

Weed Control by Species:

**Elkhorn Slough National
Estuarine Research Reserve**

October 2000



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Weed Control by Species

The following list includes weed biology that will affect the choice of control methods, and contains information on the removal of different species. ESNERR weeds are listed in alphabetical order, and weeds of particular concern on the Reserve are underlined. References can be found in the Vegetation Management and Restoration Plan bibliography.

***Acacia* spp. or acacia**

Although there are no documented acacia on the Reserve presently, there are several species of acacia present locally, any of which can be invasive. The one most commonly seen is *Acacia dealbata*, which forms dense thickets along roadsides. *Acacia melanoxylon*, or Blackwood acacia, can also be found locally, and a few other species are present here to a lesser extent (Moore and Hyland 1998).

Very small trees can be pulled or dug out, but larger ones must be cut. Because acacia readily re-sprouts both from the cut stump and from lateral roots connected to it, steps must be taken to kill the stump and its root system. One way to do this is to prevent exposure of the stump to sunlight. Cut the stump level, close to the ground, and cover it with one or more layers to 10 mm black plastic. The edges of the plastic must be completely buried, as light will keep the stump alive. Alternatively, the stump can be treated with a 1:1 mixture of Roundup to water. This must be completed within 1 or 2 minutes of cutting to be effective. Painting this mixture on with a brush rather than spraying localizes herbicide application (Moore and Hyland 1998).

Acacia, like eucalyptus, make an excellent firewood and can be readily sold if cut

and split, or given away (Moore and Hyland 1998).

Acacia spreads by sending up new shoots from lateral roots as well as from seedlings, so the site must be revisited once a year or so to remove any new growth. Seedlings can easily be pulled by hand when small, but sprouts from lateral roots will have to be dug out together with the connecting root (Moore and Hyland 1998).

***Anthemis cotula* or Mayweed chamomile**

Anthemis is an annual forb originally from Europe that was introduced into North America as an ornamental. It grows from a taproot with a secondary dense, fibrous root system that spreads rapidly during wet periods. Mayweed chamomile flowers mid-May through October. This plant reproduces primarily by seeds, although some basal shoots that are lying along the ground will develop adventitious roots along the contact surface. These weeds are prolific seed producers that can produce up to 960,000 seeds per plant. Seed may remain viable in the soil for 4-6 years (CNAP 2000).

Infestations can be mowed or tilled several times a year to prevent seed production. Smaller infestations can be pulled by hand. Mowing or pulling must be carried out early enough to prevent seed production. More than one mowing may be needed in most years. If herbicides are needed, metsulfuron is very effective, and is the preferred herbicide. Picloram or dicamba at 0.5 lb ai/acre can be applied to seedlings for effective control. Picloram or glyphosate at 1.5 lb ai/acre will control established plants when applied up to the bud or early flower stage (CNAP 2000).

***Atriplex semibaccata* or Australian saltbush**

Widespread high marsh and coastal exotic, a List A CalEPPC weed. *Atriplex*

semibaccata is a low-growing Australian perennial that reproduces only by seed. Its seed germinate from early April onward, and the plant produces seed from summer into December (UCDANR 1996).

***Avena barbata* and *A. fatua* or slender wild oat and wild oat**

CalEPPC lists these annual grasses as significant threats to California wildlands, especially on coastal slopes, coastal sage scrub and disturbed sites. *Avena fatua* is an European winter annual that adapts to many different soil types. Its seed germinates from late fall through early spring, and the plant matures, producing the next generation of seed, in April through June (UCDANR 1996). *Avena* spp. have shallow, fibrous root systems. Pull, hoe, or dig wild oat in early spring, when the plants are small. Remove them before they set seed; once in the soil, seeds of wild oat can remain dormant for up to ten years, making management difficult. Solarization and mulching can suppress seedling germination. If chemical control is necessary, use a pre-emergence product containing EPTC, oryzalin, or trifluralin in the fall. Products containing fluazifop-butyl or sethoxydim are selective postemergence herbicides for grasses growing among broad-leaved plants. A nonselective herbicide containing glyphosate or glufosinate-ammonium will kill wild oat (Sunset 1998).

***Brassica nigra* or black mustard**

A CalEPPC List B exotic that is common in coastal communities, especially in fog-belt grasslands and disturbed areas. Wild mustards are generally winter annuals, sprouting in November to April, growing slowly over winter, and flowering in the spring (UCDANR 1996). *B. nigra* can grow up to 8 feet high. Pull or hoe mustard when it is

young and before it sets seed—the plants are easy to pull from moist soil. If chemical control is necessary use a pre-emergence herbicide containing isoxaben in the fall.

Products containing MCPP, MCPA, and dicamba are also effective on mustard.

Products containing herbicidal soap will control young mustard plants. Or apply a nonselective herbicide containing glufosinate-ammonium or glyphosate (Sunset 1998).

***Bromus diandrus* or ripgut**

CalEPPC considers this annual grass to be a significant threat to California's wildlands, particularly coastal dunes, coastal sage scrub, and grasslands. *Bromus diandrus* germinates from November through April, and the plant matures in May and June (UCDANR 1996). It reproduces exclusively by seed, and management of its seed bank should be the ultimate target of control efforts. Ripgut very susceptible to fire (DiTomaso 1999), and managers at Marina State Beach have been testing the effectiveness of herbicides as well.

At Marina State Beach, Ian Harlen and Kriss Neumann have been spraying Fusilade, 0.5% (10 gal. volume with 6.5 fl. Oz Fusilade DX in a 3 gal. backpack sprayer) to control invasive populations of *B. diandrus* in coastal dune scrub. Fusilade targets monocots only, and may not cause permanent damage to native rhizomatous grasses, which have nodes along their rhizomes that can stop the flow of herbicide throughout the entire plant. At least over the short term, this herbicide appears to be very effective in killing ripgut, while not effecting perennial scrub natives (Harlen and Neuman 1999).

***Capsella bursa-pastoris* or shepherd's purse**

Capsella is an annual weed that reproduces by seed. It flowers in the spring, and its

seeds germinate from November through March. Dig out early in the season, when the plants are young, before seed sets. If chemicals are necessary, use a product containing dicamba, or spot treat with herbicidal soap or glyphosate (Sunset 1998).

Cardaria draba or hoary cress

Cardaria is a central coast List A weed found in coastal dunes and sandy soils near the coast. It is originally from southwest Asia, and it was transported to the United States in the late 1800's. Hoary cress is a hardy perennial with a deep, long-lived taproot. Horizontal roots are rhizomatous. It germinates or breaks dormancy during February and March and blooms from May to June, forming large white patches in fields. Its seeds matures in June and July (UCDANR 1996). One plant can produce 1,200 to 4,800 seeds (CNAP 2000). Seeds germinate well, but only remain viable in the soil for 3 years. In the absence of a competitor, a single plant can spread over an area 12 feet in diameter in a single year (CNAP 2000).

Hoary cress thrives in sunny, disturbed and irrigated areas but is less of a problem in undisturbed settings. The plants can spread rapidly, especially through their extremely persistent root systems. These roots can grow a few meters or more deep, and lateral roots grow for long distances and then produce more plants. These large root systems are produced quickly. A 25-day old *C. draba* plant will develop a taproot 25 cm deep and 5-6 horizontal roots with numerous vegetative buds. Intact or damaged roots left behind after control efforts can resprout. Additionally, hoary cress seeds are easily transported. They may be moved by water in drainage ditches. They can be inadvertently spread by human activity, since the seeds can contaminate crop seeds or the soil in root crops. In this way they are dispersed along roadsides and railways. Populations located along

roads and ditches should be controlled to avoid dispersal of the seeds to other locations (Lyons and Meyers-Rice, 1998).

Mowing 2-3 times a year for several years may slow the spread and reduce seed production. Mowing may increase the effectiveness of subsequent herbicide application. Mowing should be conducted during the bud stage and repeated when the plants re-bud. The effectiveness of a mowing program can be increased by planting native plants as competitors. However, mowing to control hoary cresses is controversial, particularly since machinery can spread *Cardaria* infestations. Therefore, all root fragments should be removed from machinery before it is used in other, uninfested fields (Lyons and Meyers-Rice, 1998). Fire may actually favor the fast-growing hoary cress, and should not be used as a management tool (CNAP 2000).

Cardaria root systems can also be exhausted through repeated cultivation, resulting in complete elimination if the follow-up occurs within ten days of weed reemergence. Use an initial deep plowing, followed by 10-13cm deep cultivations every five days for the first six to eight weeks of growth, and then less frequent tilling into October. Using this regimen, the plants should be killed within two years. By tilling less frequently, *Cardaria* should die back after three consecutive years. Even one cultivation before seed set can reduce infestations. Some workers have successfully eradicated *C. pubescens* in one and a half seasons by hoeing every four weeks. Cultivation is generally more successful when used with a competitive crop (Lyons and Meyers-Rice, 1998).

Herbicide treatment for *C. draba* is effective, but in most cases a multi-year commitment is required. *Cardaria draba* can re-establish rapidly if control measures are stopped too soon. Even so, just a year of herbicidal treatment may help in restoration

efforts where competitive plants are also being grown. The best time to apply herbicides in May or June before flowering. The non-crop herbicides metsulfuron and chlorsulfuron are the most effective herbicides as long as the plants still have green tissue. It is important to use a non-ionic surfactant with the herbicide. 2,4-D + dicamba is very effective when applied during the early pre-bud stage (late May through early June). Glyphosate at 1.5 lb ai/acre applied during the flower stage will provide good control of hoary cress. Picloram does not control this plant. Also, spraying followed by a spring mowing can control hoary cress by up to 90% (Lyons and Meyers-Rice 1998, CNAP 2000).

The most successful control efforts combine several management practices such as herbicide application and physical removal by hoeing or tilling, followed by competitive species plantings. A combination of weed-whacking and applying 2,4-D from a backpack sprayer has provided 50% control at a preserve maintained by The Nature Conservancy. (Lyons and Meyers-Rice, 1998).

