Agronomy Department of the University of California is conducting a series of soil nutrient studies, which are yielding information on the productive capacity and nutrient requirements of these upland soils. Ranchers are able to use this information, where it is available, in selecting those sites on their property that will yield the greatest range returns for the effort expended.

Brushlands are important as watersheds. For a large part of the land dominated by chaparral, brush is the only kind of plant cover that can be successfully grown within the present limits of ecological knowledge

FIG. 5. A soil-vegetation field crew. Classifying lands as to their suitability for range forage production is one of the steps in the soil-vegetation survey.

and economic feasibility. If range improvement sites are selected with care, and conversion from brush to grass is relatively complete, water yield may be improved in quantity and stability. Where these conditions cannot be met, it may be more desirable to leave the brush cover undisturbed. Loss of this cover can result in heavy flood runoff, deposition of mud and debris in reservoirs and low-lying areas and not infrequently in loss of human life.

Probably most range improvement projects must be a compromise, since a given area may include shallow, sterile soils on one slope and deeper fertile soils on another. Since it is not economical to clear only the favorable spots, the overall picture must be considered in choosing lands for range improvement—balancing the probable total gain in feed resources against the cost of improvement and possible damage by soil erosion following brush removal.

VARIOUS METHODS OF BRUSH REMOVAL

Brush may be cleared from the land by controlled burning, mechanical equipment, chemicals, or a combination of methods.

A method that has proven highly satisfactory is crushing brush down and burning it in place. This method has been effective in brush removal and has the advantage of not being followed by as heavy a growth of sprouts and seedlings as usually follows an ordinary burn. Studies show that where brush was burned with no prior treatment, only one-third to two-fifths as much forage was produced—apparently due to the poor seedbed provided and to competition from regrowth of brush.

Studies made in San Benito County show that crushing brush prior to burning it in place may return a cash profit approximately 50 percent greater than where standing brush was burned without treatment. More important, on this study area, the treated brush area is essentially cleared and forage is increasing while the nontreated areas are reverting to brush and forage quality is declining.

However, in most cases fire is used alone; mechanical equipment being used only to prepare external firebreaks. Ten acres are burned this way to every acre that is treated mechanically. If the rancher decides that fire alone is to be used to clear a chosen area, the operation must be carefully planned to be successful. This method should be used with great care and reservation.

Care in the Use of Fire—Although escapes of fire due to natural causes cannot always be eliminated, they can be minimized by careful planning, adequate preparation and skillful execution of a controlled burn. The safety element must be an important consideration when the decision is made to use fire.

Existing barriers to fire are the first consideration in the selection of control line location. Physical barriers such as roads, rock outcrops, bare ground, bodies of water, or recent burns are most commonly

sought as control lines. The safest control line is one with a combination of factors, for example a road near a ridge top where the density of adjacent brush is low. Control lines should not be located in the bottom of narrow canyons or near fuels that will throw sparks or ignite readily from them.

No matter how effective existing barriers may be, some type of line construction work is usually necessary. Width of such lines will depend on topography, fuels, and wind velocity and pattern. In heavy brush or woodland areas where wide fire barriers are not available, it is always safer to have a second line of defense; i.e., another fireline approximately paralleling the main or primary fireline within which the burn is to be contained. Bulldozed primary and secondary lines should be planned as access roads wherever possible. Since transportation and communication are essential to a well-conducted burn, control line roads increase the safety of controlled burning.

Orientation and shape of a burning unit should take full advantage of prevailing winds expected at the time of the burn. Ignition can often be timed to coincide with the daily shift of wind in a particular locality.

Ideal fuel conditions within the burn should be such that the fire will spread over the area in the desired manner. Fuel characteristics which may limit or promote the effective spread of fire within the burn are moisture content, sizes, and distribution of fuels. There should always be sufficient quantities of fine dry fuels to carry the flame.

REVEGETATION IMPORTANT

Revegetation of the cleared area is obviously important. It may be done naturally if sufficient seed of native grasses is present. This is particularly true in woodland grass areas or on soils that formerly grew a grass cover. Where brush was dense, artificial seeding may be necessary.

