ELEMENT STEWARDSHIP ABSTRACT
for

Carduus pycnocephalus

Italian Thistle

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The Nature Conservancy
Element Stewardship Abstract
For *Carduus pycnocephalus*

I. IDENTIFIERS

Common Name: ITALIAN THISTLE Global Rank: G?

General Description:
Carduus pycnocephalus, a member of the Thistle tribe of the Composite family, is an erect winter annual herb 3-18 dm tall.

Diagnostic Characteristics:
Carduus pycnocephalus can be distinguished from other thistle species by its relatively small and few terminal flowerheads and narrow phyllaries with copious tiny, firm, forward-pointing hairs, especially on the midrib (Hitchcock and Cronquist 1973).

II. STEWARDSHIP SUMMARY

Carduus pycnocephalus, a vigorous annual thistle, arrived in California during the 1930s and has since become a serious weed problem. It occurs in a variety of disturbed habitats and germinates rapidly and in large numbers. Hand pulling, cultiva- tion, and grazing are all effective control measures. Biological control agents, particularly the weevil Rhinocyllus conicus and the rust Puccinia Carduii-pycnocephali, show considerable promise in controlling C. pycnocephalus. Chemicals such as Picloram and 2,4-D may be of some use in controlling the weed, but an integrated management program involving a combination of techniques will prove most effective.

III. NATURAL HISTORY

Range:
Carduus pycnocephalus originated in western and southern Europe but today is widespread throughout temperate parts of the world. It is a serious pest in Australia, New Zealand, South Africa, Pakistan, Iran, and Europe. In the U.S. it is found in only a few parts of Texas and Arkansas but is rapidly spreading and "out of control" in most of California (Dunn 1976). C. pycnocephalus apparently arrived in California during the 1930s (Goeden 1974).

Habitat:
It displaces desirable forage or cover plants, but more commonly colonizes disturbed habitats where interspecific competition is less intense (Goeden 1974). It is most abundant in coastal areas and occurs as a weed of pastures, ranges, roadsides, rural areas, fallow cropland, railroad rights-of-way, field margins, and ditchbanks (Goeden and Ricker 1978).

However, this weed does displace more desirable forage or cover plants. The blanketing effect of overwintering rosettes can severely reduce the establishment of other plants, as the leaves of the rosette can become erect in dense stands (Parsons 1973). If there is reasonable ground cover during the late summer and autumn the thistle will not invade a site, but it will come in following overgrazing or creation of fire breaks (Parsons 1973). Drought favors a rapid increase in the thistle population. On soils of naturally high fertility, thistle invasion can be expected at an earlier stage than on poorer soils. Thistles will invade basalt soils earlier than granite soils, and granite soils before sedimentary soils (Wheatley and Collett 1981).(Goeden and Ricker 1978).

C. pycnocephalus has been rapidly spreading on rangelands previ- ously dominated by alien annual grasses (Evans et al. 1979). This is partly due to its germination requirements and timing. C. pycnocephalus germinates at temperature and moisture regimes and in seedbed environments which would inhibit the germination of the alien annual grass species that presently dominate California grasslands. The seeds start to germinate in the fall with the first effective rain. Seedlings grow through the winter as rosettes and produce flowering stalks in the late spring before the summer drought.

Reproduction:
Carduus pycnocephalus reproduces only by seed. It prefers soils of high fertility, and its seedlings establish best on bare or disturbed sites (Wheatley 1971, Parsons 1973).

C. pycnocephalus seeds are mucilaginous, unlike most other thistles. The mucilage is abundant and adhesive enough to aid in seed dispersal (Evans et al. 1979).

C. pycnocephalus seeds exhibit polymorphism, with brown seeds that have less mucilage and germinate at lower temperatures than silver seeds. The brown seeds do not usually dehisce from the seedheads, and this may be important in the establishment of these seeds in the seedbed litter (Evans et al. 1979). GERMINATION AND GROWTH

Seed germination rate in Carduus pycnocephalus is very high, ranging between 83-96%. The seeds germinate at a wide variety of constant and alternating temperatures. The greatest diurnal fluctuation that supported optimum germination was 10 C for 16 hours and 35 C for 8 hours in each 24-hour period. Even with freezing temperatures during the daily cold period, germination was optimum if warm-period temperatures were from 5 to 20 C (Evans et al. 1979).

