ELEMENT STEWARDSHIP ABSTRACT

for

Ehrharta spp. Thunb.
(Including *Ehrharta erecta* Lam., *Ehrharta calycina* Sm., and *Ehrharta longiflora* Sm.)

(Ehrharta, perennial veldtgrass, longflowered veldtgrass)

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SCIENTIFIC NAME

Nomenclature follows Hickman (1993), Soreng (2000), and ITIS (2004).

Ehrharta erecta Lam.
Ehrharta calycina Smith
Ehrharta longiflora Smith

Randall (2002) lists two subspecies for *E. erecta* (*E. erecta* ssp. *erecta* and ssp. *natalensis*).

SYNONYMS

For a detailed treatment of the taxonomic history of *Ehrharta*, see Gibbs-Russell and Ellis (1987).

The following synonyms for *E. erecta* are listed in Bor (1960, cited in TROPICOS 2004): *Ehrharta panicea* Sm., *Ehrharta paniciformis* Nees ex Trin., *Panicum deflexum* Guss., and *Trochera panicea* Baill.

The following synonyms for *E. calycina* are listed in Bor (1960, cited in TROPICOS 2004): *Aira capensis* L. f., *Ehrharta adscendens* Schrad., *Ehrharta auriculata* Steud., *Ehrharta geniculata* (Thund.) Thund., *Ehrharta laxiflora* Schrad., *Ehrharta ovata* Nees., *Ehrharta paniculata* Sw. ex Poir., *Ehrharta undulata* Nees. ex Trin., *Melica festucoides* Licht. ex Trin., *Trochera calycina* (Sm.) P. Beauv., and *Melica geniculata* Thunb.

The following synonyms for *E. longiflora* are listed in Bor (1960, cited in TROPICOS 2004): *Ehrharta aristata* Thunb., *Ehrharta banksii* Gmel., *Ehrharta eckloniana* Schrad. ex Schult. & Schult. f., *Ehrharta longiseta* Schrad., and *Ehrharta urbilleana* Kunth.

COMMON NAMES[1]

Ehrharta erecta: panic veldtgrass, ehrharta, Lamarck's ehrharta, veld grass

Ehrharta calycina: perennial veldt grass, perennial veldtgrass, veldtgrass

Ehrharta longiflora: longflowered veldtgrass

DESCRIPTION AND DIAGNOSTIC CHARACTERISTICS

Of the approximately 35 species in the genus *Ehrharta*, only a few are invasive in the United States. *Ehrharta longiflora* is reported as invasive only from California, *E. erecta* is reported from California and Hawaii, and *E. calycina* is reported from both California and Texas. A fourth, *E. stipoides* Labill.[2], is documented as invasive in Hawaii. *E. villosa* (pyp grass, at least two varieties *E. v. villosa* and *E. v. maxima*), *E. brevifolia*, *E. dura*, and *E. pusilla*, are invasive in natural areas outside of the United States (Randall 2002).

[1] The names veld and veldt appear to be interchangeable although regional in use.
[2] *E. stipoides* has been proposed as *Microlaena stipoides* (Labill.) R.Br. and the latter is used in the 'Flora of New Zealand' (Edgar and Connor 2000), where it is native and appears to be preferred in Australia, where it is also native. Botanists in Hawaii (J. Denslow, pers. comm.), where it is invasive, use *E. stipoides*.

The *Ehrharta* genus is highly variable (Watson and Dallwitz 1999), but all *Ehrharta* species treated in this document are characterized by flat leaf blades, membranous ligules, a panicle inflorescence, and compressed bisexual spikelets (Hickman 1993). *Ehrharta erecta* is a sprawling perennial with decumbent culms that may occasionally root at the nodes. *Ehrharta calycina* is a tussock-forming perennial, and *E. longiflora* is a sprawling annual. In California, the *Ehrharta* species can easily be confused with *Melica* species, especially if the plant is young and/or if the flowering inflorescence has not yet developed. Both *Ehrharta* and *Melica* have panicle or panicle-like inflorescences, but *Ehrharta* inflorescences are more open and the inflorescence branches are less appressed as compared to those in *Melica*. Additionally, *Ehrharta* inflorescences are present year-round (do not dehisce) after seed set.