Grasses, mostly annuals, grow and mature on winter and spring moisture at shallow depth. They germinate and grow rapidly, completing their life cycle in one season. Although they form an abundance of forage for a short period, they are not as dependable nor do they provide as long a grazing season as slower-starting long-lived perennials.

Numerous studies have shown that sowing grass seed on burned grassland (not burned brushland) is generally not necessary nor successful because of the abundance of viable resident seed unharmed by the grass fire. However, on certain grassland sites annual legumes have been successfully established.

It has also been found that generally only spot seeding is needed after a reburn of burned areas.

If conditions permit, more intensive agronomic practices may pay for themselves. Seeding of burned areas is done for four principal reasons: (1) to furnish forage for livestock and game, (2) to offer competition to reduce the number of brush seedlings that might otherwise be too

thick in places, (3) to obtain a plant cover to protect the soil from water and wind erosion, (4) to make sure that there will be adequate fuel available for any subsequent burn.

The ash of a heavy brush burn is a good medium in which to plant seed. Seed can be broadcast by hand, by the use of a breast-type seeder, by plane or helicopter. The method chosen will depend on the site involved and the complexity of the seed mixture to be planted. Most of the seeding in California is done from the air (Fig. 6). It should be emphasized that better seedbeds insure better stands.

Where conditions are unfavorable it is important to cover the seed after planting and to firm the seedbed so that moisture will be maintained at the seed level. Outstanding results were obtained on several field studies by rolling broadcast seed into the ground with a sheep's-foot roller. Even the use of a brush drag is helpful.

The most effective seeding method, if terrain will permit, is drilling the seed into the ground. Special brushland drills have been developed that not only operate on rough rocky terrain but spread a band of fertilizer below the seed at the time of planting (Fig. 7). It is worth the rancher's while to watch for and utilize suitable drilling sites.

Seeding of burns is most successful if done before fall rains the year of the burn. Observations made following seeding of wildfire and controlled burns in chaparral show that sown species will have little competition the first year from native plants and brush seedlings. However, this competition may be severe the second or third year. Vigorous grass and legume plants can help crowd out most brush seedlings the first season. However, if brush seedlings have been allowed to grow for a year or two they usually cannot be controlled by the seeded plants.

GRAZING MANAGEMENT INCREASES VALUE OF RANGE

After he has successfully selected his site, removed the brush, and revegetated the area, the rancher if he wishes his conversion job to be lasting and productive, must continue to practice range management. To carry out this all-important phase of brush range improvement, the rancher should give much time and thought to the following four factors:

1. Adjust livestock numbers to the carrying capacity of the new area. This is necessary on any ranch.
2. Plan a long term grazing program. Divide the range into fenced or controlled fields.
3. Discontinue grazing before burning or reburning an area to provide fuel to carry a hot fire.
4. Graze a newly seeded burn area only after forage plants have matured and set seed.

Grazing capacity could be increased on most California brush ranges by improving grazing management techniques such as the proper season

FIG. 6. A helicopter seeding an area that has recently been burned.

FIG. 7. This brushland drill, for seeding controlled burns, was developed by the University of California.

of use, numbers, and distribution of livestock. Most poorly managed ranges contain watering or salting areas that are heavily grazed yet also contain large areas that are scarcely touched by grazing animals. One of the greatest needs is the better distribution of watering facilities or their development. In some situations hauling water may pay dividends. Salting, fencing, and employing riders contribute to better utilization of the available range. These management practices are particularly important after an area has been controlled burned, because newly established forage plants need different treatment.

Planned grazing is necessary to develop permanent stands of forage. When the rancher opens new range by brush removal, he can adopt practices that will allow seeded or resident plants to survive and flourish or on the other hand he can use grazing methods that will gradually eliminate and destroy them. Proper range utilization lies somewhere between continuous close cropping which weakens and gradually eliminates desirable annuals and perennials, and too light grazing which tends to build up a heavy litter and allows usable forage to go to waste.

FOLLOWUP ACTION NECESSARY

A successful controlled burn is only the beginning of the conversion job. Innumerable seedlings and sprouts spring up following the fire. Reburning is the most commonly used method of sprout and seedling control. This activity amounts to one-third of the total annual burn throughout the State.