No after-ripening is required, and seeds can germinate either rapidly or after a long dormancy period. Seeds of C. pycnocephalus exhibit rapid germination (within 2 weeks) at optimum temperatures (Evans et al. 1979). Bendall (1974) found that 85% of Carduus pycnocephalus seeds produce germination inhibitors, but they are readily leached. The length of time the seeds can survive in the soil is not known but appears to be at least 8 years (Parsons 1973).

C. pycnocephalus can germinate at a variety of soil depths. Generally it does poorly on the surface of a bare seedbed, but on the surface of clay soils it shows 70% germination. At a depth of 0.5-2.0 cm germination is highest, but some seeds germinate to a depth of 8 cm (Evans et al. 1979). Seeds buried 1.3 cm deep show the highest percentage emergence, whereas 20 to 25% of seeds buried 5 to 10 cm deep remain dormant.

The growth of C. pycnocephalus is favored more by the addition of nitrogen than by phosphorus or potassium. High pH (6.5) also favors growth (Bendall 1975). SEED DISPERSAL

C. pycnocephalus does not reproduce vegetatively, but its seeds are well equipped for dispersal by wind because of the large pappus and relatively small size. The distance that seeds can be spread by wind is not known, but it is at least several hundred meters. Seeds are also spread when infested pastures are cut and the hay fed to animals on clean areas. Seed dispersal by water and on animals and machinery is less important (Parsons 1973). Ants may also play a role in dispersing the seeds (Uphof 1942).

Impacts:
Though some Carduus species are known to accumulate nitrates in toxic quantities, C. pycnocephalus has apparently not been incriminated as a toxic weed (Goeden 1974). The primary threat of this weed is its ability to dominate sites throughout California. C. pycnocephalus is a problem on Nature Conservancy property in this state and presents additional problems on grazed pastures. It reduces the establishment of annual grasses and reduces the value of hay and other crops due to the blanketing effect of the overwintering rosettes, high rate and timing of germination, and its broad range of germination conditions.

IV. CONDITION

V. MANAGEMENT/MONITORING

Management Requirements:
With the right combination of control measures, it should be possible to eliminate C. pycnocephalus from selected areas. Its inability to reproduce vegetatively makes control easier, but constant monitoring will be necessary due to its potentially long seed dormancy (to 8 years).

Control of C. pycnocephalus requires active management once it becomes established in an area. Without management it cannot be eliminated and may completely carpet the site. MECHANICAL CONTROL

Cultivation before seed production will eventually eliminate thistles, but only if repeated for several years. According to Wheatley and Collett (1981), hand-hoeing is effective for small patches, but make sure to sever the root a good 10 cm below ground level. Mowing or slashing is not always reliable because the plant can regrow from the base and produce seeds very quickly.

Similarly, plants which are cut close to flowering time can produce seed on the cut portion. A significant amount of seed can be produced even if thistles are constantly mowed at 8 cm (Tasmanian Department of Agriculture 1977). Slashing is more effective than mowing as it destroys the aerial part of the plant more thoroughly (Parsons 1973).

For larger areas where the thistles are dominant, cultivation and cropping is a successful method of control provided a vigorous perennial pasture is established immediately after the cropping phase. In high fertility situations, using a roller to compact the soil is recommended during seedbed preparation (but not during seed sowing). This usually forces a massive germination of thistles that can be destroyed during cultivation (Wheatley and Collett 1981). GRAZING

Grazing by sheep, goats, and horses can be effective in control- ling thistles, but cattle are of little value (Parsons 1973). Bendall (1974) describes a grazing control method that has proven successful in Australia: thistle-infested areas are closed to grazing in the fall when seedlings appear. They are left ungrazed until the pasture has reached a height of 10-15 cm (about 6 to 10 weeks). The areas are then heavily grazed with sheep at more than twice the normal stocking rate. Sheep selectively graze the tender thistles and will kill 90-95% of the weeds. Only 2-3 weeks should be required for control. For this method to be successful, the autumn grazing break is necessary so that vigorous growth of other plants is allowed to occur, forcing the thistles to grow tall and tender. Continuous grazing significantly reduces thistle numbers but is not as effective as the use of an autumn break (Bendall 1973). BIOLOGICAL CONTROL

Biological control techniques for Carduus species have been extensively studied. Carduus pycnocephalus was one of the first weeds selected for biological control study by the USDA (Schroeder 1980). The search for its natural enemies has included Italy, Greece, Iran, and Pakistan, as well as southern California (Baloch et al. 1971, Baloch and Kahn 1973, Goeden 1974). According to Goeden (1974), C. pycnocephalus serves as an alternative food-plant or breeding host to a diversity of phytophagous insects, most of which are euryphagous, ectophagous, sap- or foliage-feeding species.

