PEST MANAGEMENT SERIES

INTEGRATED PEST MANAGEMENT ON CALIFORNIA PARKLANDS

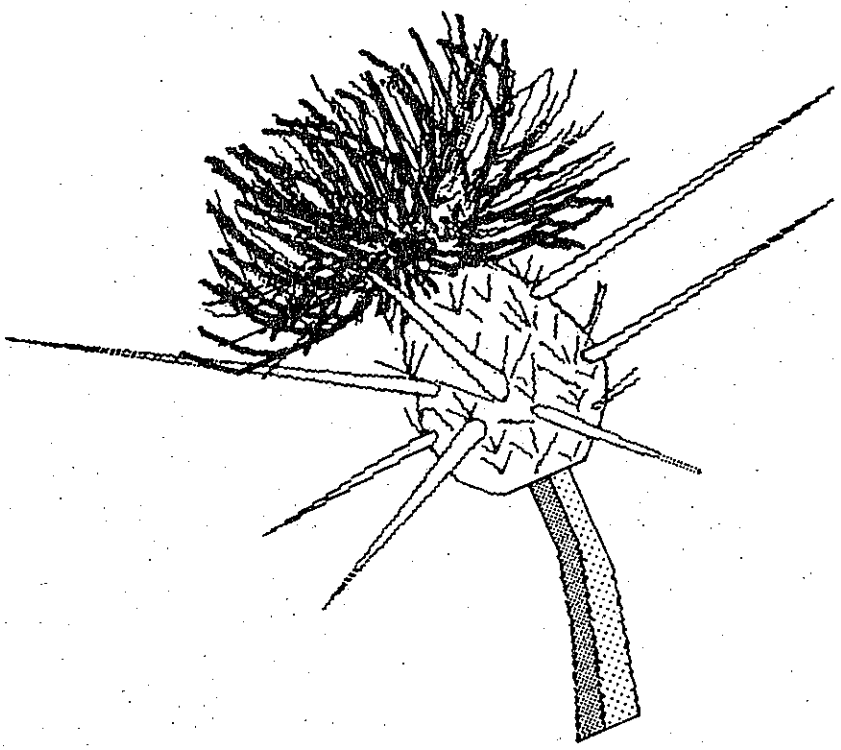
Number 5

YELLOW STARTHISTLE CONTROL

Pest Management Analysis and Planning Program

STATE OF CALIFORNIA
Department of Food and Agriculture
Division of Pest Management, Environmental Protection and Worker Safety
Branch of Environmental Monitoring and Pest Management
1220 N Street, Sacramento, California 95814

YELLOW STARTHISTLE CONTROL



Prepared by Richard Breuer

STATE OF CALIFORNIA
Department of Food and Agriculture
Pest Management Analysis and Planning

Pest Management Series

Lyn Hawkins - Program Manager
Sewell Simmons - Project Leader

Report to California Department of Parks and Recreation

January, 1987

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ACKNOWLEDGEMENTS

A special thanks is due the following:

Mark Pepple for extensive review and valuable suggestions.

Linda Heath for contributions concerning artwork, layout and style.

C. Hunter, D. Joley, and B. Kreps (California Department of Food and Agriculture); C. Thomsen (University of California, Davis); and V. Gizinski (California Department of Parks and Recreation)for technical review

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YELLOW STARTHISTLE CONTROL IN CALIFORNIA

INTRODUCTION

California has shown some major changes in vegetation types in the last two hundred years, due to the disturbance of native vegetation and the introduction of foreign species. One such species is yellow starthistle (Centaurea solstitialis), a tough, spiny, winter annual that is rated seventh of the 29 worst weeds in California (USDA 1981).

PEST MANAGEMENT NEED

Yellow starthistle within parklands presents an unsightly, spiny barrier that limits recreation and other physical movement wherever it occurs. Large clumps obscure visibility along roadways, present a roadside fire hazard when plants are dry, and interfere with parkland maintenance activities. The parklands goal of maintaining the natural diversity and complexity of the environment is compromised when infestations displace native vegetation. Horses grazing on yellow starthistle can develop a fatal condition known as chewing disease; toxins accumulate within the horse over a period of time, causing brain lesions, and eventually death (Callihan et al.1982).

The main objectives for an integrated pest management program for yellow starthistle include protection of the health and safety of park visitors and employees from control hazards, effective and target-specific

control strategies, and protection of non-target plants and animals. General approaches are modified for individual situations. Available time and expertise (pest control is usually a small part of an employee's responsibilities), equipment, and other resources all enter into the control strategy for each site.