Most reburning is done two to four years after the original fire; this method will kill many old brush roots as well as the new sprouts and seedlings. Reburning may be more effective if it can be done one or two years after the original burn. By all means it should be done before brush regrowth has had a chance to produce seed.

Any rancher who reburns, however, is usually faced with the loss of a year's feed crop if he is to have enough grass to carry a hot fire. In addition, reburning may cause some damage to stands of perennial grass if they are established on the area.

Most brush seedlings cannot compete successfully with a vigorous growth of grass. The establishment of such a stand is another method of retarding regrowth of brush.

Herbicides are one of the rancher's essential tools following most controlled burns. Even a good stand of grass is no match for brush sprouts. Research has led to the development of many techniques using hormone-type brush killers such as 2,4-D, 2,4,5-T, or combination of the two. Since timing and formulation are critical for different plant species, ranchers are advised to obtain guidance for each project from Division of Forestry range technicians, farm advisors, or agricultural chemical dealers. Herbicides can be applied from aircraft, tank truck or trailer, and hand sprayers (Fig. 8).

Few ranchers actually want to eliminate all species of brush. Most recognize the value of some brush as browse, especially during summer. They know that sprouts and seedlings produce more browse than old stands of mature brush.

FIG. 8. Applying brush-killing chemicals by helicopter for control of sprouts and brush seedlings in eastern Monterey County.

CHAPTER III

COSTS AND BENEFITS OF BRUSH RANGE IMPROVEMENT

To turn a dense chaparral field into productive pasture is not a simple job. But the rewards of such increased production may be many fold.

Most brush range improvement work in California is done on private lands and at the expense of ranchers, who expect to receive a financial return for their efforts and investments. The State has recognized a public interest in range improvement and participates in various ways. Much range improvement work has been done in the past 15 years.

SOME PROJECTS ARE SUCCESSFUL; OTHERS ARE NOT

Since 1945 more than one and one-half million acres of brushland have been subject to some sort of range improvement, yet much brush remains on some of these lands. Every range improvement project entails a certain factor of risk for the operator, and requires him to make certain important decisions as to which practices will yield the greatest financial return.

Studies have shown that a minimum investment in time and money, as may be the case when brush is burned without prior treatment or followup, may pay for itself in two or three years. However, production soon declines and the landowner is faced with conducting his brush removal operation all over again. Besides depriving the landowner of a stable source of income, this type of repeated operation may so deplete the limited soil reserve that each succeeding treatment will have a lower grazing capacity.

Intensive management, on the other hand, resulting in permanent conversion from brush to pasture may take longer to return the initial investment, but the total eventual return may be greater. Developing usable range land may involve more work for the operator, who must decide whether the prospective additional income is worth the extra effort on his part. Success generally depends on availability and use of necessary information. The rancher must make certain decisions regarding the investment of capital.

Some range improvement operations have been financial successes while others were not. The measure of success is the degree to which brush-covered range land is brought into permanently increased yield that results in increased net income commensurate with the cost of the improvement.

COSTS VARY GREATLY

The amount of labor and equipment used—therefore the cost—depends as much on the rancher's individual approach to the project as on varia-

tions in brush cover, terrain, or other factors. Some landowners do not look upon their labor or that of their friends as an expense.

Studies made jointly by the University of California and the Division of Forestry have shown that costs of burning are in part related to size of the area burned. At the time of the study—published in 1954—costs per acre to the permittee were fairly high for controlled burns of 40 acres or less. This cost per acre decreased as the area burned increased to about 440 to 520 acres in size.

This study indicated something of the highly variable nature of individual areas when considered for range improvement, and pointed out some difficulties of attempting to generalize on the basis of averages and similar common statistical measures calculated from sample data. It also showed that for several practical reasons information on costs should be collected in terms of hours of labor and hours of equipment-use. Appropriate money values may then be assigned when it is necessary.

One rancher may spend hundreds of hours with a chain saw or bulldozer in preparation while his neighbor may spend only a fraction of this time. The lack of uniformity can be explained in terms of differences in burning conditions. For example, 160 acres of brush located in a remote area surrounded by roads or open fields presents minor problems in fire control and can be burned at low cost. Controlled burning of 160 acres of brush located on a slope immediately below a stand of timber and surrounded by summer homes will provide a major problem in burning and consequently costs will be high.

