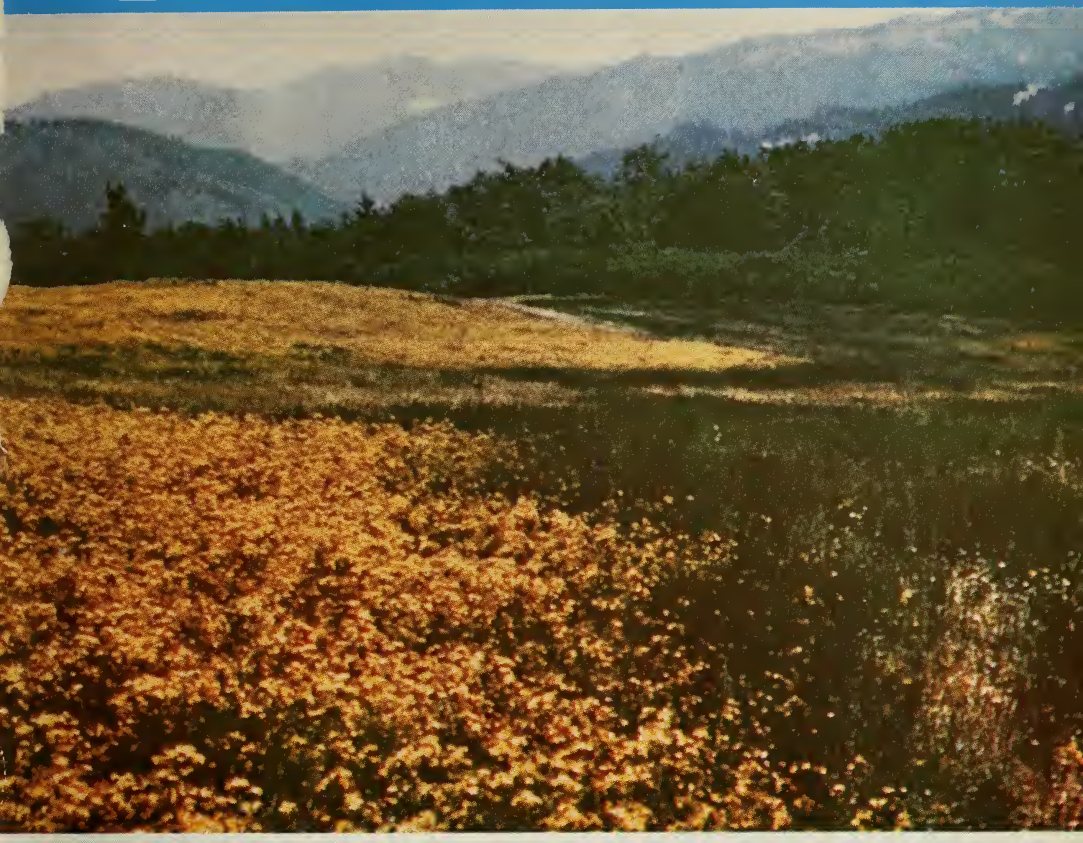
Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA



IMPROVING KLAMATH WEED RANGES

ALFRED H. MURPHY · R. MERTON LOVE · LESTER J. BERRY

CALIFORNIA AGRICULTURAL
Experiment Station
Extension Service

CIRCULAR 437

It takes TWO STEPS

to improve your

KLAMATH WEED RANGE

Control of Weeds by . . .

Beetles . . . or Chemicals . . .
or Livestock . . . or Cultivation
and Seeding.

Seasonal Grazing Rotation Plans . . .

to follow any control method.

CONTROL BY BEETLES is most effective
if you have a large area infested by a dense stand of Klamath weed.

CHEMICAL CONTROL will pay
if you have spot infestations of Klamath weed, not dense enough for beetle populations.

CONTROL BY LIVESTOCK is beneficial
if you have scattered stands of Klamath weed, particularly on land unsuited for cultivation.

CULTIVATION AND SEEDING is recommended
on land that is suitable for tillage.

These four control methods can be used separately but in most cases a combination of more than one will produce better results.

LONG-TERM GRAZING PROGRAMS are necessary
to consolidate gains won by any control method.

The Cover Photo shows the Klamath weed beetles in action. They are moving across the range, have devoured the weed from the right half and are headed for the left which is still heavily infested with weeds in bloom.