The following considerations are common in parkland situations: 1) unlike fallow ground, or open rangeland, parkland weed control sites may not only be accessable to park visitors, but may be sites of intensive use; 2) removal of vegetation creates exposed ground, which might result in erosion problems on hillsides; 3) since weeds tend to be aggressive at invading disturbed areas, yellow starthistle might be replaced with another weed. (An IPM program for yellow starthistle in parklands should include a plan for revegetation with desirable plants, for erosion control and cultivation of an ecosystem in which the native flora is emphasized.)

Nontarget fauna can be affected in two ways:

1) The control method itself may affect the health of the animals.
2) Alteration of the environment may effect the animals through loss of food source, or habitat changes. For example, the American goldfinch is an attractive bird that feeds upon the seeds of yellow starthistle, and removal of the weed eliminates a food source for the bird (Hunter 1986).

Effects upon fauna can also be beneficial. Yellow starthistle is a preferential source of pollen for honey bees (Gary et al.1978). Bees

can interfere with a visitor's enjoyment of a park, and present a health risk to those who are allergic to bee venom. Removal of yellow starthistle eliminates a bee food source, discouraging their presence within the parkland.

BIOLOGY

Yellow starthistle is a winter annual that is a member of the Compositae family. The mature plant reaches an average height of 1-3 feet (taller plants are not unusual), and has a vigorous taproot system. Within California, the plant is found in a variety of environments. The taller plants are found in soils of high fertility and soil moisture (Higgens et al., 1978).

The grey green stems of the mature plant are rigid and branched. The leaves and stems are covered with cottony hairs. The leaf petioles extend along the stem, and appear as ridges or wings. The upper leaves are short, narrow and pointed. Rigid spines project from the bracts that surround the flower head. The upper spines are long,sharp, and unbranched, while smaller, lower spines are branched, with 3 prongs each (Fischer and McHenry 1975). The flower heads occur singly at the end of the stems. The bright yellow flowers are approximately 1 inch in diameter. Like other members of the family, the flower heads are made up of many separate flowers, tightly clustered in the flower head. In fall and winter, after the completion of their lifecycle, the plants appear as silver-grey to white skeletons, with conspicuous white cottony tufts, which are remnants of the seed head.

Seeds are produced in July and August. A single plant may produce up to ten thousand seeds (Maddox et al., 1985). There are two types of seeds produced. The first is covered with a light colored pappus, with a short bristly awn. This type of seed is dispersed by mechanical means, such as by wind or water, or by biological dispersal, such as on the fur of animals, or on the clothing of man. The second type of seed is dark brown to black, and the majority of this type simply fall beneath the plant. Seed viability remains high for 2-3 years under lab conditions (80-90% germination), but seeds in the top 2-3 cm of soil under field conditions may decrease in viability quite rapidly. Seeds buried deeper survive longer than those on the surface, but do not contribute to the annual seedling population unless the soil is disturbed. The seeds germinate primarily in the fall following the onset of fall rains. The seed can be found as a contaminant in commercial seed lots of alfalfa, cereals, bermuda grass, vetch, Ladino clover, and Sudan. More important perhaps is that starthistle can get bailed up in commercial hay and straw and later distributed when put out for feed or as a mulch for revegetation projects.

The seedlings have tongue shaped cotyledons and are dull green in color (Callihan et al., 1982). The older basal leaves are lobed, and are grey- green in color. When the plant is in the rosette stage, there are 8-15 basal leaves. In May and June the plant bolts and sends up stalks, which give rise to the flower heads. The seedling and rosette stages are most susceptible to control by the majority of control methods (Figure 1).

DISTRIBUTION

Yellow starthistle became established in California in the early 1800's. It is thought to have originated from the Mediterranean region, which is similar in climate to California (Higgens et al., 1978). Yellow starthistle has been on the increase in California for the last twenty years, rising from 1.8 million acres in 1958 to an estimated 7.9 million acres in 1985 (Maddox and Mayfield 1985). Most of the heavily infested acreage is in the northern California. An increase of yellow starthistle acreage in southern California and selected northern counties is likely, because of a reduction in chemical control programs by public agencies (Thomsen 1985).

All semi-arid rangeland is susceptible to invasion. Yellow starthistle grows best at lower elevations, on level ground or south facing slopes, with well drained soils receiving 15-30 inches of precipitation. Yellow starthistle is extremely hardy, and will grow on shallow, rocky soil, receiving as little as 10 inches of annual rainfall (Callihan et al.,1985).