Ehrharta erecta is a sprawling perennial with decumbent culms that can reproduce vegetatively by occasionally rooting at the nodes, and it can also reproduce sexually by seed. Plants can grow up to 200 cm tall, but are generally 30-50 cm tall. Ligules are approximately 3 mm long and glabrous. Auricles are ciliate. Leaf blades are 5-15 cm long and 4-11 mm wide, are flat and flexible, and often with wavy edges. The loose panicle is 5-21 cm long and often drooping. Spikelets are 3-4mm. Glumes are papery, the first is 1-2mm and the second is longer and wider. Sterile lemmas are 2.5-4.5mm, unawned, and of varying hairiness (Hickman 1993).

Ehrharta calycina is a tussock-forming perennial. Its leaves are typically longer than in *E. erecta* (up to 20 cm long) and often display partially wrinkled leaf margins. Glumes are generally 5-7 mm long, and lemmas are fertile. *Ehrharta calycina* has an upright habit (Pickart 2000), and stems are 30-75 cm long. Leaf blades are 2-7 mm wide. Inflorescences are 10-15cm long, spikelets 5-8mm long, subsessile to stalked, and the stalks are generally less than 5mm long and thread like. Glumes are 5-7mm long, typically longer than the sterile florets, and become purplish over the growing season. The sterile lemmas are awned or pointed, are soft-hairy, and the fertile lemmas are awnless with hairy veins (Hickman 1993).

Ehrharta longiflora is an annual with leaves that appear similar to *E. calycina,* up to 20 cm long. This species has a more sprawling habit than *E. calycina,* longer glumes, and is easily distinguished from the other two *Ehrharta* species by its long-awned sterile lemmas (Pickart 2000).

STEWARDSHIP SUMMARY

Management of the three *Ehrharta* species covered in this document is only beginning to be understood. Some initial research results suggest that smothering (using plastic) is an effective control treatment in the short-term, but possibly not in the long-term since seeds can germinate from the seed bank once the plastic is removed. Manual and mechanical removal of scattered individuals is effective, but is very labor intensive and often creates much soil disturbance, which may encourage continued weed seed germination. Chemicals are therefore the current preferred control method for large infestations of *Ehrharta* species, using either a broad-spectrum or grass-specific herbicide. The timing of treatment is very important in determining control efficacy.

HABITAT & RANGE

The *Ehrharta* genus is mostly native to Africa, with a few species native to the Mascarene Islands and Indonesia (although the non-African species may not actually belong in the genus,

Tothill 1962; Mabberley 1998, Gibbs-Russell and Ellis 1987). Edgar and Conner (2000) do not report the genus as native to New Zealand. This genus is also found in Yemen (USDA 2004), China, North America, Northern Africa, and Europe. There are approximately 35 species in this genus (Mabberley 1998), of which at least eight are invasive (those species treated here, and *E. brevifolia, E. dura, E. pusilla, E. stipoides,* and *E. villosa*; Randall 2002). The species treated in this document all invade a wide variety of ecosystems including areas dominated by trees, shrubs, or grasses, under a range of temperatures and moisture regimes from cool to tropical, and from different vegetation types from wetlands to Mediterranean coastal dunes.

Ehrharta erecta

Ehrharta erecta is native to southern Africa and Yemen (USDA 2004), and is documented as invasive in the United States, New Zealand, Australia, southern Europe, and China. Peng et al. (2001, cited in Pickart 2000) reports *E. erecta* as naturalized in the Yunnan province of China. In New Zealand, *E. erecta* was first recorded in 1943 in Wellington (southern tip of the North Island) and is now reported from the lowlands of the North Island to the far north. In the South Island it is found around Nelson (at the northern tip), Christchurch and Banks Peninsula (middle of the eastern side) and very recently near Dunedin (southeastern tip) (C. Ogle, pers. comm.). In Australia this species occurs in the Southeast in Victoria (McIntyre and Ladiges 1985). *Ehrharta erecta* is reported from Italy (Ricciardi and Anzalone 1999). In the United States, *E. erecta* occurs in Hawaii (only on Maui, Herbst and Clayton 1998) and California. *E. erecta* was first reported in California from the UC Berkeley campus (Stebbins 1985, cited in Pickart 2000), and has since been reported throughout the San Francisco Bay Area, specifically in Marin, Alameda, Sonoma, Napa, Santa Clara, San Mateo, and San Francisco counties. Additionally, *E. erecta* has also been reported from Santa Cruz, Monterey (J. Sigg, pers. comm.), San Luis Obispo (D. Chipping, pers. comm.), Mendocino (P. Warner, pers. comm.), Yolo (Sigg 2003), San Diego, Los Angeles, Ventura, and Santa Barbara (Plants 2000) counties, and on the Farallon islands (Sigg 2003). Cal-IPC (1999) lists *E. erecta* on List A-2 (most invasive but limited to three or fewer of Jepson's regions).