IMPROVING KLAMATH WEED RANGES

Alfred H. Murphy, R. Merton Love, and Lester J. Berry

KLAMATH WEED has been a major range pest on much of the grazing land of Northern California. It has also infested abandoned cropland. The weed is most prevalent in the north coastal and north central valley zones (see map on page 4). The problems are similar in both areas except where differences are pointed out in this circular.

The pest causes blistering and a sensitivity of the skin which results in an inferior range animal. More important, the weed competes with the good forage species of the area, and the reduction of good feed results in a poorer quality of livestock. The reduced carrying capacity and the resulting poorer animal rather than the poisoning effect of Klamath weed has made the study of this problem essential. Very few animals die from Klamath weed.

THE AUTHORS:

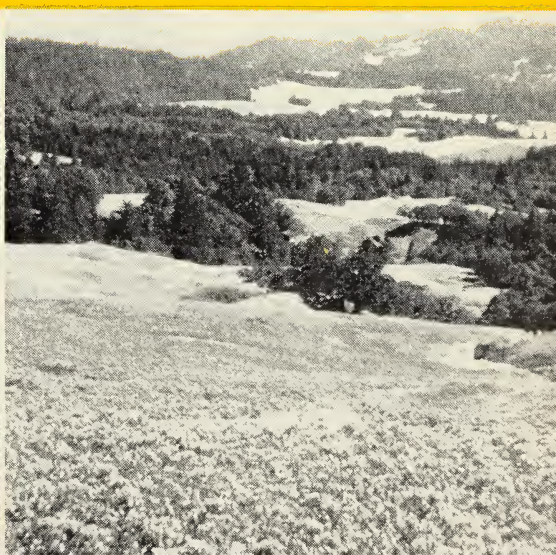
Alfred H. Murphy is Superintendent of the Hopland Field Station and Associate Specialist in the Experiment Station (Agronomy). R. Merton Love is Professor of Agronomy and Agronomist in the Experiment Station, Davis. Lester J. Berry is Extension Range Development and Conservation Specialist, Davis.