Disturbance of existing ecosytems encourages establishment of yellow starthistle. Overgrazing by livestock removes plant cover and reduces competition, favoring the proliferation of yellow starthistle. Cultivated agricultural lands are prime sites of establishment, but because of intensive agricultural practices, the yellow starthistle life cycle is interrupted. Oak woodland and grassland steppe are also prime sites for invasion by yellow starthistle. In the Sierra foothills,

yellow starthistle can be found in both orchards and rangeland. Roads and railroad rights-of-way provide disturbed areas where starthistle can establish, and be transported by vehicles to different areas.

Seventy-six percent of the acres infested in California are found in the Sacramento Valley and the northern coastal areas, including their respective watershed areas (Maddox and Mayfield 1985). Infestations have been recorded by county, and are shown in tables 1 and 2.

CONTROL

BIOLOGICAL

Though biological control has been effective with other invading weed species, the establishment of a biological control agent for yellow starthistle has been elusive. The main goal in the development of the biological control program for yellow starthistle is to decrease the plant density by reducing the amount of seed produced. Study of a seed head fly, (Urophora siruna-seva) was initially promising, but after years of release and observation, it has not established itself in naturalized yellow starthistle populations in California. The failure may be due to the variety of host phenotypes in California that are not conducive to the fly's lifecycle.

Currently, other insects are being investigated. The most promising, Bangasternus orientalis, is a member of the weevil family. The female primarily oviposits on the recepticle and the small leaves along the

peduncle. The tiny larvae burrow into the receptacle, and feed on the developing flowers and seed. Currently the weevil has been released in three counties: Siskiyou, Placer, and Yolo. It will take several years to build up populations to be ready to release in other areas (Hunter 1986).

The weevil alone will not likely be enough to control yellow starthistle effectively. Two other insects that show promise are being tested for release. They attack the more mature flower head, unlike Bangasternus, which attacks the immature flower head. The insects may provide an effective control combination with the weevil, since they attack at different stages of flower development (Joley 1986). The USDA may need to search for other biological control agents that will attack other parts of the plant to reduce plant vigor, and thereby cause a decrease in seed production.

GRAZING MANAGEMENT

Grazing management can aid in the control of yellow starthistle in areas where livestock is allowed to graze. Specific studies have been done on managing grazing to improve the vigor of native plants, thereby increasing the competition with yellow starthistle. Management programs include limiting the number of animals, timing of grazing during the year, and rotation of grazing areas.

HOEING AND HAND PULLING

Hoeing and hand pulling are two effective means of controlling yellow starthistle in small areas. These two methods present little danger to non-target organisms. Their selectivity depends on the ability of the weeder to identify yellow starthistle at the stage it is being controlled. The most effective time for control is during the seedling and rosette stages, when the plant can be pulled or hoed, and the entire root removed (Figure 1). The silvery, branched skeletons of the previous year's growth can be used as indicators of where yellow starthistle seedlings can be found.

Additional Considerations:

1) These methods are time-consuming and should begin early in the season.
2) Breaking or cutting the root of the mature plant may result in regrowth.
3) Soil disturbed by these methods may stimulate germination of seeds.

PLOWING AND DISCING

Discing, like handweeding, is best accomplished early in the season. It may take two or three well-timed cultivations to provide good control of yellow starthistle. The plants should be destroyed before they have a chance to flower. The advantage to discing is that large areas of solid

yellow starthistle can be treated with little danger to employees or visitors.

Additional Considerations:

1) Plowing and discing should only be done on fairly level ground.
2) Disturbance of the soil may stimulate germination of numerous other weed species.
3) Removal of vegetation on slopes may increase erosion.

BURNING

Burning can be used successfully to control yellow starthistle. During the seedling and rosette stage, flame from a liquid gas burner can be used to kill yellow starthistle. The plants become more resistant to heat as they get older. Therefore, plants should be burned before the seed heads are formed.

Additional Considerations:

1) Burning requires specialized equipment and a gas source.
2) Care must be used to prevent scorching of desirable herbaceous plants and trees, or the accidental starting of uncontrolled fires.

CHEMICAL

Glyphosate

Glyphosate is registered for use for general weed control in noncrop areas. Glyphosate should be used early the season (at the seedling and rosette stage), for the control of yellow starthistle. Glyphosate is nonselective, and will control both broadleafs and grasses.