Sheep will eat *C. draba*, and especially like seedlings (Lyons and Meyers-Rice, 1998). However, evidence showing sheep's effectiveness at controlling this weed is limited (CNAP 2000).

***Carduus pycnocephalus* or Italian thistle**

Carduus pycnocephalus is a vigorous annual thistle that arrived from Europe in the 1930's and that has since become a serious weed problem (CalEPPC List B weed). It occurs in a variety of disturbed habitats and germinates rapidly in large numbers. Italian thistle displaces desirable natives and commonly colonizes disturbed habitats where interspecific competition is less intense. If there is reasonable ground cover during the

late summer and autumn, the thistle will not invade a site, but drought favors a rapid increase in the thistle population (Pitcher and Russo 1988).

Carduus reproduces only by seed. Seeds start to germinate in the fall with the first effective rain (UCDANR 1996 reports germination beginning in April), grow through the winter as rosettes, and produce flowering stalks in the late spring before the summer drought. The seed germination rate of this exotic is high (83-96%), and seeds can survive in the soil at least 8 years (Pitcher and Russo 1988)..

With the right combination of control measures, it should be possible to eliminate *Carduus* from selected areas. Its inability to reproduce vegetatively makes control easier, but constant monitoring will be necessary due to its long seed dormancy. Control of *Carduus* requires active management once it becomes established in an area. Without management it cannot be eliminated and may completely carpet the site. Cultivation before seed production will eventually eliminate thistles, but only if repeated for several years. Hand-hoeing is effective for small patches, but make sure to sever the root at least 10 cm below ground level (Pitcher and Russo 1988).

Mowing and slashing is not reliable because the plant can regrow from the base and produce seeds very quickly. In addition, 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 (Pitcher and Russo 1988).

For larger area 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 (Pitcher and Russo 1988).

Grazing by sheep, goats, and horses can be effective in controlling thistles, but cattle are of little value (Pitcher and Russo 1988). Bruce Delgado is using sheep grazing to control Italian thistle on Fort Ord.

A variety of herbicides, including Picloram (Tordon) and 2,4-D, have been used on *Carduus*, but they give only temporary control. Picloram is a nonselective herbicide and 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 is considered to be of “relatively no hazard,” but persists in the soil up to 18 months (Pitcher and Russo 1988).

2,4-D has been applied to *Carduus* with limited success. 2,4-D ester should be applied when the thistles have a central stock height of no greater than 0.25 m. 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 (Pitcher and Russo 1988).

***Carpobrotus chilensis*, *C. edulis* or sea fig and hottentot fig**

Carpobrotus is a leafy, succulent plant that forms nearly uninterrupted mats over much of California’s dunes. It occurs patchily on the Reserve.

Iceplant has a weak root system and can be effectively controlled by carefully pulling out the plant and its vegetative suckers by the roots, or by rolling a group of plants up in large mats. Place unwanted plant material where it cannot re-root. Small portions of the plant can be left in place if they are simply flipped over so that their roots are in the air. For large patches, piles should be made as tall and as narrow as possible

because there may be some resprouting from the piles. Be aware, however, that iceplant stores vast amounts of water in its leaves, making it quite heavy to carry. Keep this in mind when selecting a place to stack the pulled plants (Moore and Hyland 1998).

Native vascular plants often quickly re-colonize cleared areas. It appears that this exotic can be eradicated on a site-specific basis by hand-weeding over a period of years (Bowler 1996).

***Centaurea melitensis* or tocalote**

A widespread CalEPPC List B pest that may be very invasive

***Centaurea solstitialis* or yellow starthistle**

Yellow starthistle is not a problem on Reserve, but it does occur in watershed. It is considered by some to be the most invasive weed in California grasslands, and it is a CalEPPC List A plant. It is an annual that germinates in February and March and matures in June and July (UCDANR 1996); it produces viable seeds at late senescence of flower head, and it is therefore vital to control before that point (DiTomaso 1999).

Effective control generally needs to incorporate several different methods. Burning alone is not sufficient to control yellow starthistle, because fires hot enough to kill starthistle plants may not kill mature seed. Therefore, managers must burn starthistle in the early flowering stages, before seed matures. Since plants will still be green at this time, getting a hot enough fire requires either adequate thatch from other plants (such as annual grasses) or pre-treating the area with herbicide or mowing to create enough burnable fuel. More insidious, however, is the fact that because of its copious persistent seed bank, starthistle is likely to reinvade site from which it has been chased by fire. This

is exactly what researchers discovered on infested sites at Sugar Loaf Ridge State Park. Led by U.C. Davis weed scientist Joe DiTomaso, researchers discovered that two consecutive years of burning gave 68% control of starthistle and three years gave over 90% control. The effectiveness of the three year burn cycle was reflected in a 99.5% reduction in starthistle seeds in the soil. However, when sites that had undergone three years of burning were allowed only a single year without fire, the starthistle seed bank increased 30-fold, resulting in a corresponding increase in plant establishment and reduction in diversity. Their conclusion: prescribed burning can be a valuable tool for starthistle suppression, but should be part of an integrated strategy that incorporates other methods (Wirka 1999b).

DiTomaso (1999) suggests the following control plan: 1st year—late winter/spring spray with Transline. This will also injure native legumes. So the 2nd year use burnings, which increases legumes. The 3rd year use spot treatments/hand weed.

Another option is: 1st year burn, 2nd year mow, 3rd year spot treat. However, burning must be done before thistle goes to seed. In most years, DiTomaso (1999) reports that burning should be done the first week of July, or if a drought year, late June. If using burning alone, management will need approximately 3 years of treatment to knock down seedbank. Little progress will be evident the first year. Use fire lines and back burns, or spray fire retardant to form a fire line—star thistle burns are fast.

Rushmore (1997) recommends a program of winter burning (before plants reach their full rosette stage) coupled with spring cuttings, when only 2% of the thistles are in flower. Dremann (1996) has found starthistle can also be controlled with shading. Maintaining shade-producing standing grasses or thatch may be the most cost-effective

method of controlling starthistle. Shading can also be created using mulch. Two and a half inches (250 bales/acre) of wheat straw killed 88% of starthistle, while 5 inches (500 bales/acre) eradicated all thistle plants. This ability of grasses to shade out starthistle argues against cutting, grazing, or otherwise disturbing stands of grasses during starthistle's growing season. Therefore, Dremann (1996) recommends that land managers not allow grazing on grasslands infected with yellow starthistle. If grasses are to be cut for forage, it should be done after May 15, and at least 5 inches of stubble should be left behind to shade the ground.

Yellow starthistle can also be controlled with herbicides. According to CNAP (2000), 2,4-D provides fair control (60 to 85% of the plant species is control by a single treatment), dicamba works better (offering 85-94 percent suppression of top growth), and picloram and glyphosate provide excellent control (over 95% of the plant population is killed by a single treatment).

***Chenopodium album* or lamb's quarters**

Chenopodium album is an annual from Europe that is widespread throughout North America. Its seeds germinate from early spring through autumn, and the plant matures between early August and the first winter frost (UCDANR 1996). Mature plants can grow 1-6 feet tall. *Chenopodium album* is easy to pull, especially when young. Remove the plants before they set seed, as the seeds are very long-lived; seeds of this plant found in a 1,700-year-old archaeological site in Denmark survived and germinated.

Solarization and pre-emergence herbicides are also effective management tools. Spot-treat plants with herbicidal soap or a product containing glufosinate-ammonium or glyphosate (Sunset 1998).

***Cirsium vulgare* or bull thistle**

A CalEPPC List B pest common in riparian areas, marshes and meadows. Bull thistle is an aggressive biennial weed that germinates from March to May and flowers June through September-October (UCDANR 1996). To remove, uproot or pull while the plant is a rosette, or hoe the thistle 2 inches below soil surface before it flowers.

Repeated mowings are also effective. Remove flowering plants from the site, because immature flowers ripen and set seed even after the plant is cut (Habitat Restoration Group brochure). Plants can also be controlled using 2,4-D, dicamba, picloram, or glyphosate (CNAP 2000).

***Conium maculatum* or poison hemlock**

Conium maculatum is a highly toxic weed native to Europe, western Asia and North Africa that was brought to the United States as a garden plant. Today it is a CalEPPC List B pest. All parts of the plant are poisonous to humans and livestock. However, sheep are less sensitive than cattle and horses (CNAP 2000). It is capable of rapid establishment after autumn rains, particularly on disturbed sites or where little vegetation exists at the start of the autumn growing season. Once it is firmly established under such conditions, hemlock can preclude most other vegetation and established pastures (Pitcher 1989).

Some *Conium* plants act as annuals, producing flowering stems in the first spring and dying in the summer. Others remain in the vegetative stage without producing flowering stems until the second spring, thus becoming a biennial. Plants are more likely to be biennial in very moist situations. Plants flower from April through July, and seeds

are dispersed for an extended period beginning in July and continuing into winter. After producing seeds, the plants die in the summer. Seeds may remain viable in the soil for about 3 years. The plant grows from a taproot (CNAP 2000).

Poison hemlock reproduces only from seed, which can adhere to farm machinery, vehicles, agricultural produce, mud and clothing as well as being carried by water and to a limited extent wind (Pitcher 1989). Seeds may germinate rapidly after autumn rains, particularly on disturbed sites or where little vegetation exists at the start of the autumn growing season. The plant can also germinate in the spring, producing flowers until the second spring (UCDANR 1996).

Poison hemlock can often be controlled by mechanical removal (hand pulling, grubbing, or mowing) if done prior to flowering. However, complete eradication may be difficult due to reintroductions and the presence of viable seeds in the soil. Without active control measures hemlock can become dominant on a site, particularly in disturbed areas (Pitcher 1989).