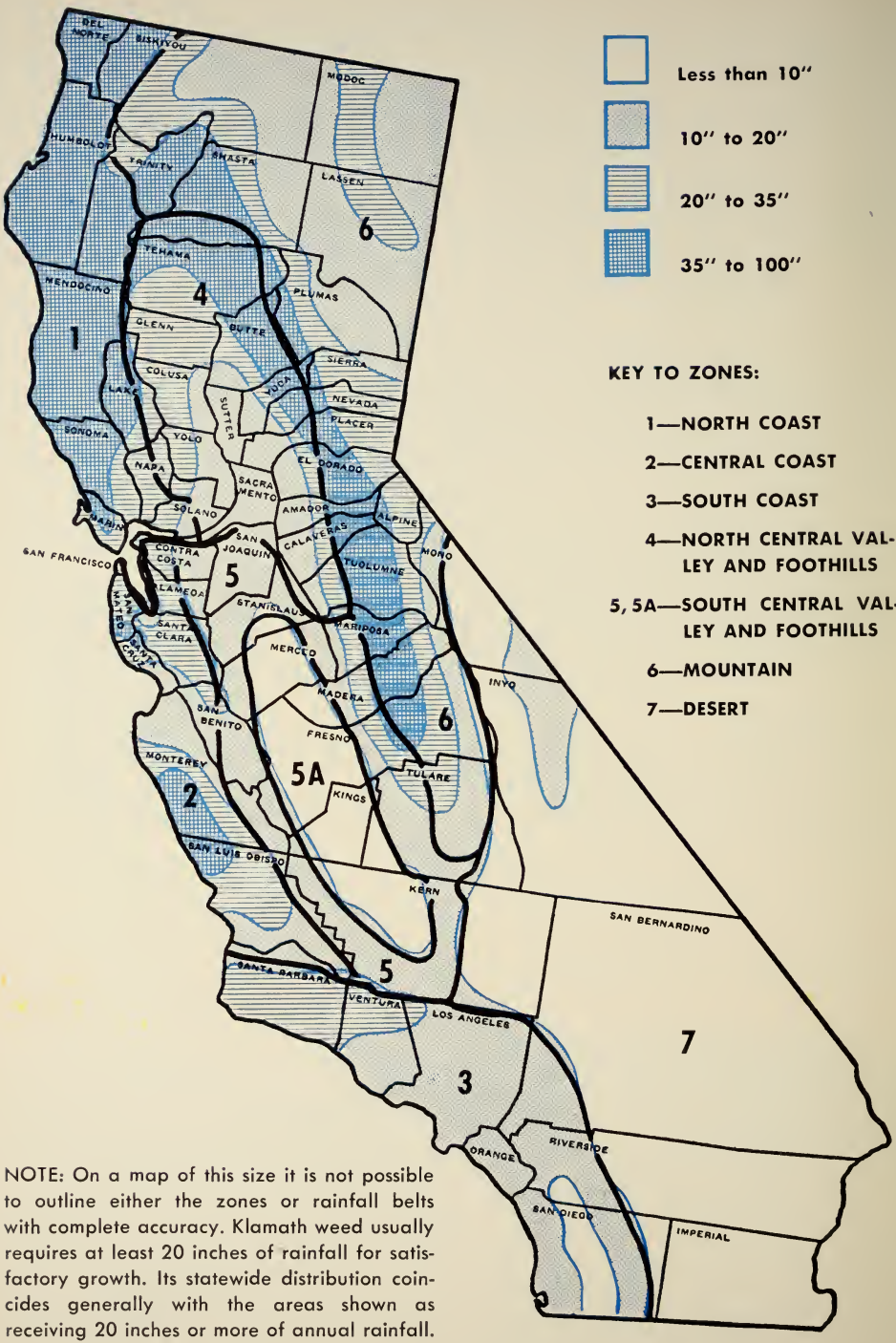
APRIL, 1954

If you don't control the Klamath weed

isolated plants . . . like these

may take over your entire range . . . like this.





NOTE: On a map of this size it is not possible to outline either the zones or rainfall belts with complete accuracy. Klamath weed usually requires at least 20 inches of rainfall for satisfactory growth. Its statewide distribution coincides generally with the areas shown as receiving 20 inches or more of annual rainfall.

STEP 1 . . . CONTROL OF THE WEED

CONTROL BY BEETLES

Is most effective on large areas of dense stands of Klamath weed

The use of leaf-feeding beetles is the most effective method of Klamath weed control. It has, over the past few years, controlled thousands of acres. In several parts of California where this range weed was a serious pest, the beetles have reduced Klamath weed to a point of minor importance. On large infestations, control by beetles is the most efficient and economical method. It is highly recommended where Klamath weed is a serious problem.

The long-range results of the control by beetles remain to be observed. Judging from other biological control work it is believed that the beetle numbers will be controlled by the amount of Klamath weed available. When the plant is greatly reduced by beetles, their population will probably decrease because

1952 Acreage of Klamath Weed in California Counties.*

County†	Approx. number acres infested	County†	Approx. number acres infested
Amador	16,000	Placer	250,000
Butte	125,000	Plumas	30
Calaveras	2,000	Sacramento	400
Contra Costa	100	San Diego	.1
Del Norte	450	San Mateo	Trace
El Dorado	414,720	Santa Clara	150
Glenn	30	Santa Cruz	220
Humboldt	250,000	Shasta	590,000
Lake	400	Siskiyou	250,000
Madera	100,000	Sonoma	5,000
Mendocino	2,500	Stanislaus	Trace
Merced	Trace	Sutter	1
Modoc	1	Tehama	5,000
Monterey	.07	Tuolumne	2,000
Napa	1,200	Yuba	300,000
Nevada	10,000	Totals	2,325,201.17

* Acreage estimates taken from The Bulletin, Dept. of Agr., State of California, Vol. XLI, No. 4, 1952.

† The study on which this circular is based was done in zones 1, 4, and 6 but results apply to counties in neighboring zones in which Klamath weed is found.

The adult beetle (left) and two stages of its larva.

they must compete for the available food. If later the Klamath weed increases, the beetle number should increase with the greater supply of food. It is expected that the beetle population and the amount of Klamath weed will finally stabilize at a much lower level than at the time when the beetles were first released in California. The beetles will not completely eliminate the Klamath weed from an area. It will be advisable to have a few plants available so a few beetles will survive on them for the event that the weeds should begin to increase again. The ultimate aim is to control Klamath weed at a point where it is not a menace as a rangeland pest.