Roundup is available as an aqueous solution of the salt of glyphosate. It can be applied as a spray from a boom or from a backpack sprayer. It can also be applied with a wick applicator, which wipes the solution onto the foliage. Low volume applicators, such as Herbi or Micrometers, can be used for larger areas. Micromax low volume sprayers have been mounted on all-terrain vehicles with great success, for spraying herbicides in areas where conventional spray rigs cannot be used.

Additional Considerations:

1) Use in tanks that are galvanized, made of zinc, or of unlined steel, will cause corrosion, and production of a combustible hydrogen gas mixture.
2) It is nonselective.

Picloram

Picloram is selective for broadleafs; most grasses are resistant. It is available as a liquid for spray application, or as pellets for soil application. The application rate is critical, as higher rates will kill the resistant grasses, thereby eliminating competition. It should not be used on slopes or light soils, where water could carry it into the root zones of trees and shrubs.

Additional Considerations:

1) It has long soil residual activity.
2) It is a Restricted Material.
3) Persistence in application equipment requires precautions to prevent contamination of other spray mixes.

Diuron

Diuron is a selective herbicide at low rates, and is nonselective at higher rates. It is applied as a spray solution to the soil surface. Diuron has a long residual, and at the higher rates, will show activity greater than one year. Care should be taken on slopes and light soils, where runoff or leaching might bring diuron into contact with nontarget vegetation. The herbicide should be applied before starthistle seeds germinate. Once the seedlings have emerged, diuron is not as effective.

Additional Considerations:

1) It has long soil residual activity.

2) It is nonselective.

Simazine

Simazine is a soil-applied, selective herbicide that prevents emergence of various broadleaf and grass weeds. At higher rates, it is nonselective. It is available in liquid and granular formulations. Simazine is applied to the soil surface, and either watered in, or incorporated at a shallow depth. It has a high affinity for the soil, especially in heavy soils. Like diuron, care should be taken on slopes and light soils, where runoff or leaching might bring simazine into contact with nontarget vegetation. Simazine should be applied before starthistle seeds begin to germinate.

Additional Considerations:

1) Long soil residual activity prevents establishment of other plants for 1-2 years.

2) Root-uptake by desirable plants is possible.

2,4-D

2,4-D is a selective herbicide that, at recommended rates, controls only broadleafs and not grasses. There are a variety of formulations

available. Because of the sensitivity of a number of crops to 2,4-D, some formulations are restricted, according to their propensity for drift and volatilization. The low volatile esters and amine salts have the least amount of volatility.

Because of its selectivity for broadleaf plants, 2,4-D can be used to control yellow starthistle without killing native grasses. It can be applied by ground or by air (subject to county permit limitations). The seedling and rosette stage are the most susceptible to control by 2,4-D.

Additional Considerations:

1) There is drift hazard to nontarget vegetation (some formulations).
2) Some formulations are toxic to fish.

Aminotriazole

Aminotriazole is nonselective. Yellow starthistle should be sprayed when it is in the seedling or rosette stage. Aminotriazole is a good postemergent herbicide because many deep rooted woody species are sensitive to herbicides such as glyphosate, picloram, or 2,4-D, but resistant to aminotriazole.