Hand pulling works easiest with wet soils and with small infestations. Be sure to wash your hands thoroughly after handling any part of this plant, especially when plant sap is present (CNAP 2000). Hoeing two inches below the ground can also be effective. It is not necessary to remove the entire root system since the plant is not perennial, but it is best to pull/hoe the plant out prior to flowering. Follow-up cultivation is necessary to deal with any seedlings, and native vegetation should be established to compete with any further seedling growth. Patti Kreiberg suggests planting *Leymus triticoides* in many of these areas. Poison hemlock remains toxic for several years after being pulled, and it is wise not to leave the dead plants where they might be eaten by wildlife or children

(Pitcher 1989).

Multiple mowings close to the ground may also eventually kill *Conium maculatum*. Mowing or slashing the plants just before flowering is often effective. However, *Conium* often resprouts from the taproot, requiring repeated mowing until the root dies. An alternative to re-mowing is covering the mowed area with a thick mulch of cardboard or landscape fabric, topped with chopped tree trimmings or bark chips (Sunset 1998). Mulch also prevents seed already in the soil from sprouting, but it may be impractical on a large scale. Another technique is to use spring/winter burns (CNAP 2000).

If extensive areas are covered with *Conium maculatum*, chemical controls are simpler and less labor intensive. However, herbicide treatment may need to be repeated for several years until the seed bank is depleted. When using foliar herbicides, spray during the rosette stage with a wick to minimize damage to adjacent desirable vegetation. Cut any stems that arise after treatment (CNAP 2000).

Managers at the private Palo Corona Ranch south of Carmel report that Roundup is effective on hemlock if it is used before the plants get tall. 2,4-D is most effective against poison hemlock when the ester form is mixed with diesel oil to allow penetration of the leaves and stems. It can be used to hand spot (the most effective technique), or to spray larger areas. The suggested mixture is 1.5 lbs acid equivalent per acre. Mix 2 quarts of diesel oil with 1.5 lbs of 2,4-D ester and add to 100 gallons of water in a spray tank. A 100-gallon tank should cover approximately one acre.

Patti Kreiberg suggests cutting back the poison hemlock before spraying with Roundup, and Palo Corona Ranch managers suggest slicing down tall stalks. When new growth appears, treat it with a product containing MCPA, MCPP, and dicamba, or with a

product containing glyphosate (at 1.5 lb ai/acre). 2,4-D (at 1lb ai/acre) is reportedly the most effective herbicide, but dicamba (Banvel) can be used as a mixture of 1/4 to 3/4 per 100 gallons of water. A surfactant is also required. Other effective chemicals include tebithuron (pre-emergent), chorosulfuron and chlorosulfuron + metsulfuron (pre-emergent and foliar control), and picloram (at 1lb ai/acre) (CNAP 2000).

An Integrated Weed Management approach calls for the elimination of seed production and the exhaustion of the soil seed bank by removing seed heads before seeds mature. Use gloves for hand pulling, and avoid touching the plant with bare skin. Integrated management could also utilize treatment with herbicides combined with reseeding to promote healthy plant communities (CNAP 2000).

***Convolvulus arvensis* or field bindweed or wild morning-glory**

Field bindweed is a persistent, perennial vine of the morning-glory family which spreads by rhizome and seed. It may also proliferate if broken into small parts. It is found in a wide range of habitats: orchards, vineyards, roadsides, ditch banks, cropland, stream banks, and lakeshores, and it is also a pest in foggy areas along the coast. It is difficult to eradicate, and it can pose a serious threat to native plant communities because it has such a great capacity for regeneration (Lyons 1998). It cannot tolerate shade, but it is capable of surviving drought (CNAP 2000).

Field bindweed begins growing in the late spring or early summer and may persist until the first frost. In California, it grows from May through October and flowers from June to September. Fourteen to thirty days after field bindweed is pollinated, its seed matures. The number of seed per plant varies between 25-300, and estimates of the number of seeds in a pure stand of field bindweed range from 50,000 to 20 million per

hectare. Seeds must wait at least until the next season to germinate, and they may lie dormant in the soil for decades. Most herbicides are not absorbed by dormant seeds and therefore chemicals ineffective at controlling them (Lyons 1998, CNAP 2000).

Field bindweed has an extensive underground root/stem system. Most roots perish at the end of the season, but some persist through the winter. Rhizomes and attached lateral roots can persist independently if severed from the primary root. Field bindweed can resprout repeatedly following removal of above-ground growth, and it must be managed for several years to bring it under control (Lyons 1998).

Unfortunately, cutting, mowing, and pulling usually has a negligible effect on bindweed, unless plants are cut below the surface in the early seedling stage (CNAP 2000). However, the plant can be controlled if cutting or pulling is followed by planting of native species and continuous monitoring for resprouts. If you decide to pull field bindweed it should be done frequently. Mowing is unsuccessful because plants can be missed and it encourages ground-hugging growth. Repeated cultivation is required for field bindweed control because plants can regenerate from roots as deep as 1.5m (Lyons 1998). Fire is an ineffective tool due to the plant's potential for vegetative regrowth and a long-lived seed bank (CNAP 2000).

In agriculture, control has been most successful where tillage is combined with herbicide application, although herbicide application alone can be effective. But, chemical treatments often require high rates and repeated applications. Foliar applications of glyphosate at 1/5 lb ai/acre or picloram at 0.25-0.5 lb ai/acre, dicamba, or 2,4-D at 1lb ai/acre can provide good control. Control is best when applied during early flowering and when soil moisture is low, and herbicides should be used before seed set

(Lyons 1998, CNAP 2000). Repeated applications are advised for long-term control (CNAP 2000).

Light reduction (by smother crops or mulching) also decreases field bindweed vigor. If light reduction is used as a means of control the area must be continuously monitored for breaks. Light reaching field bindweed must be reduced about 50% shade or more for three years for control (Lyons 1998).

Because bindweed is aggressive and difficult to control, even small infestations should be viewed as a serious threat and they should be actively managed. Due to its vegetative reproductive ability and its large seed bank, successful control requires repeated applications over several years (CNAP 2000). The following are good general goals in the control of field bindweed: 1. reduce seed in soil, 2. prevent seedling growth, 3. deplete food reserves in the root system, 4. prevent spread of the weed. With diligence the roots can be removed leaving only the seedlings, however, even with intensive management field bindweed will persist as seed for several years. Three to five growing seasons are required in agricultural settings to eliminate all seedlings (Lyons 1998).

***Cortaderia jubata* and *C. selloana* or Jubata grass and pampas grass**

Two species of *Cortaderia* are widely distributed weed problems in California. Introduced through the nursery trade to Santa Barbara in the mid 1800's, both species escaped cultivation and spread rapidly throughout the state (Tschohl 2000). Jubata grass (*Cortaderia jubata*) is the dominant species in Northern California, where it is found in areas influenced by coastal fog. The plant is a grassy hummock with pinkish, feathery seed plumes that are borne high on long stalks that can reach 15 feet in height. Populations of Jubata grass consist of entirely female plants which produce genetically

identical seed through an asexual process called apomixis. Each plume produces tens of thousands of seeds which can be wind-dispersed over many miles, making this plant is a severe threat to wildlands (Moore and Hyland 1998, Drewitz and DiTomaso 2000). At least three of these plants were growing on the Reserve in the fall of 2000.

Pampas grass (*Cortaderia selloana*) is a similar, but larger species that is prevalent south of Santa Barbara. Unlike Jubata grass, Pampas grass has more slender, bluish-green leaves and a pale off-white or yellowish seed plume. The plume is borne on a short stalk just above the leaf mass (Moore and Hyland 1998). Also unlike Jubata grass, California populations of Pampas grass have separate male and female plants that reproduce sexually. Outbreeding species have the ability to react to selective pressures, and it may be that Pampas grass is slowly adapting to several California climates (Moore and Hyland 1998, Drewitz and DiTomaso 2000).

Once established, both *Cortaderia* species are strong competitors (Moore and Hyland 1998, Drewitz and DiTomaso 2000). Many of the sites infested with pampas grass and jubata grass are environmentally sensitive, which limits the available control options. Unfortunately, biological control efforts have not been investigated. In addition, burning or grazing do not provide long-term control, as plants quickly resprout (DiTomaso et al. 1999).

On the other hand pulling or hand-grubbing jubata grass seedlings is highly effective. For larger plants, a Pulaski (axe on one end and hoe on the other), mattock (pick on one end and hoe on the other), or long-bladed shovel is the safest and most effective way of removing established clumps. No matter which method you use, protect yourself from the sharp-edged leaves by wearing long sleeves and gloves when hand

removing Jubata or Pampas grass (Moore and Hyland 1998). Well-established plants should be removed first because they have the highest reproductive potential. If adequate manpower is available and the plants are not too large, Jubata grass can be manually removed with a pick and shovel. It is important that all of the crown is removed to prevent resprouting, but other small roots can be left in place. A large chainsaw or weedeater can expose the base of the plant and allow better access for removal of the crown. Once the plant is out of the ground, shake the root crown free of dirt and turn it upside down, making the sure the roots are out of contact with the soil; otherwise the plant may re-root (Moore and Hyland 1998). Furthermore, once flowering has occurred, cutting and removing or burning the inflorescence is important to prevent seed dispersal (DiTomaso et al. 1999, Moore 1999). Fortunately, seeds do not germinate well in the dark, and if it is too difficult to haul plumes offsite, they can be left to decompose in deep shade (Drewitz and DiTomaso 2000). Additionally, Jubata grass seed does not persist in the soil for more than 4 months, so management of a soil seed bank is not necessary (Drewitz and DiTomaso 2000).