In its native range in Africa, *E. erecta* occurs from the southwestern Cape along the moist eastern coastal belt through Mozambique into East Africa. It grows from moist Mediterranean habitats to tropical forest, shrub, and grassland with rainfall ranging from 500 to 1875 mm per year and from sea level to 2100 meters elevation (Acocks 1953, cited in McIntyre and Ladiges 1985). In Australia, invaded habitats include suburban areas and *Leptospermum laevigatum* scrub (McIntyre and Ladiges 1985). In New Zealand this species invades a wide variety of habitats, although they are often in semi-shade and never in areas grazed by sheep or cattle (C. Ogle, pers. comm.). *Ehrharta erecta* is found in grass-, shrub- and tree-dominated areas and in highly managed as well as in non-managed areas. Invaded landscape areas include road edges and lawns, among shrubs and trees in landscaped areas, and in forestry plantations. Invaded natural areas include off-shore islands, in light gaps in native forests, among native shrubs on coastal bluffs, and in a wide range of lowland habitats such as coastal dunes, which may extend up to 15 km inland in the Manawatu region. In these dunes, annual rainfall is 800-850 mm, and the dunes historically supported a native forest of drought-tolerant species on the upper areas and wetlands or small lakes in the low areas (C. Ogle, pers. comm.). In the United States, *E. erecta* generally occurs in shaded habitats. Invaded habitats in California include moist wildlands, urban areas,

riparian, and coastal habitats (Cal-IPC 1999), especially stabilized dunes. Areas invaded tend to be areas of above-average moisture including irrigated landscaped areas, under native shrubs within an open sand matrix, and within the drip line of trees and shaded areas (Goldblatt and Manning 2000, reported by D.C, Le Maitre, pers. comm.). Once established, *E. erecta* can expand into drier, open areas.

Ehrharta calycina

Ehrharta calycina is native to southern Africa, and is recorded as invasive in New Zealand, Australia, and the United States. *Ehrharta calycina* was first recorded in New Zealand at Santoft in 1956 (Edgar et al. 1991), and is now reported as naturalized in 5 instances in the northern and southern parts of New Zealand's North Island (Edgar and Connor 2000). It is now also common around Perth in Western Australia (S. Lloyd, pers. comm.) and in Chile (Pizarro 1959, cited in Tothill 1962). In the United States *E. calycina* is invasive in California and Texas (PLANTS 2004). *E. calycina* was first introduced as a forage crop into California from Australia in 1929 (Love 1948, cited in Pickart 2000), and is now spreading rapidly in the California central coast region, and can also be found along southern coast and the western transverse ranges (Cal-IPC 1999). Hickman (1993) notes *E. calycina*'s presence in California at Bodega Bay on the northern central coast, Nipomo Mesa on the outer southern coast, and Casitas Pass in the Western Transverse Ranges. M. Kelly (pers. comm.) reports *E. calycina* from San Diego County. Cal-IPC (1999) places *E. calycina* on List B (Wildland Pest Plants of Lesser Invasiveness; invasive pest plants that spread less rapidly and cause a lesser degree of habitat disruption; may be widespread or regional). However, this species appears to be rapidly changing the composition and dynamics of California central coastal dune systems, and this ranking may change in the revised list (that is in process as of 2005). It should be noted that *E. calycina* is, at least regionally, a species of greatest concern.

Sandy soils, especially dunes, are susceptible to *E. calycina* invasion (Cal-IPC 1999). In New Zealand, *E. calycina* is reported on sand dunes, areas of pine plantations, or as a weed in housing areas built on sand dunes (C. Ogle, pers. comm.). Hickman (1993) reports this species in California on sandy soils below 200m. Although most noted in California on stabilized dunes, this species also grows in savannas in its native range and invades woodlands in Australia (Smith et al. 1999). This broad habitat tolerance and current localized California distribution warrants vigilance in uninvaded areas.