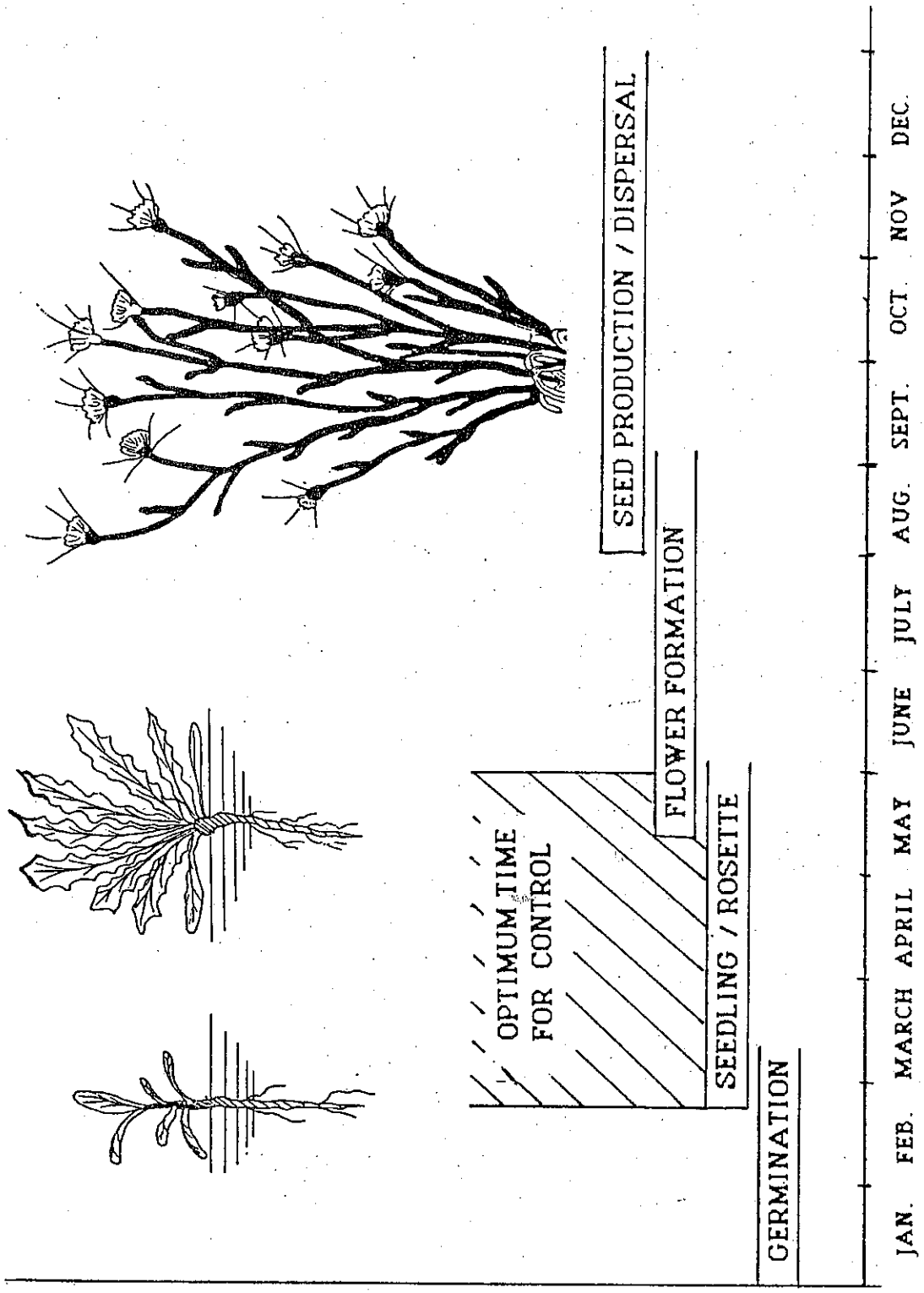
Additional Considerations:

1) It is a Restricted Material; designated protective clothing must be worn while mixing.
2) It is nonselective.

Chlorsulfuron

Chlorsulfuron has shown promise for selective control of broadleafs in grass crops. The product was first used in California for selective broadleaf control in grain crops, but was discontinued because California growers rotate crops, and chlorsulfuron has a long residual effect against sensitive broadleafs. Studies with sensitive crops show that at labeled rates, the herbicide can cause damage up to 18 months after application. There are several experiments currently being carried out in California parklands, including one on Angel Island, testing the combination of glysophate with chlorsulfuron for both post and preemergence control of brooms. The problem with chlorsulfuron is that even at lower labeled rates, some inhibition of annual grasses occurs. Where chlorsulfuron is used in a yellow starthistle control program, it must be used with the knowledge that sensitive grasses and broadleafs may be affected for more than a year.

Figure 1. Growth Stages of Yellow Starthistle



Courtesy of U.C. Cooperative Extension, 1985

Table 1. Distribution by Area

Courtesy of U.C. Cooperative Extension, 1985

Gross acreage and percentage of yellow starthistle and precipitation range of major California drainage areas

Drainage area	Yellow starthistle Acreage	Yellow starthistle Percentage	Precipitation range, 1931-55
			Inches
1. Northeast Interior Basins	58,219	0.7	8-24
2. Sacramento Drainage	3,235,035	40.9	12-72
3. North Coast Drainage	2,792,186	35.3	12-80
4. Central Coast Drainage	355,042	4.5	16-56
5. San Joaquin Drainage	1,458,300	18.4	8-56
6. Southeast Desert Basins	2,796	0.1	4-24
7. South Coast Drainage	4,256	0.1	12-40
TOTAL	7,905,834		

Fig. 2. The Sacramento Drainage Basin has the largest acreage of yellow starthistle, with the North Coast Basin not far behind, according to a survey of counties.