Control of Pampas grass and Jubata grass can also be achieved by spot treatment with a postemergence application of glyphosate (Roundup Pro) at about 2% solution or 8 quarts per 100 gal. Homeowner formulations of Roundup will require a 4% solution. The addition of a nonionic or silicon-based surfactant may be necessary to enhance foliar penetration of the herbicide. For most effective control, plants should be sprayed to wet but not to the point of runoff. Fall applications result in better control compared to summer applications, as photosynthetic assimilates are translocating downward at a faster rate late in the season. However, it may be necessary to apply the herbicide prior to the

maturation of viable seed in late summer. Although glyphosate generally results in 80% Jubata grass control, regrowth will almost invariably occur the next summer (Drewitz and DiTomaso 2000). Therefore, it is important to revisit sprayed plants annually. Other registered postemergence herbicides may also be effective in the control of pampas grass and jubata grass. These include the postemergence graminicides sethoxydim (Poast) fluazifop (Fusilade), and clethodim (Prism), as well as the broad-spectrum herbicide imazapyr (Chopper, Stalker, or Arsenal) (DiTomaso et al. 1999, Moore 1999).

Once plants have been killed, clumps can be removed mechanically and left to decompose naturally. In wildlands, leaving the dead clumps may prevent subsequent pampas grass or jubata grass seedling establishment. However, detached pampas grass left lying on the soil surface may subsequently take root and reestablish under moist soil conditions (DiTomaso et al. 1999, Moore 1999).

For very large clumps, cutting or burning can remove the top foliage and the regrowth treated with a systemic postemergence herbicide. This method reduces the amount of herbicide applied compared to treatment alone. (DiTomaso et al. 1999)

***Cynodon dactylon* or Bermuda grass**

Bermuda grass is warm-season, prostrate, perennial grass that is sometimes confused with native salt grass (*Distichlis spicata*). The distinguishing characteristics of *Cynodon dactylon* are the conspicuous ring of white hairs of the ligule, the fringe of hairs on the keel of the lemma, and the gray-green appearance of the foliage. This grass reproduces vegetatively by rhizomes or stolons, producing new plants at stem joints. In the spring, new stolons elongate and aerial shoots sprout, but most of *Cynodon*'s lateral

growth occurs throughout the summer. *Cynodon* also reproduces by seeds, which are often carried in hay, and by wind and water (Newman 1992).

This species requires high temperatures and high light levels to thrive, and it tends to grow where water is available. The plant is not frost or shade tolerant and the rhizomes and stolons are susceptible to desiccation.

Cynodon dactylon is difficult to control by clipping. To control chemically, apply 0.5% glyphosate before summer dormancy. However, this herbicide does not work well during flowering. Do not disc or till. Replant or reseed large areas with appropriate native plants. Leave the grass in place if sprayed; however, remove uprooted plants (Habitat Restoration Group brochure).

If removing Bermuda grass where restoration projects include revegetating with tall-stature plants, a single season of controlling the Bermuda grass following by the transplanting or seeding of native plants will most likely be a sufficient control measure. Periodic spot control or shade mats or organic mulch placed over the young plants may be necessary during the establishment of the native plants. A more severe eradication procedure is necessary when the native vegetation will not shade the Bermuda grass. Several repeated herbicide applications may be required to remove the maximum amount of underground rhizomes and stolons prior to the re-vegetation phase. Many years of spot control may be required until all remaining Bermuda grass is removed or until the ground is covered by the native vegetation (Newman 1992).

The best management practice is to avoid the initial invasion of *Cynodon dactylon* by limiting soil disturbances and maintaining a vegetation cover. Areas where the soil

and native plants are kept intact should have little problem from Bermuda grass since it mainly invades disturbed (Newman 1992).

Delairia odorata or cape ivy (Senecio mikanoides or German ivy, ivy groundsel)

Cape ivy, a composite native to South Africa, was brought to the U.S. in the 1800's as an ornamental plant. It spreads rapidly in riparian areas and over coastal scrub, crowding out native vegetation and the animals that depend on it. Cape ivy also contains potent alkaloids including pyrrolizidine, which are potentially toxic to aquatic organisms (Nelson 1999). In California it occurs along the coastline from Del Norte to San Diego counties (Bossard 1999), and it is considered a List A weed by CalEPPC. It has been steadily expanding its range of habitat types: first from riparian understories, then to non-riparian forests (Monterey pine, eucalyptus, and redwood forests), and now to unshaded slopes near the coast.

Cape ivy is sometimes confused with the native wild cucumber, but there are several key differences. Wild cucumber has white flowers which emerge in the spring, hairs on its leaves, and twining tendrils like a pea. Cape ivy has yellow flowers that emerge in the winter, hairless leaves, and it lacks tendrils (Moore and Hyland 1998).

Cape ivy spreads primarily by vegetative means. It grows year round, and it expands rapidly. Individual plants grow 30-100 cm a month. A two inch piece including a leaf node will sprout readily—even after sitting on dry ground for months. Uprooting cape ivy can cause stems to break, creating re-rooting pieces and leaving purple runners under leaf litter (Bossard 1999, Nelson 1999). Until recently it was thought that the plant did not set viable seed in California. However, recent observations and tests suggest that

viable seed is produced. Seed viability of 6% was seen in Oakwood Valley by Jennifer O'Connell and Dr. Carla Bossard at St. Mary's College, although seed from other sites did not germinate. Viable seeding may increasingly become a problem in California. Most populations of cape ivy in California appear to be made up of clone plants that are unable to produce viable seeds. However, as these populations spread throughout the state, different clones may meet, exchange genetic material and produce seeds. Therefore, control of cape ivy throughout California is a high priority (DiTomaso 1999).

Though Cape ivy is easy to pull, its stems often break, leaving pieces that can quickly resprout. Despite this, managers at the Golden Gate Recreation Area have successfully used "carpet rolling" in cape ivy monocultures with loose soils and little woody vegetation. Carpet rolling is done using a line of volunteers along an ivy's edge. Workers turn the vegetation over using trowels, and then roll it over. It is important to remove the roots as well, and monitoring resprouts is essential to prevent re-infestation (Bossard 1999).

In areas with woody vegetation, mixed species, or varied soils, hand pulling is an option. However it is difficult to get the roots without hurting intermixed natives, leading to a "scorched earth" effect. In fact, Moore and Hyland (1998), claim that to effectively remove Cape ivy, other plants, native or non-native, must be cut to the ground and cleared. Otherwise it will be nearly impossible to find and reach the ivy. They also suggest scraping off the duff layer to help remove small pieces of ivy still in the ground. Again, follow-up is necessary with this removal method (Bossard 1999, Nelson 1999). In Morro Bay State Park, mechanical removal cleared a site to bare ground, but a lack of follow up resulted in a complete reoccupation of the site within a year at a greater than

original density. For cape ivy growing in trees, have workers climb and pull the plant out.

Because Cape ivy reproduces vegetatively, its disposal is a problem. Cape ivy has been seen to remain viable as long as it has moisture—even when stored in sealed garbage bags and left, forgotten in a hot parking lot many months. The surest way to kill Cape ivy is to spread the plants on a tarp to dry in the sun. Plants should not be stacked higher than four inches. Several months may be required for complete desiccation. Any pile left in contact with the soil should be closely watch and pulled whenever regrowth occurs (Moore and Hyland 1998).

Herbicides are the most effective method for removing cape ivy. Cape ivy can be sprayed any time of the year. Studies done at Golden Gate National Recreation Area show that a backpack application of 0.5% glyphosate, 0.5% triclopyr (Garlon), and 0.1% silicon surfactant at a rate of 640 liter/acre is the most effective mixture (Bossard 1999). The plant's thick cuticle makes the use of surfactant essential. This application takes effect after 3-4 weeks, and kills cape ivy roots, making resprouting rare. Nonetheless, re-treatment is vital. It may be possible to leave sprayed cape ivy in place, allowing it to act as a mulch that can later be planted into.

Nelson (1999) recommends herbicides at a rate of 1 liter Roundup with 200 ml Pulse/100 l water in spray bottles, or 100 ml Roundup with 20 ml Pulse/10 l water in a backpack. Another mixture calls for a standard mix of 1.25 oz Roundup Pro and 0.6 oz of Garlon 4 for each gallon of water (Forbert 1998). Spray cape ivy's leaves and vines until they are wet, but not dripping. More spray does not necessarily result in a better die back or kill rate of the plant, so use only what is needed to treat the target species

(Forbert 1998). Again, follow up spraying is necessary. Two foliar applications, four months apart, should reduce 85-95% of the cape ivy and expose any understory. Assess your efforts 3-4 months after the second application and determine the next best method to remove the remaining cape ivy (Forbert 1998).

A combination of mechanical removal followed by herbicide treatment is also effective and can decrease the amount of herbicide used. Kim Hayes, the land manager at the UC Reserves, has found that both hand removal and Roundup work well at Fort Ord.

***Ehrharta calycina* or veldt grass**

Veldt grass is a CalEPPC List A weed that is rapidly spreading along California's coast, especially on sandy soils. It is a perennial that was introduced from South Africa as a livestock forage grass and a soil stabilizer. Veldt grass invades a landscape by prolific seed dispersal, easy sprouting and growth. A fast grower, veldt grass exploits available water and nutrients that would otherwise be available to slower growing native shrubs. The seed germinates and regrowth occurs in late spring, and the plant matures June through August (UCDANR 1996). It has existed on the ESNERR since at least 1988, when it was identified growing along the driveway at 1454 Elkhorn Road.

Veldt grass can be destroyed by tillage (UCDANR 1996). Attempts to remove this weed by isolated methods, including manual removal, spraying or mowing generally fail. An integrated model using several different techniques should be used to eradicate it. In the Morro Bay watershed, restorationists have controlled veldt grass using the following sequence:

1. an initial mowing

2. initial application of post-emergent herbicide (Roundup)
3. second mowing
4. second application of Roundup
5. two applications of pre-emergent herbicide
6. planting *Baccharis pilularis* and other natives and watering
7. mulching

When planting, the restoration team planted natives on the site in clusters with each plant about three feet apart. The decision to use *Baccharis* was based on its effectiveness as a weed deterrent and competitor. *Baccharis* requires very little water to survive. The workers used a thick layer (4 inches) of woodchip mulch in order suppress weed seedlings, aid in moisture retention, and protect the soil from erosion.