In southern Europe, more than 80 species are associated with C. pycnocephalus; about one third of them are stenophagous and restricted to host plants belonging to the tribe Cynareae.

In southern Europe, all major parts of C. pycnocephalus plants are damaged by one or more insect species, whereas in southern California the thistles are relatively free of insect damage. In California, more than 40 species of indigenous or introduced phytophagous insects have adopted this alien weed as an alternate food-plant, at least 15 of which also find it a suitable reproduc- tive host. Unfortunately, half of the identified species of insects found feeding on C. pycnocephalus in southern California are also pests of cultivated plants, thus not good choices for biocontrol.

Only three insect species appear to hold promise as biological control agents in California (Goeden 1974). These species are Psylliodes chalsomera, Rhinocyllus conicus, and Ceutorhynchuys trimaculatus. All three species are unknown as artichoke or safflower pests, apparently only reproduce on Cadruinae, cause injury to vital plant parts at a critical growth stage of their host-plant (and thus appear capable of influencing the reproductive potential of C. pycnocephalus), and occur over a relatively wide geographic area. However, according to Charles Turner (1985) of the USDA Biocontrol Lab in Albany, California, it is possible that these insects may also prey on several of the endangered native thistles in the genus CIRSIUM. Because of this concern, their use has been somewhat limited.

Psylliodes chalcomera was a fairly consistent associate of C. pycnocephalus in its vegetative and early reproductive stages throughout central and southern Italy. The adults are foliage feeders, but more importantly the larvae mine crowns of rosettes and tips of expanding and expanded shoots, blasting the latter, and thus reduce the production of flowerheads. This species has been studied in depth by USDA entomologists as a natural enemy of musk thistle, but certainly should also be considered for importation into California for C. pycnocephalus control" (Goeden 1974).

Larvae of Rhinocyllus conicus feed within the flowerheads of C. pycnocephalus, mining the receptacle and destroying the developing achenes (Goeden 1974, 1978). This weevil mainly reproduces on certain thistles belonging to the Carduus-Silybumcirsium complex. It survives best at low temperatures with short photoperiods (Kok 1979). Rhinocyllus conicus was first introduced into Canada in 1968 for the biological control of musk thistle (Carduus nutans L.) and plumeless thistle (Carduus acanthoides L.) (Harris and Zwolfer 1971).

It was imported into California in 1969 for the biological control of milk thistle (Silybum marianum Gaertn.) (Hawkes et al. 1972) and in 1973 to control C. pycnocephalus in southern California (Goeden and Ricker 1978). After their introduction to See Canyon in southern California, the weevil destroyed 90% of the achenes and infested 91% of the capitula; however, the population of C. pycnocephalus did not decline (Goeden and Ricker 1978). The weevil was released on infestations of Italian and slender-flower thistles at 16 sites in 11 counties in northern California during 1975-77 with establishment at most of the sites (Hawkes et al. 1978).

Certorhynchus trimaculatus occurs in Europe and northern Africa (Bolt et al. 1980). "Larvae thought to be Ceutorhynchus trimacu- latus were recovered from mines in crowns of C. pycnocephalus rosettes in central Italy, though only adults were positively identified as fairly consistent associates of this plant. This weevil has been studied in depth as a candidate biological control agent by USDA entomologists and may be usefully employed against C. pycnocephalus and other CARDUUS species in North America in the near future" (Goeden 1974).

The fungal rust Puccinia Carduii-pycnocephali Sydow, is known to occur only on the genus Carduus (Batra et al. 1981). Repeated greenhouse inoculations of the rust on growing rosettes signif- icantly reduced the growth of C. pycnocephalus but not the number of florets (Oliveri 1984). In field situations, the added hardship of intra- and interspecific competition may cause a greater effect on thistle populations. Optimum conditions for rust infection (18 to 20 C, 90 to 100% relative humidity) are likely to occur in autumn, in regions with a Mediterranean climate. This period also corresponds to the germination and vegetative growth periods of C. pycnocephalus (Oliveri 1984). Two other rusts, Puccinia centaureae dc and Puccinia galatica Sydow are also reported to attack Carduus pycnocephalus, but their impact has not been researched (Batra et al. 1981).
CHEMICAL CONTROL

The use of herbicides to control C. pycnocephalus may not be appropriate on natural areas such as Nature Conservancy preserves. Near streams or lakes particular cautions should be taken when using herbicides. Prior to using any herbicide, check with the County Agricultural Commissioner to determine which chemicals are legal to use in a given situation. The labels also give more precise information on mixing and safety precautions. A Certified Pest Control Applicator should be hired for large jobs or those requiring nonselective herbicides.

