Aegilops triuncialis **System:** Terrestrial

Kingdom	Phylum	Class	Order	Family
Plantae	Magnoliophyta	Liliopsida	Cyperales	Poaceae

Common name

goat grass (English), barb goat grass (English), barbed goat grass (English), jointed goat grass (English), rompesacos (Spanish), blat bord (Catalan), trigo-montesino (Portuguese), aegilope-alongado (Portuguese), langähriges Hartgras (German), halmuca tregishtëe (Albanian)

Synonym

Aegilops elongata , Lam. [= *Aegilops triuncialis* var. *triuncialis*]
Aegilops persica , Boiss. [= *Aegilops triuncialis* var. *persica*]
Aegilops squarrosa , L. [= *Aegilops triuncialis* var. *triuncialis*]
Aegilops triuncialis , var. *assyriaca* Eig [= *Aegilops triuncialis* var. *triuncialis*]
Aegilops triuncialis , subsp. *persica* (Boiss.) Zhuk. [= *Aegilops triuncialis* var. *persica*]
Aegilops triuncialis , subsp. *triuncialis* [= *Aegilops triuncialis* var. *triuncialis*]
Triticum persicum , (Boiss.) Aitch. & Hemsl. [= *Aegilops triuncialis* var. *persica*]
Triticum triunciale , (L.) Raspail [= *Aegilops triuncialis* var. *triuncialis*]
Aegilopodes triuncialis , (L.) Á. Löve [= *Aegilops triuncialis* var. *triuncialis*]
Aegilopodes triuncialis , subsp. *persica* (Boiss.) Á. Löve [= *Aegilops triuncialis* var. *persica*]

Similar species

Summary

Aegilops triuncialis (barb goatgrass) is an annual grass with a native range throughout Europe, Asia and the Mediterranean Basin. It has invaded the United States, where it is particularly invasive in California. It is expanding its range in the state and becoming a dominant grass in foothill grasslands of central California. It outcompetes native grasses, reduces habitat for threatened species, affects microbial communities and alters nutrient cycling dynamics. Management of this species is one of the most important issues in rangeland management in California.

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Species Description

Aegilops triuncialis (barb goatgrass) is a selfing, annual, allotetraploid, C3 grass (family Poaceae) (Cal-IPC 2010) It has stiff, erect culms 20-40 cm tall. In late spring plants produce cylindrical spikes (inflorescences) consisting of 3-5 large spikelets (Peters *et al*. 1996). Spikelets contain dimorphic caryopses (seeds) that remain together after dispersal and germinate at different times (Dyer 2007). Seeds have long awns which make them easily dispersed by animals, wind and water (Peters *et al*. 1996).
Barb goatgrass is distinguishable from wild oat (*Avena* spp.) by several features including its long, white hairs that are sparsely distributed along all parts of the leaves; the slightly blue colour of the leaves at the early stage; its ligule which does not protrude visibly above the leaf blade as it does in wild oat; the angle of the blade/sheath joint which is approximately 90 degrees; and the collar which wraps around the stalk of the plant, which is absent in wild oat (Frye 2007).

Notes
Genetic diversity:*Aegilops triuncialis* in its introduced range has very high genetic uniformity caused by a genetic bottleneck upon invasion. Molecular data indicate that plants in California originate from just two introductions from its native range. Despite this, *A. triuncialis* is a very successful invader and highly invasive (Meimberg *et al*. 2006). This can likely be attributed to phenotypic plasticity and trans-generational plasticity (whereby parental responses pre-condition offspring for the environment they are most likely to encounter). Several studies have demonstrated its plasticity in terms of seed germination timing, acceleration of phenology and regulation of photosynthetic rate in response to different environmental variables in order to maximize plant fitness (Dyer 2003; Dyer 2007; Dyer *et al*. 2010).
Interactions with other species:The invasion of barb goatgrass in California annual grasslands is influenced by a complex association with pocket gophers (*Thomomys bottae*) and the fungus *Ulocladium atrum*. *Ulocladium atrum* aids the establishment of barb goatgrass by weakening the grass's tough seed head, thereby accelerating germination and seedling establishment. In contrast, gophers decrease establishment of this invader by selectively burying patches of goatgrass seedlings under mounds (Eviner & Chapin 2003). Gophers may also reduce goatgrass establishment indirectly by reducing fungal infection rates, although the mechanism for this decrease is unknown (Eviner & Chapin 2003).
While gophers decrease establishment of barb goatgrass by their preferential burrowing activity in patches of this weed, this is complicated by the fact that barb goatgrass is the most frequent species to establish on gopher mounds. It is unknown whether the negative effects of gopher burrowing on goatgrass decreases the abundance of the weed in the long run (Canals *et al*. 2005). Gopher burrowing activity has also been recorded to increase nutrient cycling in goatgrass litter (Eviner & Chapin 2005).