Near Marina, R. L. Cromeenes has been testing the effects of Roundup and Fusilade on a large veldt grass infestation. Fusilade (0.75 oz/gallon of solution) sprayed in late April did largely kill the grass, but did not prevent it from going to seed weeks later. Roundup (1.5%) was more effective in killing *Ehrharta*, but is not grass selective, and results in a “scorched earth.” It is not known if this herbicide allowed the grass to go to seed (Roberts 1999).

***Erechtites glomerata* or Cut-leaved fireweed**

A CalEPPC List B weed found in coastal woodlands and scrub. Not currently a problem on the Reserve, but it is a spreading problem in the region. *Erechtites glomerata* is a fire-adapted weed from Australia that is an annual to weak perennial. Currently being studied at Fort Ord/BLM. If it becomes a problem here, we should check in with Bruce Delgado and Emily Briscoe at Ford Ord for their results in 2000.

***Erodium cicutarium* or storksbill/redstem filaree:**

Erodium is an annual or biennial weed That was apparently introduced in California in the early 1700s by Spanish explorers. It is a pioneer species on disturbed sites and is considered an indicator of recent or frequent disturbance (CNAP 2000). Storksbill filaree germination is triggered by seasonal rains. Typically, plants germinate in late fall and develop a few leaves by December. The following spring the plant resumes growth and flowers in March-April. Seeds ripen in May-June and are soon disseminated. The plant reproduces solely by seed, and seeds can remain viable for many years (UCDANR 1996, CNAP 2000).

Mow, hoe or pull young plants, and mow, dig or pull larger plants before they set seed to prevent future infestations. Fill open spaces with natives or mulch. Filaree can also be controlled by soil solarization. 2,4-D or dicamba at 1 lb ai/acre can be applied to rosettes in the late fall or early spring. Products with glyphosate also work. However, glufosinate is not effective on this species (Sunset 1998, CNAP 2000).

Eucalyptus globulus

Eucalyptus globulus is a persistent exotic that is designated a List A pest by CalEPPC. Eucalyptus is widely distributed throughout California riparian areas, grasslands, and moist slopes, and usually requires repeated eradication treatments. Most mature, undisturbed stands of *E. globulus* are virtually devoid of herbaceous annual species in the forest understory (Del Moral and Muller 1969), although many animals, both vertebrates and invertebrates, have adapted to life in the Eucalyptus groves. Eucalyptus trees can threaten native vegetation in a variety of ways. In coastal

California, a grove has the potential to spread 10 to 20 feet in diameter a year, eliminating the diversity of native species as it colonizes new ground. This aggressive Tasmanian species releases phytotoxins not only from its litter but also directly from its leaves (Bean and Russo 1989).

Eucalyptus reproduces by seed, although it is difficult for blue gum seeds to germinate within a dense forest of parent trees. Not only does the presence of deep litter pose a germination problem, but there are also germination-inhibitive chemicals produced in the leaves of mature trees. *Eucalyptus globulus* has a higher percent germination rate in open land (Bean and Russo 1989).

Eucalyptus globulus has evolved highly effective mechanisms for coping with the threat of fire, and it thwarts most single attempts to kill it. Whatever method is used, repetition of the treatment will undoubtedly be necessary. Mechanical methods of control (cutting, pulling seedlings, and stump removal) seem to have the least amount of impact on the surrounding area. Removal should begin in the spring, but will require several return trips to cut regrowth from coppice shoots. Shoot regrowth is most vulnerable to cutting when the shoots are six to eight feet high. Where the native understory is fairly dense, pulling out the seedlings and saplings up to an inch in diameter has proven to be a successful method of halting a grove's spread. Mechanical removal of the tree and subsequent coppice shoots could take up to six years before carbohydrate reserves are depleted. Stump removal, using a stump grinder or tractor, although effective, is costly and impractical on a large scale (Bean and Russo 1989).

There are two main types of chemical control. Herbicides can be applied as foliar sprays or directly onto the inner tissue of the trees. Direct application of herbicides to the

growing tissue has been proven more effective than foliar spraying. Another method is to apply herbicides to cut stump. Such stumps can be treated with crystals of Ammate, 2,4-D, and picloram with a high percentage of mortality. A freshly cut stump acts as a sponge, transferring toxins to its roots, thus spray, liquid or crystal forms of herbicide can be effective. Follow-up treatment will be necessary each time the unaffected buds produce coppice sprouts of a height of six to eight feet. It is also important that the herbicide be applied immediately after the cut is made to avoid blockage of cells by air pockets and subsequent poor absorption of the herbicide (Forest and Richardson 1965). The stumps should be cut no more than six to ten inches from the ground to insure delivery to the tree's root system (Bean and Russo 1989). On the Reserve, trees have been cut and the remaining stumps treated with Roundup. Later, stump resprouting was successfully controlled using a mixture of 25% Garlan IV and 75% Mor-Act applied as a low volume bark treatment.

If felling the tree prior to treatment is not an option, frill-cutting the tree is an excellent alternative. Frilling, the method of placing a ring of downward axe-cuts around the base of the tree and filling the cuts with herbicide, has received very good results. Frills act as reservoirs to hold herbicide as it soaks into the growing tissue; picloram, 2,4-D, and Ammate have all been successful to varying degrees. Spraying should be done in windless conditions and under moderate pressure to avoid spray drift. Dry weather during treatment is also important (Bean and Russo 1989)

Time of herbicide application is an important factor when using herbicides. As a rule of thumb, optimum results of herbicide applications are obtained during the early summer months (Morze 1971).

***Festuca arundinacea* or tall fescue**

Festuca arundinacea is a horticultural escape (turf grass) and a CalEPPC List B weed. Tall fescue is a perennial clump-forming grass that was once added to lawn seed mixtures as a nurse crop because it is fast growing, and is now found in central coast scrub and grasslands . When mowed, tall fescue grows as a flat, spreading clump, but if unmowed, it produces leaves 10-28 inches long and seed stalks up to 4 feet tall. It reproduces by seed.

Remove clumps of tall fescue by cutting under the root crown with a sharp shovel. This grass does not spread by runners, so digging out the clumps usually gets rid of it. Remove plants before they set seed. If chemical control is necessary, use a product containing sethoxydim, a selective herbicide that controls grasses, or a nonselective herbicide containing glyphosate (Sunset 1998).

***Foeniculum vulgare* or wild fennel**

Fennel is a perennial weed included on CalEPPC's List A that forms monocultures in uncontrolled areas. *Foeniculum vulgare* has the capacity to reproduce from both its crown and its seeds. The seeds germinate at almost any time of the year (UCDANR 1996 claims they germinate mostly in April and May), but plants generally do not flower until 18 months to 2 years. Once a plant is established, flowering stems are produced from the perennial crown each spring. Flowering begins in May and continues into September. Seeds are produced during the summer and autumn, and the flowering stems die back during winter to be replaced by new growth in late winter. Some stems stay alive towards the base and produce new leaves from nodes along the stems during the winter. New

leaves are also produced in winter at the base of the plant (Bean and Russo 1988, UCDANR 1996). Fennel's taproot may extend 10 feet, and its seeds may remain viable up to 7 years.

Dispersal of the seeds by water accounts for the occurrence of *Foeniculum vulgare* along watercourses. Other means of dispersal include vehicles, machinery, wool, animal skins, clothing, mud, and agricultural produce. Reproduction also occurs by root division. This adaptation allows the species to become well established and invade new areas. Occasionally, pieces of fennel crown or root are dragged by cultivation equipment or spread by earthmoving machinery into uninfested areas (Bean and Russo 1988).

The plant cannot be controlled by burning (DiTomaso 1999), but can be managed by manual means and chemicals. Fennel can be dug out by the root. You do not need to remove the entire taproot, but you must remove the bulb at the top of the root to kill the plant. Workers have found that digging out 4 inches of the bulb is sufficient to kill the plant. Unfortunately, digging disturbs the soil, and can encourage colonization of other weeds. Another manual strategy is to cut fennel's stalk. The plant will send up another stalk after cuttings, but repeated cuttings during a season will eventually kill the plant (Overtree 1999)

Chemicals work best if the plant is sprayed before stalks form. Garlon 3A at 2% concentration works well as a selective herbicide, and Roundup at 2% concentration is effective, but non-selective. Pathfinder is an effective basal treatment, and it does not have to wet the full circumference of the fennel stalk to work. If the stalk has bolted, cut the stalk and directly apply Garlon at 50% concentration to the stump (Overtree 1999).

***Genista monspessulana* or French broom**

French broom is not a substantial problem on Reserve, but it is a regionally invasive weed designated as a CalEPPC List A exotic. It is an aggressive perennial shrub that reaches up to 15 feet tall, and reproduces vegetatively or by seeds that remain viable for 80 years. The plant flowers March through May. It has been purposefully propagated from cuttings, and it sprouts back after cutting (Hoshovsky 1986).

French broom looks similar to *Cytisus scoparius* (Scotch broom), another invasive shrub listed by CalEPPC as a significant threat. While French broom is often single-stemmed, Scotch broom usually has many branches near the base. Furthermore, French broom's leaves are much more numerous than Scotch broom's—Scotch broom's leaves are so small as to be unnoticeable from a distance, giving the plant the appearance of a tangle of nearly naked green to brownish stems (Moore and Hyland 1998).

French broom is usually easy to hand-pull, but if plants are large, use a Weed Wrench. It is best to pull broom in the winter and spring, before the plant goes to seed while soils are moist, and when the yellow flowers make the plant easy to distinguish from other species on the site (Moore and Hyland 1998). When pulling, the root should come up easily. However, if the stem breaks while pulling, it will be necessary to dig up the remaining root. Seedlings should be destroyed whenever they are found.

Small plants that have not yet flowered may be left where pulled, but plants that have set seed need to be handled with care to avoid spreading broom to another site. One approach is to remove seeds from the stems, remove them from the site, and leave all other portions of the plant to be used as mulch. Stacking and burning broom is another disposal method. Yet another method is to stack the broom in deep shade, where any

seeds still attached will not have enough light to germinate (Moore and Hyland 1998).