PUBLIC AS WELL AS PRIVATE VALUES ARE INVOLVED

California's Public Resources Code declares "the people of the State have a direct interest in the protection and improvement of public and private lands which are principally useful for range or forage purposes for domestic livestock and wildlife." The private values are evident.

It is obvious that a rancher, like any businessman, must make a considerable investment in time and money if he intends to make a profit. In addition, if he uses fire in his land clearing he runs a risk, a risk of public, as well as private values.

Fire is not consistently reliable. One day fire burns all vegetation hot and fast—the next day it merely creeps through the grass—or as happens 10 percent of the time, escapes control. Of 150,564 acres controlled burned in 1958, there were 11,617 acres outside of planned burns. Comparable figures for 1959 were 83,079 and 2,405 respectively.

When a controlled burn escapes and becomes a wildfire, it may reverse all of the good that it might have done for the rancher and the general public. The landowner who had anticipated increased grazing

capacity and financial gain from his project may lose needed grass, hay, or grain crops or even some of his or his neighbor's ranch buildings. Watershed land that was never intended to be burned may be stripped of a needed brush cover with resulting damage caused by flood and debris runoff. He may find himself involved in a lawsuit.

WHAT HAS BEEN ACCOMPLISHED IN RANGE IMPROVEMENT

Brush burning does not necessarily result in range improvement, but it has been the major activity of the majority of ranchers seeking to improve their brush ranges. During the 15 years from 1945 through 1959, 5,944 ranchers controlled burned a total of 1,681,020 acres of their brush. The results of these burns lie somewhere between the extremes of complete success and failure to improve the range safely at acceptable cost. Other benefits may result besides the primary one of range improvement.

There is a relationship between the success of a controlled burn and the landowner's experience with fire, his planning and preparation as well as the nature of the terrain and kind of cover. Landowners have expressed the opinion that in more than half of the projects a sufficient amount of brush was removed to satisfy the cost in effort, time and money.

Since 1945, California ranchers have seeded almost half a million acres of burned brush land to range grasses and legumes.

Field studies on some treated areas have shown a 4 to 1 ratio of increased meat production per acre compared to untreated foothill range. If such an increase in the production of meat, wool and other animal products were to result on most of California's brush-range land through improvement programs, it would be of economic importance to all Californians.

Other accomplishments claimed for range improvement programs include increased production of game and usable water. However, these benefits do not result universally, and there are some offsetting problems in some areas.

The interspersion of grass and brush forms a favorable habitat for deer and quail. Not more than 70 percent of brush areas should be treated at one time where improved wildlife habitat is the objective. The remaining area should be left in dense brush as cover for game. Sprout regrowth will provide browse for deer during most of the year while during late winter and early spring the grasses can be grazed. Research conducted by the University of California in conjunction with the State Department of Fish and Game shows from 40 to 110 deer per square mile in open brush but only 10 to 30 in dense heavy brush. Thus optimum game habitat requires somewhat more brush than stockman would consider ideal for his purposes, but some change in brush cover can be beneficial for both stock and wildlife.

Water use can be increased by the conversion of areas of deep-rooted brush to grass-covered land. If the annual grass is replaced by deep-rooted weeds and brush sprouts, the increase in soil moisture is lost.

Besides the damage done by the occasional escape of a range improvement fire, there is some damage resulting from the erosion of soil from burned areas. No way has been found to obtain a protective cover during the early part of the first year. The first rainy period is a risk that must be taken into account in any brush burning program. However, steps outlined in Chapter II will help to minimize these risks.

CHAPTER IV

STATE POLICY, ASSISTANCE, RESEARCH AND REGULATION

State and federal agencies are concerned with range improvement activities on private lands in California. They participate through advisory and other services, research and regulation.

BOARD OF FORESTRY POLICY

California's State Board of Forestry has formally recognized brush range improvement with a statement of policy which includes:

"For the guidance of the State Forester and for the information of others, the Division of Forestry, in the development, management, and conservation of the natural resources, and in the interest of brush range improvement, should encourage the following:

1. The development and improvement of brush-covered lands as an over-all project involving site selection, clearing the lands of undesirable vegetation, revegetation following clearing, application of effective followup measures and use of appropriate range management practices.