How the Beetles Were Introduced

Klamath weed spread rapidly in California because it was brought into the state without its natural enemies that controlled it in the countries of its origin. To control it here, it was necessary to find a satisfactory natural enemy and introduce it into California.

The leaf-feeding beetle, *Chrysolina gemellata* was introduced in 1943 from Australia to California by Professor Harry S. Smith, chairman of the Department of Biological Control. These beetles had been imported from France to Australia where they had become established and shown considerable progress.

History of Klamath Weed

Klamath weed is well distributed in most of the temperate zones of the world. It has developed as a weedy pest only in Australia and western United States.

In California the most commonly accepted name is Klamath weed. In other areas it is known as St. Johnswort, goatweed, Tipton weed.

Its first appearance in California was probably at the turn of the century. Movement of livestock and settlers from the North and East were the most likely sources of infestations. Small infestations during its initial invasion were not of much concern as its seriousness as a weedy pest was not known.

By the 1920's it covered many acres of good range land, and livestock ranchers requested aid in fighting this weed. During the 1930's the toxic character of the weed was determined, the use of borax recommended, and effect of Klamath weed on rangelands ascertained. The latest experimental studies are represented by the findings of this circular.

Before the insects were released in this country, it was determined that they would not feed on any other plant but the Klamath weed. The Australians had tried them on 42 plant species, representing 19 botanical families. Six more plant groups were tested in California. The tests proved that these leaf-feeding beetles would starve rather than feed or reproduce on other types of plants.

The tests were completed and the first beetles released in California in 1945–46. By 1948, the two species of beetles had been released in 122 locations throughout 19 California counties. This represented a population of about 557,000 adult beetles.

What the Beetles Look Like

The adult beetle is about ¼ inch long and is shaped like a ladybird beetle. It has several color forms, with shades of dark blue, blue-green, and bronze predominating. The larvae vary in size depending upon their age. Newly-hatched larvae are about 1/20 inch long. They grow until ready to change to a pupa at a length of about ⅜ inch. The larvae are grey-green, and mottled, and are very difficult to observe in the earlier stages.

How Beetles Work

The life cycle of the beetle is well synchronized with the growth stages of Klamath weed. Each female beetle is able to lay about 5,000 eggs, which are placed on the basal leaves of the Klamath weed during the late fall after the first rains. The eggs hatch in a few weeks into the first larval stage, and feed on the basal foliage. As the larvae grow larger they inflict increasing injury to the plant. The most effective control is done by the larvae. In the early spring the larva goes into the soil, pupates, and changes to an adult beetle. The Klamath weed is then starting to put up flower shoots on which the adults feed. If enough beetles are present the plant is completely stripped of leaves. By the end of June when the flowers are in bloom, the beetles go into their summer resting period—in the soil or in trashy litter on the ground. This period is concluded in the fall when the rains commence and the Klamath weed's basal growth starts. The beetles then mate, lay their eggs, and die, thus completing their life cycle.

How to Establish a Beetle Colony

Time to collect beetles. Establishing a beetle colony on a Klamath-weed infested range requires a few set procedures for success. In California, the adults usually emerge during May. At that time, the adult beetles are feeding in large numbers on the plant's terminal shoots.

Number. By shaking the infested plant over a wide-mouth container, many beetles can be collected. When they are numerous, enough beetles for a colony (about 5,000) can be collected in a very short time. On a warm day they congregate in greater numbers on the plant than on a cool day.

Five thousand beetles fill a quart paper container to a depth of about three inches. Foliage of Klamath weed should be included in each container as a food supply. To insure good condition of the beetles, they should not be kept in the containers more than three or four days, nor left in the direct sunlight.

Location of colony. Selection of a beetle colony location and method of beetle placement is important. They should be placed where the Klamath weed is thick and where there is a large enough acreage to permit rapid increase in population. When releasing the beetles, it is recommended to place a unit colony (5,000) in an area of not over 10 square feet. This concentration is essential for best development, as the beetles collected in the spring are unmated and do not mate until the fall after the rains commence. If the beetles are separated by too great a distance,

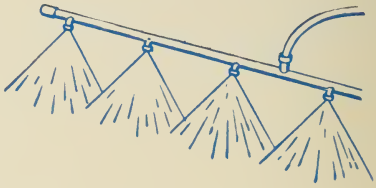
poor mating and low fertility of eggs will result. Thus, for fast population buildup, beetles must be closely concentrated when first released. A successful colony of 5,000 beetles for 1,000 acres of dense Klamath weed should give adequate control within a period of three to five years.