Ehrharta longiflora

Ehrharta longiflora is native to southern Africa and is documented as invasive in New Zealand and Australia (Cade 1980, cited in Pickart 2000), and recently in Southern California (Brey 1999). C. Ogle (pers. comm.) reports that in New Zealand, it is only recorded from Wanganui, where it is found on sand along paths and under trees in urban areas (but always on top of sand). It is now common around Perth in Western Australia (S. Lloyd, pers. comm.). In California *E. longiflora* is only reported from San Diego county (Cal-IPC 1999). M. Kelly (pers. comm.) reports this as the worst of the three *Ehrharta* species in San Diego County. Cal-IPC (1999) lists *E. longiflora* on the Need More Information List, which indicates "Plants for which current information does not adequately describe nature of threat to wildlands, distribution, or invasiveness. Further information is requested from knowledgeable observers."

In New Zealand, Edgar and Connor (2000, reported by C. Ogle*)* report *E. longiflora* from Wanganui in “Waste places and weed of gardens and their surrounds; locally common." In southern California *E. longiflora* is invasive in the understory of the Torrey Pines State Reserve, a woodland community dominated by *Pinus torreyana*.

IMPACTS AND THREATS POSED BY *Ehrharta* spp.

All three *Ehrharta* spp. invade a wide variety of habitats from urban sidewalks to healthy coastal dunes. Interior dunes, coastal scrub, meadows, seeps, and forests are all susceptible habitats for *Ehrharta* spp. invasion. Apparently facilitated by elevated moisture, these species can become problematic where duff accumulates or where irrigation is used. Sandy habitats appear to be particularly susceptible in California and New Zealand.

As a sprawling perennial, *E. erecta* (and the other species discussed here) can dramatically change the plant community composition in invaded habitats, altering fire potential and increasing the rate of organic matter accumulation. Specific ecosystem impacts are poorly documented, but the invasion of non-native perennial grasses is a growing problem in Mediterranean grasslands in California. Gluesenkamp (in press) documents an inverse relationship between native percent cover and *E. erecta* percent cover. *E. erecta* is reported to have had “one of the most spectacular increases in abundance and range of any exotic species in New Zealand” (Ogle 1988).

Ehrharta calycina-invaded shrublands have shifted the vegetative community to a non-native grassland by suppressing shrub seedling germination (US Air Force 1996, cited in Pickart 2000). Fire may form a positive feedback loop encouraging the invasion of this species (Milberg and Lamont 1995). This species is a pernicious invader of stabilized dunes along the central coast of California. The potential for expanded invasion appears great. Prevention, early detection, and rapid response are the most sensible approaches to slowing the spread of this species. The north coast of California is not yet invaded but there seems to be only a propagule limitation, not an environmental limitation. It is essential that managers in these areas educate themselves on this species and conduct immediate removal programs at the first signs of the *Ehrharta* species. In New Zealand this species appears to be spreading slowly, although perhaps speeding up in recent years (C. Ogle. pers. comm.). It is now a dominant grass in otherwise sparse pasture, sand along roadsides, and under widely-spaced pine plantations (C. Ogle, pers. comm.).

Much more information is needed about the environmental (and economic) impacts of *E. longiflora*. However, the impacts of annual grasses in California are well documented and may also pertain to this species. C. Ogle (pers. comm.) reports that its “behavior and life history are so similar to ripgut brome (*Bromus diandrus*) that it would probably grow in similar places in natural vegetation on dunes."

BIOLOGY AND ECOLOGY

Light, Temperature, and Soil Conditions

Little is known about the specific growing requirements of the *Ehrharta* spp., but *E. erecta* and *E. calycina* have been observed growing under a wide variety of light, temperature, moisture and

substrate conditions including in urban areas, forest edges, shrublands with some shade, and in the forest understory. The *Ehrharta* spp. are typically found in sand and sandy-clay soils (pers. obs.) and in well-drained soils (Tothill 1962). Additionally, Tothill (1962) reports that *E. calycina* does not survive in completely dry soil, but since its roots can reach deep depths, it is able to exploit dry, sandy soil habitats (from Pickart 2000). Information on *E. longiflora* is limited. Invasions appear facilitated by moisture (Sigg 1996).

Flooding and/or Drought Tolerance
Ehrharta erecta and *E. calycina* (and presumably *E. longiflora*) have not been found to occur anywhere where there is prolonged standing water and they do not tolerate inundation (Tothill 1962). The *Ehrharta* spp. are however, able to tolerate the extensive annual summer drought of Mediterranean climates by its far-reaching deep roots (Tothill 1962).