A variety of herbicides have been used on C. pycnocephalus, but they give only temporary control (Wheatley and Collett 1981).

Picloram (Tordon): Dr. Jim McHenry (1985) of the University of California, Davis, recommends picloram to control C. pycnocephalus on Nature Conservancy lands. Since it is a nonselective herbicide, it must be carefully applied. It is most effective when applied in February or March at 1/8 to 1/16 lb acid equivalent per acre. Picloram kills half the test animals (LD50) at 8000 mg/kg body weight and is considered to be of "relatively no hazard." One drawback is its long persistence in the soil, up to 18 months.

2,4-D: 2,4-D is a phenoxy-type herbicide used for broadleaf weed control that works as a selective hormone or growth regulator. 2,4-D does not affect grasses. It is foliar absorbed and trans- located, making it effective in destroying the roots. 2,4-D is available in ester, amine, emulsifiable acid, and low volatile ester formulations. The chemical is noncorrosive and is generally considered nonharmful to wildlife. 2,4-D is lethal to 50% of tested animals (LD50) at 300-1000 mg/kg body weight and is classified as being of "little" to "some" hazard. It persists in the soil for 1-4 weeks.

2,4-D has been applied to C. pycnocephalus with limited success (Taylor 1977). 2,4-D ester should be applied when the thistles have a central stock height of no greater than 0.25 m (Wheatley and Collett 1981). Application should be at the rate of 1-1.5 lbs/100 gallons of water with 1 quart of surfactant/100 gallons. Surfactants affect the surface property of the spray by lowering surface tension to increase the herbicide's effectiveness.

2,4-D can be used in combination with biological control measures to control Carduus. Several recent studies (Kok 1980, Trumble and Kok 1980a, 1980b) have shown that the weevil Rhinocyllus conicus is not adversely affected by field applications of 2,4-D.

Selective weed oils: There are several petroleum oils used for weed control. The herbicidal use of oils depends on their chemical and physical properties. Most contact oils evaporate slowly and owe their plant toxicity to their high content of aromatic compounds. Spraying oil on thistle will be effective only if entire plants are coated.

APPLYING HERBICIDES: Herbicides can be applied uniformly over an area (for large infestations) or by spot spraying only the individual plants. Dr. McHenry recommends using a flat-fan nozzle (Spraying Systems Co. #8003 or 8004 nozzle tip) rather than the cone nozzles available on most garden sprayers. Cone sprayers produce greater atomization of the chemicals and increase the chance of drift into unwanted areas. Spraying should be done on calm days with dry plants (dew or rain will dilute the herbicide, reducing its effectiveness). When spraying large areas, a horizontal boom (6-8 feet long) made from aluminum tubing will improve herbicide coverage.

Management Programs:
Carduus pycnocephalus is present on both the Ring Mountain and Jepson Prairie preserves in California, with Ring Mountain having the most significant infestation. Although other thistle species present greater problems on these preserves, C. pycnocephalus control has been included as an adjunct to other control efforts. Former preserve manager Greg Wolley (1986) has used both hand pulling and cutting to destroy the plants at Ring Mountain Preserve, CA. This has proven most effective during the spring and early summer.

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Monitoring Requirements:
Monitoring is needed to determine the effectiveness of any C. pycnocephalus control measures. The necessity for constant monitoring is all the more important given this weed's potentially long seed dormancy period (to 8 years).

VI. RESEARCH

Management Research Needs:
A great deal of research has been conducted on Carduus species throughout the world, but much more needs to be done on Carduus pycnocephalus. Additional research needs to be conducted on insects that can be used to control C. pycnocephalus and on the potential impact of these insects upon endangered native Cirsium species (Kok et al. 1982). Several

management techniques appear promising, and integrated control operations involving a combination of practices need investigation. The effects of prescribed fire on C. pycnocephalus also need investigation.

VII. ADDITIONAL TOPICS

VIII. INFORMATION SOURCES

IX. DOCUMENT PREPARATION & MAINTENANCE

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