Several favorable conditions must exist for a rapid build-up in beetle population. There must be early fall rains followed by some growing weather to permit enough early Klamath weed growth to support the larvae. The soil must be loose enough to permit the larvae to enter easily and pupate. If the soil is hard, the establishment of the colony may be delayed up to five or more years.

Spread. Once a colony is successfully established, the beetles will spread over an infested range without additional help. It takes two years, under the most favorable conditions, for a colony to develop sufficient numbers to show a large effect on the plants' growth in the immediate vicinity of release. The beetles are able to fly considerable distances to seek out other Klamath weed areas. The importance of proper procedure in collecting and establishing beetles is essential for good results. The small effort required to collect and distribute beetles as compared to the large areas they can control justifies the care exerted.

CHEMICAL CONTROL

May pay on spot infestations of Klamath weed



The use of chemicals in Klamath weed control is limited to situations where the weed is scattered and not of sufficient density to sustain a beetle population. It is in these situations that the cost of chemical control can be justified.

2,4-D

The weed killer 2,4-D is the best chemical for controlling Klamath weed. It is available commercially in several forms. The ester and amine forms are most effective on Klamath weed. There are different preparations but no appreciable difference in killing ability has been noted with any of them.

Advantages of 2,4-D are fourfold. It is cheaper in material and labor than other chemicals; it is not poisonous to livestock and humans; it is not a soil sterilant; and its selective action allows the grass vegetation to continue growing. The remaining growth of grass helps, to a degree, prevent seedling Klamath weed from becoming re-established.

Disadvantage of 2,4-D is that timing of application is critical. 2,4-D is effective only during certain stages of the plant's growth, usually during the spring. During this time the Klamath weed is not in flower which means that the location of isolated plants is difficult to spot. Also, the proper method of spray application sometimes cause initial difficulties. But the disadvantages can soon be overcome and the simplicity of 2,4-D application is appreciated.

How to Spray 2,4-D. For spot infestations a small two- or three-gallon compressed air or knapsack-type sprayer is satisfactory. If a large range area is to be spot treated and is accessible with a jeep, a 25- or 50-gallon power-driven spray rig is useful.

For a water or diesel oil mixture of 2,4-D the use of proper spray nozzles will often determine the success of a

Stage of plant development in the spring during which Klamath weed should be sprayed.

Application of 2,4-D on the right shows clean field while unsprayed section on the left is still heavily infested.

spraying program. Low-volume fan type nozzles (such as Tee-Jet No. 650067 or Monarch No. 22) give good results and make efficient use of the chemicals. The use of low-volume spray nozzles makes it possible to cover an acre with 10 to 20 gallons of spray solution. A coarser nozzle often causes too much runoff, and wastes spray material.

For any spraying job good results can only be obtained if right amounts of the chemical are properly placed on the plant to be treated. This means that the spray equipment must be calibrated by applying a known amount of material on a measured area. Once the spray operator becomes accustomed to applying the right amount of spray material on a known area, proper spray treatment on a field scale is possible. Calibration takes a little additional time, but pays off in good results.

When to Spray 2,4-D. The best time for applying 2,4-D is during the early spring, between the time the plant is six inches tall and the time preceding flower bud formation. Treatment beyond bud formation is more expensive because it requires the addition of diesel oil to water.

During the above described stage of growth, a rate of 1½ pounds of 2,4-D acid per acre will give a good kill. As the plant becomes more mature, a rate of two to 2½ pounds of 2,4-D acid per acre is advisable.

Follow-up Spraying. Wherever a chemical control program is started, respraying is essential. With the best coverage technique in an area, plants are often missed, making additional coverage necessary. If Klamath weed has gone to seed for many years, new seedlings will develop after the mature plants have been killed. Klamath weed seeds have been known to be viable in the ground for at least 10 years. This gives some indication of the time required to recheck a weed-infested field.

Borax

Besides 2,4-D, borax is a chemical that finds favor with ranchers under some conditions as a killer of Klamath weed.