Reproduction
The *Ehrharta* perennials reproduce both by seed and vegetatively (including expanding tussocks and, for *E. erecta*, rooting at the nodes of decumbent stems). The annual species (*E. longiflora*) invests all of its resources in seed production, and the allocation of resources is assumed to be the same for the perennial *Ehrharta* species. *Ehrharta erecta* can produce seeds throughout the wet season or year-round in irrigated or perennially wet habitats (C. Ogle, pers. comm.).

Seed Production
Seeds are produced throughout the wet season, especially in moist or irrigated sites. Rossiter (1947, cited in Tothill 1962) reports flowering in *E. calycina* for over 25 weeks. The number of seeds per inflorescence or per plant are not known. C. Ogle (pers. comm.) reports that only two common exotic grasses in New Zealand are known to produce fruit year-round, *E. erecta* and *Poa annua*.

Seed Dispersal, Seed Banking
Seeds are dispersed locally by wind and may occasionally be carried on animal fur (Sigg 1996). *Ehrharta erecta* seems to travel along trails and then expand from there (D. Glusenkamp, pers. comm.) Deer trails and water bars also appear to function as paths for dispersal (D. Rao, pers. comm.). Ogle (1988) reports anecdotal evidence of bird dispersal for *E. erecta*.

Seed Germination
Seeds germinate following rain (Pickart 2000). Seed germination rates are high (>99% within 11 months in a lab from soil collected from an invaded site in Australia) in *E. erecta* (McIntyre and Ladiges 1985). Seed germination rates are 48% (across all treatments; but often >70%; all testing done in a lab from soil collected from an invaded site in Australia) in *E. calycina* (Smith et al. 1999). High germination rates may prove advantageous for management efforts if the seed bank can be easily and rapidly exhausted.

ECONOMIC USES
Ehrharta erecta and *E. calycina* have been used for forage and erosion control in California and Australia (Mulroy et al. 1992, cited in Pickart 2000, U.S. Air Force 1996, cited in Pickart 2000, Pickart 2000). The U.S. Air Force stabilized sand dunes with *E. calycina* at Vandenberg Air Force Base in the late 1950s (U.S. Air Force 1996, cited in Pickart 2000).

MANAGEMENT

Few recommendations have been published about managing these species although *E. calycina* has received more attention than the others (Pickart 2000). *E. longiflora* is an annual and may respond to management techniques employed for other annual grasses throughout California.

Potential for Restoration of Invaded Sites

Pickart (2000) reports of a study conducted by the U.S. Air Force (1996) that indicated that *E. calycina*-invaded dunes could be sufficiently restored to native dune scrub. However, the potential for restoration of heavily-infested sites greatly depends on the continued monitoring and control of new invading *Ehrharta* (generally from the seed bank) for several years, and also on the restoration effort (native seeding and/or plantings). If there are sufficient funds and resources for the continued and intense control and maintenance of *Ehrharta* in restoration sites for several years, then the potential for restoration of invaded sites is medium to high.

In areas where herbicide use is difficult and shrublands are dominated by *E. erecta*, a "scorched earth" approach (removing all vegetation) and treating any new plants may be the only solution to successfully manage the spread of this species (T. Doherty, pers. comm.). This method removes all above-ground vegetation and involves intense follow-up. Managing small populations and preventing initial invasion are both far preferable in terms of time spent and damage done.

Prevention and Early Detection

Prevention and the early detection and rapid response to new populations are the most effective strategies for the local control and management of these species. For instance, *E. erecta* can grow and set fruit when very small (< 7.62cm (3 inches) tall), and can also thrive underneath native vegetation. It is therefore important to identify high-quality (uninvaded) sites and prevent and/or detect early any new infestations.

Manual and Mechanical Control

Hand pulling or digging is reported as a successful short-term strategy, although these methods are extremely time-consuming. Additionally, the soil disturbance associated with pulling and digging may result in a flush of new *Ehrharta* plants soon after plant removal. Removal must be thorough and altered environmental conditions that may favor re-invasion need to be addressed. For example, a $10m^2$ area subject to fog drip (under non-native *Cupressus macrocarpa* and *Pinus radiata*) on the Presidio of San Francisco was cleared by hand and completely reinfested with *Ehrharta* after six months (pers. obs.). Some recommend strongly against mechanical control because the soil disturbance facilitates the germination of seeds in the seed bank (D. Chipping, pers. comm.).

Covering with black landscape fabric and rice straw (15.24cm (6 inches)deep) appears to be an effective control method at least over the short term (pers. obs.).