Since broom seeds may remain dormant but viable for decades, follow-up—in the form of patient, persistent removal of seedlings—is essential to prevent new seed set while the existing seed bank is gradually exhausted. Only a small percentage of the seed bank will germinate each year, so although there may be fewer plants to pull each year, eliminating this plant is a long-term effort. One follow-up alternative is to cook new seedlings with a propane torch (Moore 1999).

If chemicals are needed, use 2,4-D and 2, 4, 5-T, alone or with additives. Broom has also been determined to be susceptible to picloram. Herbicides may be applied with spot treatment methods, stem injection, or cut stump treatment. Burning and grazing are also effective management tools in controlling broom.

Researchers at Mt. Tamalpais State Park have found that large broom can be removed economically (\$500/acre) using a cut-and-burn strategy (Boyd 1997). At the Jackson Demonstration State Forest near Fort Bragg, workers reported that a herbicide-cut-burn treatment worked well at controlling French broom. They used a low volume, basal bark treatment 30% triclopyr (Garlon) in penevator oil, followed by cutting of dead broom and burning (CalEPPC 1997).

Hedera helix or English ivy

Hedera helix is an evergreen woody vine that reproduces by seeds and vegetative means. Ivy spreads by trailing branches that root at the nodes as it grows along the ground, or it develops aerial rootlets that cling to walls, fences, or trees. English ivy is widely planted in the West as a ground cover and as a climbing vine for fences and wall, and it is an aggressive spreader that can smother small plants in its path (Sunset 1998).

English ivy is a CalEPPC List B pest, it does not need a disturbance in order to spread, and it can smother and kill trees (Moore 1999).

To manually remove English ivy growing as a ground cover, mow it close to the ground with a heavy-duty mower. Then dig up the roots, removing as many as possible, or treat the cut surface of the root with a 1:1 solution of Roundup and water. This must be done within 1 minute of cutting. As ivy is deep rooted, expect regrowth from roots that were missed, and further digging. Once the area is clear of top growth, fill bare ground (with native seeds/plants, landscape fabric, black plastic, cardboard, or other mulch) for at least a full growing season (Sunset 1998). English ivy can also be hand pulled. This is easiest in the winter and spring when the soil is damp; stems can be pulled one at a time or in clumps and traced back to their roots. If a thick thatch of stems has formed, cutting them apart will make removal easier. The roots will usually pull up with the rest of the plant, but digging may be required (Moore and Hyland 1998).

Another manual removal method is “carpet rolling” (see cape ivy section). Have a line of workers roll ivy, while an extra volunteer roams with clippers to cut stubborn stems. As always, it is important to remove roots and follow-up with maintenance later (Moore 1999). To control ivy growing into trees, cut all stems growing up the trunk. Dig out the roots, repeating until they stop sprouting (Sunset 1998), or treat the stump end with 0.5% glyphosate (Moore 1999). The upper end of the severed vine, which may reach to the top of the tree, can be left in place and it will slowly die. Don’t be impatient: it can take many weeks before the climbing portion starts to look like it is dying. If living parts remain, look for small stems still clinging to fissures in the bark (Moore and Hyland 1998).

English ivy can be left in piles to decompose or composted with other yard waste. It will not usually resprout once removed from the ground, and it breaks down easily (Moore and Hyland 1998).

A re-visit to the site after several months will reveal sprouting from any roots which were missed the first time. English ivy grows slowly, and once the roots have been eliminated, the only follow-up necessary should be annual monitoring, and re-pulling of new seedlings or regrowth (Moore and Hyland 1998).

If chemical control is necessary, use a product containing dicamba, taking care not to get it on desired broad-leafed plants. Products containing glyphosate provide some control; take care not to get this nonselective herbicide on any desired plants (Sunset 1998).

***Hordeum murinum ssp leporinum* or wild barley**

Hordeum leporinum is an annual grass thought to have originated in western Asia. It is a successful invader species, particularly where land has been disturbed (i.e. continuously grazed) and where soil nutrient levels are high and nitrogen rich. In Mediterranean climates the species can become dominant over native plants. In the 1950's barley grass was described as the most common barley in California ranges, being especially abundant in valleys and foothills where it frequently formed pure stands. It grows most often on well-drained soils and sometimes on clay in grasslands of California's Central Valley and coastal ranges (Dean 1990). *Hordeum leporinum* appears as a common spring weed in cities and towns, along roads, fencerows, ditches, rubbish dumps, disturbed soils, and in and about croplands (Crampton 1974).

Hordeum leporinum is a vigorous winter annual. After flowering in the spring, the grass matures rapidly to produce a large number of viable seeds. These seeds easily disperse when the long awn attaches to wildlife, and then to the soil. The majority of seeds remain dormant during the summer, not germinating until the autumn. Some more general reasons for its success as an invader species throughout the world include its early germination and early rapid growth rate, as well as its high seed production and efficient dispersal mechanism. Growth to seed maturation is rapid, and ripe seed production is copious—19 to 29 seeds produced per head (Dean 1990).

Hordeum leporinum can be controlled through mowing, which decreases seed production and subsequent germination, as well as through herbicide applications. Mowing works best if the grass is cut close to the ground about ten days after the head started to turn color. Remove the cut herbage, and then sow native seeds to further discourage establishment of barley grass. This treatment is most effective when repeated for one or two years, though there is little indication in the literature of precisely how many years of treatment would be required to completely eliminate barley grass (Dean 1990).

However, mowing must be followed up with further maintenance and native plantings. In a California experiment, mowing-only treatments (without additional management, such as burning, grazing or planting with native grasses) resulted in barley grass returning in full vigor the following season (Dean 1990).

Some herbicides have proven effective in controlling barley grass but more research, preferably on tests done in natural areas, is needed. In southern California, pronamide (1 lb. ai/acre) and prophan (6 lb. ai/acre) were applied in mid-February to

control a cropland infestation, when barley was 20-25 cm tall. In another test on grasses already 15 cm tall, DPX-Y6202 and fluazifop provided superior control, with no apparent phytotoxicity in the alfalfa. When herbicides were applied to the soil just after emergence (Jan. 25), they had little effect. Of pre-emergent herbicides, pronamide offered the best control, with a combination of 2 lbs. ai/acre of pronamide and paraquat the best overall (Dean 1990). In Australia paraquat and 2,2-DPA killed barley grass (Dean 1990).

Several years of data have been collected in California on the response of grasslands to prescribed burns, and *Hordeum leporinum* has been found to be the annual grass most sensitive to burning. In grasslands originally comprised of ~ 90% of barley grass, burning reduced *Hordeum*'s cover to less than 5%. This reduction persisted for up to three years without additional management (Dean 1990).

***Hypochaeris radicata* or spotted cat's ear**

Hypochaeris is a European, perennial weed that reproduces by seed and pieces of its long, fleshy taproot. Seeds germinate or regrowth begins in March and the plant grows over the summer, maturing in the November (UCDANR 1996). Young plants can be pulled or hoed in spring. You need to dig out larger plants to remove the taproot. If chemical control is needed, use a product containing MCPA if *Hypochaeris* is growing in grasses. Glyphosate will also kill this weed (Sunset 1998).

***Lactuca serriola* or prickly lettuce**

Lactuca is an annual or biennial native to Europe that reproduces by seeds. Seedlings sprout from October to March and the plant matures in June and July (UCDANR 1996). Prickly lettuce is often confused with annual sowthistle, *Sonchus*

oleraceus. It can be distinguished by the rough, prickly midribs on the undersides of the leaves. The midribs on the undersides of annual sowthistle leaves are smooth and without prickles (UCDANR 1996).

For control, pull or hoe seedlings and mature plants before they set seed. If chemical control is necessary, use a pre-emergence herbicide containing isoxaben or spot treat glufosinate-ammonium or glyphosate (Sunset 1998).

***Lolium multiflorum* or Italian ryegrass**

CalEPPC considers this annual grass to be a significant threat to California's wildlands, particularly in wetland areas and disturbed sites. *Lolium multiflorum* is an annual that behaves like a biennial or short-lived perennial under certain conditions. Its seeds germinate from late fall to early spring, following rain, or at any time of the year if irrigated. The plant matures in early summer. Once seedlings are established, Italian ryegrass is very competitive, probably due to its rapid growth rate and its release of toxins that inhibit the germination and growth of other plants (UCDANR 1996).

***Malva parviflora*, *M. neglecta* or mallow**

Malva is an annual that can live through California's mild winter, and is therefore sometimes classified as a biennial. Its seeds germinate November to April, and the plants grow quickly, maturing from July to October (UCDANR 1996).

Hoe or pull mallow plants when they are young. As the mature, mallows develop a long, tough taproot. To remove older plants, cut the taproot below the crown (the area where the branches originate) with a sharp hoe or clippers. If chemical control is necessary, use a pre-emergence herbicide containing oryzalin or isoxaben. But do not

use oryzalin on cool-season grasses. Spot-treat young mallow plants with an herbicide containing glufosinate-ammonium or glyphosate (Sunset 1998).

***Marrubium vulgare* or horehound**

Horehound is a perennial native of Europe that reproduces only by seed. Its seeds germinate and regrowth occurs from its rootstock during the spring months, and it matures in late summer (UCDANR 1996). At Fort Ord, Bruce Delgado is using sheep to control *Marrubium*.

***Myosotis latifolia* or Forget-me-not**

This common and attractive garden plant is invasive in wildlands. It is becoming an increasingly common site along trails the Monterey Bay area (Moore and Hyland 1998).

***Oxalis corniculata*, *O. pes-caprae* or oxalis**

Both *Oxalis* species are persistent perennial weeds throughout the West that reproduce by rooting at stem joints, by seeds, and by small bulbs. *O. corniculata* has spreading stems, 2-12 inches long, that initially grow from a single taproot. The stems soon root at the joints, eventually invading large areas (Sunset 1998). Furthermore, its seeds germinate and its fruit ripen throughout the year (UCDANR 1996). *Oxalis pes-caprae* was introduced from South Africa as an ornamental. It sprouts in fall, sending up long-stalked leaves directly from its base. Flowers appear in late winter. This plant has a deep rootstock that produces numerous small bulbs, and it reproduces mostly by these bulblets (UCDANR 1996).