Advantage of borax is that timing of application is not as critical, as for 2,4-D.

Disadvantages of borax are that it costs more per acre than 2,4-D; it sterilizes the soil for varying length of time depending on rainfall; and the large bulk that is needed increases labor and transportation in applying the material.

CONTROL BY LIVESTOCK

Is useful on scattered stands of Klamath weed

Livestock grazing can be planned to cause unfavorable growth conditions for Klamath weed and good conditions for desirable forage grasses. Sheep are most suitable for this type of control as they do not seem to be bothered as much by the toxic effect of the weed. Animals not used to Klamath weed are more affected during the first year. No animals are known to have died directly as a result of eating the plant, but cattle sometimes

lose body control after feeding on weed-infested ranges and occasionally have drowned or run into obstacles as a consequence.

Seasonal Use

Spring grazing. Seasonal grazing of sheep during March and early April will control Klamath weed on scattered areas, particularly in the north coastal

Klamath weed controlled (right of fence) by judicious use of livestock on a range near Alder Point, Humboldt County. The ungrazed left field is still heavily infested.

zone. During this season the weed is putting up its terminal shoots and is growing vigorously. Grazing of these shoots retards growth and reduces size of the plants. As a result the weed is less able to compete with other range vegetation. The greater injury to Klamath weed than to the grass at this stage can be partly explained by the fact that the weed grows from terminal buds which are usually taken first by the sheep. Grass plants grow from the base of the leaf which is not so easily removed by the animal.

Summer grazing. The second grazing period for Klamath weed control by sheep is early summer. At this time the animals remove the flowering tops of the weed. This does not injure plant vigor too severely but reduces the seed crop formation and number of seedlings for the next year.

Grazing the Klamath weed at these two critical periods in the spring and summer weakens both plant vigor and reproductive ability. Next to timing of grazing, concentration of the sheep on weedy areas is essential.

Successful on coast. Control by livestock grazing is particularly successful in the north coastal zone because of the longer season during which grasses can be used, and because of the presence of bunch grasses which can thrive under this type of seasonal grazing. In one study area an excellent stand of California oatgrass developed while the weed was controlled by grazing. This was possible because the critical stage of growth for the oatgrass came at a time between the spring and summer grazings. During this stage, grazing of the Klamath weed is not necessary. The oatgrass was able to maintain strong plants and also produce a seed crop by this grazing system. Thus the weed is controlled, the better forage encouraged, and the range feed utilized by the livestock.

Continuous Use

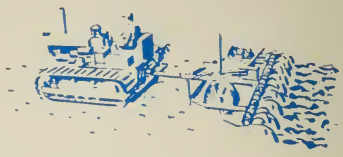
Continuous close grazing by livestock was used on many range areas to keep

Klamath weed under a degree of control before biological control through beetles was successful. This reduced the vigor of the weed but also the vigor of other plants. Usually, on a continuously stocked range the more aggressive and hardy plants survive. Unfortunately these most often are undesirable weedy plants. Thus continuous heavy stocking does not result in permanent weed control without harm to the range.

CONTROL BY CULTIVATION AND SEEDING

Is recommended on land that can be tilled

Klamath weed infestations in areas that can be cultivated may be controlled by a seeding program following the cultivation. Hay and grain fields that are left idle for several years may be invaded by Klamath weed. If nothing is done to these fields, the more aggressive weedy types of forage will usually develop along with an increasingly thick stand of Klamath weed.



The control method consists basically of ridding the field of the Klamath and other weeds by cultivation, and the seeding of grasses and legumes that will successfully compete with the weeds.

Cultivation

The first step consists of cultivation in the fall, then planting a crop of oats and vetch for hay or pasture. In the spring, after the crop is removed, the

This infestation of Klamath weed in an abandoned hay field could be controlled by cultivation and seeding.

field is plowed. If a late rain occurs after plowing, a disking will be necessary to kill any Klamath weed seedlings that develop. It may be necessary to carry out the practice two or more years. This first step in the control plan also gives some cash returns as a by-product.

Seeding

The second step is to seed the area in the fall with grasses and legumes that will keep the weeds from the cleared fields. The types of plants best suited for this purpose are different in the two areas in which Klamath weed is a problem.