Grazing
Chesnut (1997, cited in Chesnut 1999) reports a decrease in *E. calycina* with cattle and sheep grazing[3]. Van der Westhuizen and Joubert (1983, cited in Pickart 2000) and Chesnut (1999) indicate that severe or continuous grazing results in a decrease in *E. calycina*. Rossiter (1947, cited in Tothill 1962) claims that *E. calycina* cannot withstand rotational grazing at normal stocking rates for more than three years. In New Zealand, *E. erecta* occurs throughout coastal dunes on the North Island except where grazed (C. Ogle, pers. comm.).

Prescribed Fire
Fire may facilitate *E. calycina* invasion by negatively impacting native competitors (DiTomaso and Healy, N.D., Milberg and Lamont 1995). Fire is a natural component of many of the ecosystems in southern Africa and may therefore play a role in *E. calycina*'s invasion success. *E. erecta*'s extensive root system may increase the fuel load in forested systems (R. Dao, pers. comm.). This alteration may change the intensity or frequency of fires.

Flaming plants using a gas or vapor torch (such as a Red Dragon Torch; 500,000 BTU/hr torch with 7.6cm diameter bell; Flame Engineering Inc.) can work locally to control *E. erecta* plants. Flaming works better on seedlings than adults (K. Cooper, pers. comm.)

Chemical
Monocot-specific and broad-spectrum herbicides are both reported as generally effective on the *Ehrharta* spp. presented in this document (D. Chipping, pers. comm., M. Kelly pers. comm., M. Skinner, pers. comm.). The timing of herbicide application is important in determining control efficacy.

M. Skinner (pers. comm.) used 22.2ml./3.8L (0.75oz./gallon) (up to 2.1L (72 oz.) per acre per year) of fluazifop-p-butyl (Fusilade DX®; a monocot-specific herbicide) for foliar spot-treating plants before their peak seeding, and reported a greater than 75% kill rate in San Luis Obispo County, California. He also recommends collecting any seeds before treatment by first clipping and collecting the infructescences prior to herbicide application. M. Kelly (pers. comm.) also reports >90% control when using Fusilade II® (using approximately 17.7ml./3.8L (0.6 oz./gal)), applied when the plants are over 10.2 centimeters (4 inches) tall. He adds however, that spraying in late winter/early spring when the plants are less than 10.2 centimeters (4 inches) tall, was unsuccessful. The U.S. Air Force (1995, cited in Chesnut 1999) however, found that applications of monocot-specific herbicides to be unsuccessful. They reported that sethoxydim (Poast®; a monocot-specific herbicide) and fluazifop-p-butyl (as Fusilade®) were both ineffective (no other details available in Chesnut 1999).

M. Skinner (pers. comm.) also reports that Pete Waldberger, the restoration specialist for The Morro Group, has had good success controlling *E. calycina* with foliar applications of glyphosate, using a 2% solution of RoundUp Pro® in early spring. D. Glusenkamp (pers. comm.) of Audubon Canyon Ranch and M. Alvarez (pers. comm.) of the National Park Service in the Golden Gate National Recreation Area (California) both report good success using 2% RoundUp Pro® in early spring on *E. erecta.* M. Alvarez reports a kill rate of greater than 90%.

[3] Chesnut (1997) could not be located and the information in Chesnut (1999) is brief. Please contact the author if you have this document or contact information for Chesnut.

Biological Control
Doidge (1948, cited in Pickart 2000) reports on the presence of a fungal pathogen (*Uredo ehrhartae-calycinae*) on *E. calycina* in South Africa. The fungus has not been evaluated for its effectiveness in control of *E. calycina*.

EXAMPLES OF MANAGEMENT PROGRAMS FOR *Ehrharta spp.*
Ehrharta erecta control in the Presidio of San Francisco (California) often employs a "scorched earth" approach (manually removing all vegetation) in heavily invaded dune scrub if the invader is established beneath native shrubs. This strategy allows easier access to target plants and dries the area out. With this model all aboveground vegetation is removed, but belowground parts of native species are left intact if possible to allow resprouting. Smothering with >20.3 centimeters (8 inches) of rice straw has proven successful throughout the year (P. Brastow, pers. comm.). Another approach - smothering the plants with landscape fabric - is currently being tested.