2. The practical application of methods in brush range improvement determined through experimentation, including the use of fire and its application in combination with other methods and in revegetation of denuded wild land areas for soil erosion control.

3. The use of plans in brush range improvement projects which are designed to enhance their value for fire hazard reduction and fire control, stabilization of soil, water conservation and production and betterment of range land and game habitat."

RESEARCH AND EDUCATION

To develop answers to the many questions that rise out of range improvement activity, many groups, public and private, have contributed a great deal of time and effort. The State Board of Forestry has established a Range Improvement Advisory Committee having representation from public and private organizations interested in brush range improvement. It serves as a focal point for accumulation and dissemination of information and ideas on this subject.

There is some good information available on the techniques of using fire, chemicals or mechanical methods of conversion. Research has shown that a number of forage plants can be adapted to brush range areas. Some of these plants have been put into wide use by ranchers.

On the other hand, knowledge is limited as to the best management and maintenance requirements of converted brushlands. Perhaps most

of all, knowledge is limited on accurate and ready identification of the forage potential of many sites.

Knowledge in all of these fields can be increased through laboratory, greenhouse, and large-scale field studies. Most of these studies are co-operative in nature between landowners, other interested agencies such as the University of California or the U.S. Forest Service, and the Division of Forestry. Co-operation between agencies has eliminated the duplication and has utilized the best resources of the participants.

Much of the knowledge gained from these field studies has been put to wide use by the livestock industry. This includes information on pre-burn treatment such as crushing brush down, the use of herbicides in sprout control, and the cost and returns that can be anticipated with land conversion.

ASSISTANCE AVAILABLE TO RANCHERS

The rancher seeks help from his neighbors and assistance from the California Division of Forestry in planning and conducting his burn with safety. The University of California, through the Agricultural Extension Service, keeps the rancher informed on methods and techniques in managing his land and livestock.

The Soil Conservation Service provides advice and assistance to the rancher on developing his soil and water potential. The U.S. Forest Service and Bureau of Land Management strive to make the lands in public ownership more productive.

Division of Forestry employees examine areas proposed for burning, provide an advisory service as to methods that may be used, prepare a list of suggested precautions, and issue a burning permit to the rancher (Fig. 9). This permit does not absolve the rancher from the responsibility for damage from an escaped fire and it may be amended, suspended, or canceled by the State Forester or his agent in case extreme fire danger weather develops making inadvisable the carrying out of the burn as scheduled.

In addition, the division provides standby crews for the protection of nearby landowners. The standby crew is not authorized to do any of the burning for permittees.

Controlled burning projects are carried out by the permittee on his own land, or land under his legal control. Generally, planning and conducting all phases are done by the rancher himself at his own expense. Occasionally groups of ranchers may join together to hold a co-operative burn. In this case the planning may be a joint venture with one individual appointed as leader or fire boss.

In some areas of the State, ranchers have organized themselves into county or regionwide range improvement associations. These groups are so well organized that they are able to schedule burns during the summer months in such a manner that a rancher intending to burn can help his neighbors conduct their projects and can expect ample help in terms

FIG. 9. Specialists of the California Division of Forestry assist ranchers in planning and conducting their controlled burns.

FIG. 10. Many homes have been built in brush areas, and communities have expanded into the brush zone in recent years.

of men and equipment when his turn to burn comes. In addition, these associations serve as outlets through which the Agricultural Extension Service, the Division of Forestry, and others can distribute information on range management practices and fire safety.

REGULATION OF CONTROLLED BURNING

Changes in legislation in 1945 set forth a regular procedure for issuing permits for range improvement burns. Since the Division of Forestry is charged with administration of the state laws governing the use of fire on most foothill range lands, it is the agency through which all range improvement projects involving use of fire during the fire season are channeled.

One of the purposes of the Division of Forestry's administration of burning permits is for the protection of adjacent landowners and the public interest. In many areas of the State the brush zone lies adjacent to or directly below very valuable commercial timberland or recreation areas. In addition, thousands of homes have been built in the brush areas and many communities have expanded into them during the last several years (Fig. 10). The use of fire even under the most favorable conditions poses a great threat to these values.

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