What to seed on the coast. In the north coastal zones (1 and 2 of map on page 4) the best competitors to Klamath weed are highland bentgrass, chewings fescue, hardinggrass, burnet, and winter annual legumes such as subclover, bur clover, crimson clover, and rose clover. Seeding a combination of any of these plants on a good seedbed will help hold Klamath weed in check. However, the stocking and time of use should be adjusted so that strong plants develop and seeds are allowed to mature at least once every three years.

What to seed in the valley. In the north central valley (zones 4, 5, and 6 of map on page 4) good competitors to Klamath weed are the same winter annual legumes as on the coast, or a grass-legume mixture such as hardinggrass, rose clover, crimson clover, and subclover. Trials indicate that on abandoned grain land in zone 4 rose clover is the best annual winter legume to build up the soil and support an increasing growth of desirable forage plants.

Range fertilization. More and more ranchers are finding that improving soil fertility by the proper combination of phosphorus, sulphur, and nitrogen pays dividends in increased forage production of higher quality. Local farm advisors are prepared to help solve soil fertility problems on ranches.

STEP 2 . . . GRAZING PLAN FOLLOWING CONTROL

Control of Klamath weed by any method—beetles, chemicals, grazing, or cultivation—must be followed by a grazing plan to make it lasting. On any range area the cover consists of desirable and undesirable plants. It is the aim of range improvement to replace an undesirable population of plants, such as Klamath and other weeds, with a more desirable cover. This is an ever-continuing process.

Types of Forage that Thrive on Klamath Weed Ranges

In both areas, the long-lived native perennial grasses that can be encouraged on Klamath weed ranges include nodding, purple, and foothill stipas, blue wildrye, and pine bluegrass. In the north coastal zone, in addition, California oatgrass and Idaho fescue may be found.

In both areas, the desirable annuals and short-lived perennials include soft chess, slender wild oats, California and mountain bromegrasses, bur clover, and Spanish clover.

The undesirable grasses, in both areas, include nitgrass, red brome, crested dogtail, ripgut, and medusahead. In zone 4, in addition, goatgrass is invading some range areas. Goatgrass should not be confused with goatweed which is another name for Klamath weed. These undesirable grasses are aggresive, abundant seeders. Given the opportunity, they will

Why a grazing plan should follow control: Control of the Klamath weed alone in infested fields such as on the left may make room for infestation of other undesirable weeds such as Medusahead, as shown in picture on the right, unless other improvement measures are taken.

occupy much of the grazing land where Klamath weed is controlled. These undesirable grasses are poor feed resources and of value only for a short period in the spring.

Recommended Grazing Plans

Seasonal grazing rotation plans help encourage the more desirable plants in all instances. Ideally, this plan divides the range area into three subdivisions. Livestock is allowed to graze one subdivision early each year, rotating on all three subdivisions during a three-year cycle. The plan is based on the finding that perennials and desirable annuals will survive and prosper if permitted to nourish themselves once in each cycle of the three years. The subdivision with the most weedy annuals is first grazed. Enough livestock is placed on it to graze it down closely while the resident annuals are green and palatable and before the seedheads are formed. The animals should be removed early enough so adequate soil moisture will be present to mature the desirable annuals and perennials. The animals are grazed on the second subdivision the following spring, and on the third during the third season. There will be some differences in carrying out this rotation plan in the coast and valley zones because of differences in climate and types of grasses present.

Standard seasonal grazing rotation plan.

A	B	C
Water O	Water O	Water O
Early Close Grazing First Year	Early Close Grazing Second Year	Early Close Grazing Third Year

ACKNOWLEDGMENTS

The section on "Control by Beetles" was contributed by J. K. Holloway, Specialist in the Experiment Station (Biological Control), and C. B. Huffaker, Associate Entomologist in the Experiment Station (Biological Control), both at Albany, California, who also supplied photos for the cover and page 6. M. R. Pryor, Dept. of Agr., State of California, assisted in the preparation of the section on "Chemical Control." The Humboldt County Range Improvement Committee cooperated in the field investigations in Humboldt County.

GRASSES AND WEEDS . . .

discussed in this circular are listed here by their common and scientific names.