The most detailed information on *E. erecta* control is provided by Dan Gluesenkamp at the Audubon Canyon Ranch in California (D. Gluesenkamp, in press). Plots established in 2003 in a mixed hardwood forest floodplain at the Bolinas Lagoon Preserve with >80% *E. erecta* cover were designed to test smothering with a black tarp for six months, hand pulling, and 2% RoundUp Ultra® (foliar sprayed in June, the peak of seed output). Initial results suggest that chemical control results in a dramatic decrease in cover of *E. erecta* and low seedling production in the following season. Tarping and chemical control had low impacts on the native flora (i.e. they came back in higher proportion than *Ehrharta* after the treatments). Tarping may not result in long-term control because the seed bank germination may be suppressed while tarped, but may germinate soon after the tarps are removed. Manual removal produced substantial seedling germination. Seed germination experiments are underway. Preliminary results support the finding of McIntyre and Ladiges (1985); germination in shallowly buried bags was extremely high. It seems likely that two years of chemical control followed by persistent manual removal will be an effective control technique. One year of control is clearly not sufficient and even after two years, follow-up treatment is still required.

The most detailed information on *E. calycina* control is provided by The Land Conservancy of San Luis Obispo County (California) working in the Guadalupe-Nipomo Dunes. Chesnut (1999) lists a detailed review of *E. calycina* and its control. Mark Skinner (pers. comm.), from The Land Conservancy describes a three-stage process:

1) Mow when the grass is 5.1 to 7.6 centimeters (2-3 inches) tall; do not cut the grass to ground level. Mowing reduces the target surface area.
2) Immediately after mowing spray with a Fusilade® tank mix (in a 11.4L (3 gallon) tank mix 88.7ml. (3oz.) Fusilade DX® (fluazifop-P-butyl), 88.7ml. (3oz.) Magnify® surfactant, 88.7ml. (3 oz.) Marks-It® blue dye, and fill with water). There is a label limit of 2.1L (72 ounces) of Fusilade® per acre. If this treatment is insufficient, follow-up treatments with glyphosate may be required.
3) When *E. calycina* is in seed, do not attempt to mow. For late stage (i.e. seeding) populations spray with glyphosate (in a 11.4L (3 gallon) tank mix 295.7ml. (10oz.)

glyphosate, 88.7ml. (3oz.) Magnify® surfactant, 88.7ml. (3 oz.) Marks-It® blue dye, 88.7ml. (3oz.) Oil Spreader, and fill with water). When plants are dormant do nothing.

M. Kelly (pers. comm.) reports the following for *E. longiflora* control in the Torrey Pines State Park in San Diego County. Spraying Fusilade II® in February is futile. Wait until the leaves are at least 10.2 centimeters (4 inches) long. If it is a drought year and all plants are small, wait until they begin to bolt. Use a foliar application based upon the label rate (approximately 17.7ml. per 3.8Lb (0.6 oz. per gallon)) with a surfactant. Following this technique has resulted in areas with a flush of released wildflowers.

The following information on *E. villosa* control may be useful. *E. villosa* is a robust perennial with long rhizomes. It forms small tufts or single erect culms (Hoare 2004) up to 1500 mm tall (A. Mercer, pers. comm.). Andrew Mercer from the New Zealand Department of Conservation Palmerston North Area Office (North Island) reports on the control efforts for *E. villosa* (pers. comm.). He uses both a 15 liter backpack sprayer and the hose and gun with a 200 liter truck mounted spray tank. He uses the grass-specific herbicide Gallant® (100g/L haloxyfop-r-methyl and 347g/L diethylene glycol). The mix is 1.5 liters of the herbicide plus 200 ml Uptake® oil (paraffin oil and surfactant) plus 200 ml of Kiwi Highlight® (a dye) for 100 liters of applied mix. He reports an approximately 90% kill.

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MONITORING

Monitoring the spread of the *Ehrharta* spp. and preventing and detecting it early are keys to success. Also, monitoring is necessary to detect any changes in condition of the desired community, and to see what the response of the weed and your community is in response to your management treatments.

RESEARCH NEEDS

Much is still unknown about the *Ehrharta* spp., especially *E. erecta* and *E. longiflora*. The best management practices and techniques (including chemical and physical) for these species should be refined. It is likely that *E. erecta* control is similar to *E. calycina,* but no conclusive evidence exists. *E. longiflora* is an annual and therefore likely requires different management strategies. Control techniques that are successful for annual *Bromus* spp. control should be investigated for application to *E. longiflora*.

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