Table 2. Distribution by County

Yellow starthistle infestations reported in California

County	Gross acreage infested in county Level*	Acres	Comment
Alameda	H	20,000	In all but urban areas
Amador	H	243,000	Western section throughout foothills
Butte	H	463,000	Throughout western and central areas
Calaveras	H	100,000	Throughout county up to 4,000 feet
Colusa	H	246,000	Throughout valley floor
Contra Costa	H	470,400	Scattered infestations throughout county
Del Norte	L	4	Near Klamath Glen, Gasquet, and by Collier Tunnel
El Dorado	H	5,000	Western area to 3,500 feet
Fresno	H	3,000	Increasing in distribution
Glenn	H	10,000	Throughout county, both valley floor and foothills
Humboldt	H	686,000	Countywide, roadsides, mountain valleys, pastures wastelands
Kern	L	100	Spreading very slowly in Tehachapi foothills
King	L	10	Scattered, small infestations throughout county
Lake	H	800,000	Throughout; density varies
Lassen	L	500	Heaviest infestations near Shasta county line
Los Angeles	L	2	About 20 small active infestations
Madera	L	300	In previously cultivated areas returned to native pasture
Marin	H	2,000	In Laguna Lake and Novato areas
Mariposa	H	200,000	Along ditches and roadsides
Mendocino	H	250,000	Scattered to heavy infestations in rangelands and cereal-growing areas
Merced	H	1,000	In dry fields, fencerows, ditchbanks, irrigation borders
Modoc	L	120	Scattered, mostly in noncrop areas
Monterey	H	6,000	Major infestations in Hunter-Liggett Reservation
Napa	H	242,560	All over county in rangelands, roadsides, wastelands
Nevada	H	200,000	Covers half of county, widely scattered
Placer	H	274,000	Covers half of county
Plumas	L	800	Along roadsides and some dryland pastures
Riverside	L	251+	Infestations near Beaumont, Elsinore, Cleveland Nat. Forest
Sacramento	H	320,000	Scattered throughout county
San Benito	H	72,000	Along ditches, roadsides, canal banks, pastures
San Bernardino	H	2,890	Western side of county, near Chino, Cajon Junction, other
San Diego	L	15	Small infestations along ditch-banks, canals, fencerows
San Joaquin	H	72,000	Scattered all over county
San Luis Obispo	H	10,000	Widely distributed, central county
San Mateo	L	27	Only a few plants in scattered areas, center of county, Hwy 101, along coast
Santa Barbara	H	3,000	Extensive in Los Padres Nat. Forest
Santa Clara	H	5,000	Heavy along right-of-ways and in foothills
Santa Cruz	L	75	Mostly in noncrop areas
Shasta	H	400,000+	In most parts of county under 3,200 feet
Sierra	L	5	Mostly roadside infestations
Siskiyou	H	768,000	Central areas including Shasta Valley, some in Scott Valley
Solano	H	20,000+	Common in almost all dryland pastures and roadways
Sonoma	H	100,000	Widespread throughout
Stanislaus	H	227,000	Mostly valley floor, roadsides, canal banks, waste areas, pastures
Sutter	H	200,000	Scattered throughout
Tehama	H	40,000	More prevalent on valley floor than in foothills
Trinity	H	612,672	Along highways, roads, logging areas, open fields
Tulare	H	10,000	Mostly in western section
Tuolumne	H	212,818	Widespread up to 2,800 feet
Ventura	L	5	Very few plants, mostly on range and grain land
Yolo	H	198,600	Widely distributed throughout foothills, western section.
Yuba	H	407,680	Distribution countywide

NOTE: The following counties had no known infestations: Alpine, Imperial, Inyo, Mono, Orange, and San Francisco.
*Infestation levels: H=infestations over 1,000 acres; L=under 1,000 acres.

Courtesy of U.C. Cooperative Extension, 1985

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METHODS

This report is based upon information gathered from literature searches, personal observations, and oral interviews. Initially a Dialog computer search was done to identify key references. Additional references were identified from the reference sections of the Dialog references. Using the CDPR outline to determine format, a rough draft was created on the A.T.and T. computer using Wordmarc word processing software. The first draft was then evaluated within CDFA. Corrections were made, and the second draft was written. The report was then sent to outside reviewers. Corrections and additions were then made based on input from the outside reviewers.

Figures and tables were taken from the sources cited. Some tables and figures were created, using the Wordmarc software, or on the MacIntosh computer using MacPaint software.