Pull or dig small plants of *O. corniculata* before they form seeds. To manage *O.*

pes-caprae, you need to get rid of the bulbs. Dig the whole plant in late winter, sifting through the soil to remove as many of the small bulbs as possible. Solarization will help in management, too. Both kinds of oxalis can be suppressed, although not completely exterminated, by covering a cleared area with landscape fabric or cardboard, topped with mulch, for at least a full growing season (Sunset 1998).

For chemical control, use a pre-emergence herbicide containing oryzalin or pendimethalin. Spot treat with glyphosate (Sunset 1998).

Phalaris aquatica or Harding grass

Phalaris aquatica is a perennial grass that forms large clumps with short rhizomes around the base. It is probably a native of the Mediterranean region and was originally introduced to North America as a forage plant from Australia. Harding grass is still commonly planted, and it is now naturalized at lower elevations in California (Peterson 1988). CalEPPC has designated it a List B pest.

Harding grass develops slowly but forms sizeable, localized bunches after several years. It reseeds itself fairly well but not uniformly, and can increase its size through tillering. It can displace native species in preserves with grassland or some grass species. Grazed lands with established Harding grass populations provide a source of seed that may disperse to adjacent areas and are, therefore, a constant threat (Peterson 1988).

There is no evidence that Harding grass threatens to dominate areas where the native vegetation is healthy, but it is important to monitor *Phalaris* populations to determine if they are spreading. Areas adjacent to preserves where Harding grass populations occur should also be watched, and the dispersal of seeds from these areas should be reduced/stopped (Peterson 1988).

Phalaris requires active management once it is established or if it threatens to invade across preserve boundaries. In general, frequent removal of Harding grass during the active growth period can be effective and can reduce tillering. There is some disagreement over the effect that the timing of clipping has on subsequent growth of Harding grass. Tillering is typically suppressed when plants are cut during flowering, although clipping in the spring retards growth more severely than clipping at the beginning of flowering. Clipping at the end of the growing season when soil moisture is low reduces growth the following year (Peterson 1988).

Mechanical methods seem to be able to control Harding grass rather effectively with repeated clipping or mowing treatments. There is some disagreement as to the most effective time for mowing, but it should be done during the active growing period. Repeated defoliations (during a single growing season) will be most effective (Peterson 1988).

Burning the vegetative shoots of Harding grass during the winter can reduce subsequent growth for about two years and allow more competitive fire-adapted plants to increase their density and biomass. Burning during the winter, when there are large numbers of new shoots, allows native species to compete more favorably. Harding grass required at least two years to recover. Therefore, burning at two-year intervals might be a management option (Peterson 1988).

Several herbicides are effective in controlling Harding grass, although relatively high rates (at least 3.4 kg/ha) are necessary (Berry and Buchanan 1975). At 3.4 kg/ha, the following herbicides achieved good control of six-week-old seedlings: 2,4-D amine; 2,4,5-T; 2,4-D ester; dicamba, picloram; and 2,4-D plus atrazine. The pre-emergent

herbicides naptalam, vernolate, alachlor, chlorpropham, diphenamid, and tri-fluralin provide good control at rates of 1 kg/ha (Berry and Buchanan 1974). Repeated mowing and an application of Roundup to resprouts seem to be the most effective means of control (Peterson 1988).

***Picris echioides* or bristly ox-tongue**

Picris echioides is a common invasive annual, biennial, or short-lived perennial weed that reproduces by seed. Its seeds germinate and regrowth occurs from March to May, and the plant flowers April through December. To control, pull, uproot, or hoe (2” below surface) when soil is moist, or mow weeds repeatedly. Remove flower parts from site (Habitat Restoration Group flier)

***Plantago major* and *P. lanceolata* or plantains**

Plantago plants are perennials that reproduce by seed. *Plantago major* germinates or breaks dormancy through March and April, and matures from June through October (UCDANR 1996).

Dig out plantains before they set seed. They can regrow from pieces of their fibrous rootstalk left behind in the soil, so it is important to remove as much of the roots as possible; a dandelion weeder is helpful. If chemical control is necessary, use a pre-emergence herbicide containing isoxaben. A selective herbicide containing MCPP, MCPA, and dicamba can be used on plantains growing with grasses. Spot-treat plantains with a product containing glyphosate (Sunset 1998).

***Poa annua* or annual bluegrass**

Poa annua is one of the most widely distributed winter annual weedy grasses in California. It is a low growing cool season grass that germinates and grows during the fall, winter, and early spring. Its seeds mature from May through July, and the plant dies during the summer. It can easily be distinguished from other grasses by its typical leaf tip which is shaped like the bow of a boat. The leaf blade is often crinkled at midsection. The mature plant grows as dense, low-spreading tufts, 8 to 30 cm tall, and often roots at the lower nodes. (UCDANR 1996, 1997). Pull or dig annual bluegrass when the plants are young, before seeds form. Chemical control can include the application of a pre-emergence herbicide, or spot treatments containing glyphosate (Sunset 1998).

***Rubus discolor* or Himalayan blackberry**

A widespread pest and on CalEPPC's List A, Himalayan blackberry is a widespread, perennial, bushy weed. Contrary to its common name, Himalayan blackberry is a native of western Europe that is difficult to control due to its ability to regenerate from sections of root stock. New canes are produced each year from the base of the plant (crown), replacing those that die naturally. New plants start from the regrowth, from rhizomes, and from seed that germinate in March and April. Its fruits, which are edible berries, mature May through June (UCDANR 1996), and *Rubus* thickets can produce 7000-13,000 seeds per square meter. When grown in dense shade, however, most species of blackberry do not form seeds (Hoshovsky 1989).

Himalayan blackberry is often confused with our native blackberry, *Rubus ursinus*. Himalayan blackberry is larger than the California blackberry, and it has thicker 5-angled

stems with very large, stiff thorns all along them. California blackberry's stems are round, in comparison. In addition, Himalayan blackberry leaves typically have five lobes, while native blackberries typically have three.

Mechanical removal may be one the most effective ways of removing the mature plants. If plants are young, *Rubus* is best pulled after a rain when the soil is loose. Young plants can also be destroyed readily while they are still small by hand hoeing, either by cutting off their tops or by stirring the surface soil so as to expose the seedlings to the drying action of the sun. The object of hoeing is to cut off weeds without going too deeply into the ground and doing damage to the roots of desirable vegetation (Hoshovsky 1989).

Mature plants should be pulled as soon as they are large enough to grasp but before they produce seeds. But before tackling this plant, put on heavy clothing and thick gloves. Begin by cutting off the canes, or stems, one at a time within a few inches of the ground and stacking them out of the way. Then the central cluster from which the canes grow can be dug out with a mattock or shovel. The dirt around the root is loosened by the mattock, and the plant is pulled out in the same way that a claw hammer is used to pull out nails. There may be long lateral roots connecting one cluster to another, and these must be dug up along with the roots. Shake the roots free of any dirt that remains and stack them with the canes (Moore and Hyland 1998). Subsequent treatment with herbicides can be done, but should be conducted cautiously for two reasons: (1) *R. discolor* often grows in riparian areas and the herbicide may be distributed to unforeseen locations by running water, and (2) some herbicides promote vegetative growth from lateral roots (Hoshovsky 1989).

Stacked canes can be disposed of by burning. If you cannot burn them but have a place where they can be allowed to slowly break down, the blackberry stems can be stacked there. Be sure to remove all the berries before stacking this plant anywhere to prevent a new infestation. The process of decomposition may take several years, so be sure to pick a place that will not be needed for any other use in that time. If you have no suitable place either to burn or store the stack, cut the canes into lengths short enough to be placed in cans for disposal. Canes may be taken to the landfill for composting (Moore and Hyland 1998).

Other strategies for removing blackberries include using manually operated tools such as brush cutters, power saws, axes, machetes, loppers and clippers can also be used to cut *R. discolor* (Hoshovsky 1989). One integrated strategy is to remove, mow or cut the blackberry, and then to spray new sprouts 3 weeks later with 0.5% glyphosate, or spray the entire plant with 0.5% glyphosate during its active growth stage. Repeat spraying as necessary. Another method is to repeatedly dig out all plant parts (Habitat Restoration Group flier). If cut before seeds are produced, stems may be piled and left, or debris may be fed through a mechanical chipper and used as mulch during revegetation procedures. Particularly with *Rubus*, care should be taken to prevent vegetative reproduction from cuttings. Burning slash piles is also an effective method of disposal (Hoshovsky 1989).

The removal of rootstocks by hand digging is a slow but sure way of destroying *R. discolor*, since it resprouts from its roots. The work must be thorough to be effective as every piece of root that breaks off and remains in the soil may produce a new plant.

Such a technique is only suitable for small infestations and around trees and shrubs where other methods are not practical (Hoshovsky 1989).

Rubus discolor plants can also be trimmed back by tractor-mounted mowers on even ground or by scythes on rough or stony ground. However, this method is non-selective, and wildlife forage is eliminated, cutting down on the general habitat value of the area. Another disadvantage of cutting, chopping or mowing is that perennial weeds such as *Rubus* usually require several cuttings before the underground parts exhaust their reserve food supply. If only a single cutting can be made, the best time is when the plants begin to flower. At this stage the reserve food supply in the roots has been nearly exhausted, and new seeds have not yet been produced. After cutting or chopping with mechanical equipment, *Rubus* may resprout from root crowns in greater density if not treated with herbicides (Hoshovsky 1989).

***Rumex acetosella* or sheep sorrel**

Sheep sorrel is a perennial weed that reproduces by creeping rootstocks and by seed. Pull, hoe or dig it out, removing as much of the shallow, spreading root system as possible. If regrowth occurs from the roots left behind, cut and dig up roots again. After clearing an area, apply a thick mulch to smother the remaining roots and to prevent seed germination. If chemical control is necessary, apply an herbicide containing dicamba or spot treat with glyphosate (Sunset 1998).