Common Name	Scientific Name
Blue wildrye	*Elymus glaucus*
Bur clover	*Medicago hispida*
Burnet	*Sanguisorba minor*
California bromegrass	*Bromus carinatus*
California oatgrass	*Danthonia californica*
Chewings fescue	*Festuca rubra* var. *commutata*
Crested dogtail	*Cynosurus echinatus*
Crimson clover	*Trifolium incarnatum*
Foothill stipa	*Stipa lepida*
Goatgrass	*Aegilops triuncialis*
Hardinggrass	*Phalaris tuberosa* var. *stenoptera*
Highland bentgrass	*Agrostis tenuis*
Idaho fescue	*Festuca idahoensis*
Klamath weed	*Hypericum perforatum*
Mountain bromegrass	*Bromus marginatus*
Nitgrass	*Gastridium ventricosum*
Medusahead	*Elymus caput-medusae*
Nodding stipa	*Stipa cernua*
Pine bluegrass	*Poa scabrella*
Purple stipa	*Stipa pulchra*
Red bromegrass	*Bromus rubens*
Ripgut	*Bromus rigidus*
Rose clover	*Trifolium hirtum*
Slender wild oat	*Avena barbata*
Soft chess	*Bromus mollis*
Spanish clover	*Lotus americanus*
Subclover	*Trifolium subterraneum*

REFERENCES

Control by Beetles:

Holloway, J. K.
1948. Biological control of Klamath weed. Progress report. Jour. Econ. Ent. 41(1):56–57.
Holloway, J. K., and C. B. Huffaker
1948. Klamath weed beetles: Biological control program now is in the second of three phases. Calif. Agr. 3(2):3, 10.
Holloway, J. K., and C. B. Huffaker
1951. The role of *Chrysolina gemellata* in the biological control of Klamath weed. Jour. Econ. Ent. 44(2):244–247.
Huffaker, C. B.
1951. The return of native perennial bunchgrass following the removal of Klamath weed (Hypericum perforatum L.) by imported beetles. Ecology 32(3):443–458.
Wilson, Frank
1943. The entomological control of St. Johnswort (Hypericum perforatum L.) with particular reference to the insect enemies of the weed in southern France. Austral. Council Sci. & Indus. Res., Bul. 169:1–88.

Chemical Control:

Ball, W. S.
1944. Germination of buried weed seed. Calif. State Dept. Mo. Bul. 33:105–7.
Pryor, M. R.
1950. Klamath weed control with 2,4-D. Weed circular #40. Calif. State Dept. Agric.
Raynor, R. N.
1937. The chemical control of St. Johnswort. Calif. Agr. Sta., Bul. 615:1–38.
Sampson, A. W., and K. W. Parker
1930. St. Johnswort on range lands of California. Calif. Agr. Expt. Sta., Bul. 503:1–48.

Control by Cultivation and Seeding:

Ball, W. S.
1952. Annual Report, Bureau of Rodent and Weed Control and Seed Inspection. State of Cal. Dept. of Agr. Bul., 41:4:295–309.
Johnson, W. H.
1953. Reseeding dry range. Calif. Agr. 7:9:12, 13.
Love, R. M.
1952. Range improvement experiments on the Arthur Brown ranch, Calif. Journal Range Management, 5:3:120–123.
Love, R. M.
1953. Sudan crop good preparation for dryland pasture seeding. Western Feed and Seed. 8:4:52.
Love, R. M., V. P. Osterli, L. J. Berry
1953. Improve your range with harding. Agr. Ext. leaflet.
Love, R. M., and D. C. Sumner
1952. Rose Clover, a new winter legume. Cir. 407:1–11.

Grazing Plans Following Control:

Jones, B. J., and R. M. Love
1945. Improving California range. Calif. Ext. Cir. 129:1–48.
Love, R. M.
1948. Good range management. Calif. Agr. 2:7:6.
Love, R. M., and D. C. Sumner
1952. California range plants. Calif. Agr. 6:7:3, 12, 14.
Love, R. M., D. C. Sumner, and V. P. Osterli
1952. Improving California brush ranges. Calif. Exp. Sta. Cir. 371:1–38.

Co-operative Extension work in Agriculture and Home Economics, College of Agriculture, University of California, and United States Department of Agriculture co-operating. Distributed in furtherance of the Acts of Congress of May 8, and June 30, 1914. J. Earl Coke, Director, California Agricultural Extension Service.

12½m–4,'54(1597)J.F.

141