***Rumex crispus* or curly dock**

Curly dock, native to Eurasia, is a tenacious perennial that grows from a thick, fleshy taproot. It reproduces by seed and by regrowth of pieces of its taproot and crown.

Dock's seeds germinate from early spring into summer, and the plant can grow and produce seeds all year. One curly dock plant can produce as many as 40,000 seeds; once buried, these remain viable for up to 80 years (UCDANR 1996).

To remove curly dock, dig out young plants, removing as much of the root as possible. Large plants can be killed by cutting the top growth every week or two until the roots die and they stop resprouting. Be sure to get rid of curly dock before it sets seed. Effective chemical postemergence products include MCPP, MCPA, and dicamba. For non-selective control, use glyphosate (Sunset 1998).

***Salsola tragus* or Russian thistle**

Salsola is a noxious, bushy annual that reproduces by seed. It germinates from late winter to early summer, and blooms from July to October. Mature plants later break away from the soil and blow away, scattering thousands of seeds (UCDANR 1996).

Hoe or pull Russian thistle plants when they are young. Be sure to remove them well before they set seed to prevent later problems. If plants are older, hoe just below ground level just before they set seed (Habitat Restoration Group flier). Repeated mowings are also effective. Whatever method is used, it is important to remove all plants with seeds. Mulch and solarization can prevent seedling germination. If chemical control is necessary, use a pre-emergence herbicide containing trifluralin, or use a herbicide with dicamba to spray mature plants. Nonselective products containing herbicidal soap work well on young plants. Glufosinate-ammonium, 2,4-D, dicamba, picloram, and glyphosate are also effective on *Salsola* (Sunset 1998, CNAP 2000).

***Senecio vulgaris* or common groundsel**

Common groundsel is an annual (or sometimes biennial) forb native to Europe that is found throughout California. It prefers cool, wet environments, and nutrient rich soils, and is poisonous to livestock and humans (CNAP 2000).

Common groundsel reproduces solely by seed. This plant flowers from April through October (CNAP 2000), and the flower heads mature into puffball seed heads, which separate, allowing the wind to disperse the seeds. Seeds are able to germinate as soon as they ripen; thus common groundsel can produce several generations in a single year. Seeds may mature in opened flowers even after the plants have been killed (CNAP 2000).

To reduce later problems, hoe or pull common groundsel before the plants set seed. Their root system is small, so pulling is easy. Small infestations can be pulled, but larger infestations should be cut or mowed (CNAP 2000). Common groundsel can also be killed by flaming. Fill open spaces created after weeding. Before planting, it may be necessary to solarize the soil to destroy seeds. The plant is somewhat immune to triazine and dinitroaniline herbicides. However, dicamba at 1 lb ai/acre or glyphosate at 1.5 lb ai/acre, or pre-emergence products containing oryzalin should provide adequate control (Sunset 1998, CNAP 2000).

***Silybum marianum* or milk thistle**

Silybum marianum is an erect, annual or biennial herb. Seed dispersal is the only means by which the milk thistle spreads. Each terminal head of the plant produces

approximately 100 seeds; 10 to 50 heads are produced per plant. *Silybum* seed has the potential to remain viable in the soil for up to 9 years (Bean 1985).

The seeds of *Silybum marianum* germinate in the fall after the first rains. Plants develop slowly through the seedling stage, becoming flat rosettes by late autumn/early winter. Growth is rapid in late winter and early spring producing large cabbage-like plants up to 3 feet in diameter from which center stems develop in spring. Flowering begins in late spring and continues into early summer (Bean 1985).

To achieve control and potential eradication of *S. marianum*, physical removal, cultivation and mowing can be effective if bare space is filled by sowing native perennials or competitive grasses. The most effective herbicide used on *S. marianum* is 2,4-D. The plant is most susceptible to the chemical from the seedling to the rosette stages of growth (Bean 1985).

Physical removal of thistle in troublesome spots has had limited success in Pt. Reyes National Seashore. However, digging the individuals out by hand may create disturbance conditions ideal for thistle germination (Bean 1985).

Mowing can be effective before seeds are produced. It is important to mow before the flowers are fully developed because fertile seeds may still form in the heads. In California, a mowing regime should begin in May, and mowing should be repeated four to six times during the spring and summer to suppress seed development. This program could take two years before control is visible. This method will not be successful if natives are not sown into the resulting bare space (Bean 1985).

Herbicide most readily kill *Silybum marianum* in the seedling and rosette stages of growth. The more mature the plant, the more resistant it becomes to treatment. One

method of herbicide application is spot spraying with ester 2,4-D (80% ai.) at the dilution of one part in 1,600 parts water, increasing to one part in 400 as the plants near maturity. Because germination occurs over a period of several months in the fall, autumn spraying will have to be followed up in the winter to deal with plants germinating later (Bean 1985).

In an experiment of herbicide use on *Silybum marianum* in wheat, authors R. Meissner and C. Mulder found that when sprayed selectively at the two to three leaf stage, the thistle was controlled 100% by picloram and methabenzthiazuron in combination with phenoxyacetic acid compound, "at rates normally recommended." After forming a rosette of three whorls or so, they discovered that *S. marianum* was not adequately controlled by methabenzthiazuron alone. They mention that spot treatment with dicamba may prove successful at later stages (Bean 1985).

***Sonchus oleraceus* and *S. asper* or sowthistles**

Sowthistles are common annual weeds that reproduce by seeds. *Sonchus oleraceus* germinates February through June and the plant matures from late summer through fall. They germinate in spring, and mature by late summer or fall. *Sonchus asper* germinates from February to March and the plant matures from June to August (UCDANR 1996). Seeds are spread by wind.

Pull sowthistles when they are young, making sure to remove them before they flower. Sowthistle seeds may mature even after the plants have been pulled from the soil. When pulling larger plants, try to remove the taproot, as new shoots can regrow from it. Mulching and soil solarization also help in management. If chemical control is necessary, use a pre-emergence herbicide containing isoxaben or spot treat with

herbicidal soap when they are young, or glyphosate when they are mature (Sunset 1998).

***Stellaria media* or chickweed**

Chickweed is a low-growing annual succulent that grows vigorously in the cool weather of fall, winter, and spring. It germinates from November to early March, it matures from April through June (UCDANR 1996). It generally sets seed and dies in the summer, but it can live through the summer in cool, shaded areas. It reproduces by seed and creeping stems that root at the nodes (Sunset 1998).

Chickweed is easy to pull when the plants are young. As they develop and spread by rooting at the leaf nodes, pulling is less successful because it is difficult to get out all to the roots. If chemical control is needed, in fall to late winter use a pre-emergent containing oryzalin or pendimethalin. Spot-treat chickweed with a product containing herbicidal soap or glyphosate (Sunset 1998).

***Vinca major* or periwinkle**

Vinca major is a perennial, evergreen herb that was introduced as an ornamental from Switzerland. It has erect flowering stems and trailing non-flowering stems which root at the nodes. It grows most vigorously in moist soil with partial sun, but it can also grow in deep shade and poor soil. It is susceptible to cold damage during hard winters and hot, dry weather (Bean and Russo 1988). CalEPPC has designated periwinkle a List B weed.

In California, *Vinca major* does not reproduce by seed. It often grows in patches around the bases of trees or spreads up and down drainages where the cover is dense. Under optimal growing conditions, *Vinca major* can spread with quickly by its arching

stolons which root at the tips. Once established, *Vinca* forms a dense carpet to the exclusion of native flora (Bean and Russo 1988).

Hand pulling does not work well in controlling *Vinca* (Moore 1999), and herbicide alone is ineffective. *Vinca*'s leaves are covered by a waxy cuticle which makes chemical penetration difficult. However, Geoffrey Babb tested cutting/spraying regimes on *Vinca* at TNC's Mile-Hi/Ramsey Canyon Preserve in Arizona. He tested nine eradication designs. Three groups were simply sprayed with Roundup but in various concentrations: 3%, 4%, or 5% solutions. Another three groups were first cut with a scythe and then sprayed with the three different concentrations of Roundup. The last three groups were sprayed in the same way but afterwards covered with clear plastic. The greatest success occurred in the groups that were first cut, then sprayed. Wounding the plant appears to allow sufficient absorption of the herbicide, which is usually prevented by *Vinca*'s thick waxy cuticle. Although Babb had the greatest eradication success (nearly 100%) using the cut/spray method with a 5% solution of Roundup, he recommends cutting then spraying with a 3% solution (which resulted in a 70-75% success rate in his tests), and then spot treating where necessary. Uniform medium to heavy spraying should be done within 5-10 minutes of cutting. Treatment should be done after a rain in early or late spring when soil moisture and air temperatures (at least 70 F, preferably 80 F) are best for active plant growth. Continued warm, moist conditions encourage active growth, quickly translocating the herbicide, helping to kill the plant. The initial spraying is most efficiently done using a back-pack sprayer (Bean and Russo 1988).

The Habitat Restoration Group suggests that spraying the entire plant with 5% glyphosate using extra surfactant will also work. Sprayed plants may be left in place.

***Xanthium strumarium* or common cocklebur**

Xanthium strumarium is a coarse, annual plant that out competes or shades out more desirable plant species. It germinates at a wide range of temperatures and can invade large acreages of wetlands. Some treatment techniques such as disking, only make this plant problem worse. However, mowing can be effective. Mow cocklebur close to the ground after maximum stem growth but prior to flowering. Because cocklebur growth is apical (grows from the tip), "knocking the top off" of the vegetation will stop growth. After the first mowing, any new germination can again be mowed prior to flowering to increase the impact.

Established cocklebur stands have tremendous "seed banks" which have long viability and do not all germinate at the same time. As a result, treatments may need to be repeated throughout the growing season or for a number of years to all but eliminate this problem plant (Ducks Unlimited 1997).