Lifecycle Stages
In California barb goatgrass seeds usually ripen in late June, although timing is dependent on rainfall and temperature, and it matures later than most other common annual grasses. Seeds may remain dormant for two or more seasons before germinating, and can remain dormant for up to five years. Seeds with the glumes removed experimentally (Peters 1994 in Peters *et al*. 1996), or weakened by the fungus *Ulocladium atrum* (Eviner & Chapin 2003) germinate quicker and have greater germination rates.
Barb goatgrass heads drop from the stalk of the grass as one whole piece, so that spikelets often remain together after dispersal, each containing two dimorphic seeds. Thus it actually has a two year lifecycle because one seed develops in the first year, and the other will develop the second year (Frye 2007).
Roots and shoots develop quickly, with roots quickly occupying a large soil volume and penetrating deeply; characteristics which contribute to its invasiveness in California (Peters *et al*. 1996).

Habitat Description
Barb goatgrass grows in rangelands, grasslands and oak woodlands, and is often found in disturbed roadside environments (Harrison *et al*. 2002). It prefers areas with some moisture (DiTomaso & Healy 2005 in Cal-IPC 2010).
This species can occur in nutrient-rich soils, as well as nutrient-depleted, infertile serpentine soils, which are usually relatively resistant to plant invasion and thus serve as refugia for endemic grassland species (Drenovsky & Batten 2007; Batten *et al*. 2005).

Reproduction
This species is highly selfing (Thomson 2007).

General Impacts
Competition: Barb goatgrass is an aggressive invasive species, particularly in northern California grasslands. It outcompetes and displaces other plant species (Canals *et al*. 2005) and forms dense above-ground stands (Batten *et al*., 2006), greatly reducing biodiversity (Eviner *et al*. 2009) It rapidly takes over grassland areas, and it has been reported to expand from a single infestation to complete domination in 20 years (DiTomaso & Healy 2005 in Cal-IPC 2010).
Reduction of habitat: Barb goatgrass invades infertile serpentine grassland, which is characterized by low calcium: magnesium ratio, low nitrogen content, high heavy metal content and low water holding capacity (Batten *et al*. 2005). These features make serpentine grasslands relatively resistant to exotic species invasion and thus host many endemic species. Thus barb goatgrass invasion in serpentine grassland reduce the area of habitats that supports federally threatened Bay checkerspot butterflies (*Euphydryas editha bayensis*) and rare plants such as the federally endangered Santa Clara Valley dudleya (*Dudleya setchellii*), and CNPS List 1B.2 most beautiful jewelflower (*Streptanthus albidus peramoenus*) (Niederer 2008).
Altering nutrient cycling:*Aegilops triuncialis* has been shown to affect soil properties such as aggregation (Batten *et al*. 2005) and rhizosphere soil microbial community composition in areas it invades; in greenhouse (Batten 2004 in Batten *et al*. 2006) and field-based experiments (Batten *et al*. 2006). These impacts may affect native plant fitness and could have important cumulative effects on microbial-driven processes such as nutrient cycling on an ecosystem scale (Batten *et al*., 2006).
Barb goatgrass produces more abundant, low quality biomass compared to native grasses, leading to reduced litter decomposition rates and altered nutrient cycling characteristics in grassland communities. Higher biomass production of low quality litter by barb goatgrass over time will lead to higher soil C levels and decreased C:N, which may negatively affect native and other exotic plant establishment (Drenovsky & Batten 2007). The ability of *A. triuncialis* to exacerbate low nutrient conditions in serpentine grasslands could pose a threat to these habitats which are refugia for native California grassland species (Harrison 1999 in Drenovsky & Batten 2007).
Aegilops triuncialis may also affect nitrogen dynamics in native grasslands. Its rapid accumulation of aboveground biomass causes the plant to compete with microbes for nitrogen, leading to reduced biologically active nitrogen in microbes that are available for uptake by native plants (Canals *et al*., 2005).
Agricultural:Barb goatgrass reduces forage quality and quantity as it is unpalatable to cattle and can directly injure livestock when its barb awns (slender, bristlelike appendages with sharp \"hooks\") lodge in their eyes, noses or mouths (DiTomaso *et al*. 2001).
Hybridisation:*Aegilops triuncialis* and two other *Aegilops* species that occur in California are closely related to winter wheat (*Triticum aestivum*) and have been shown to hybridize with the cereal crop, although natural hybrids have not been observed in North America (DiTomso *et al* 2001; Hedge & Waines 2004).

Management Info
Burning: Carefully timed burning carried out over two years can provide control of barb goatgrass for at least two years after treatment. Timely burning can also enhance the population of native plant species (DiTomaso *et al*. 2001).
As burn temperatures at the soil surface are lower than in the grass canopy, it is crucial to burn after the other grasses and forbs have cured enough to withstand a fire, but before the goatgrass seeds have matured and dropped to the soil. The fire must also be hot enough to destroy the seeds. Thus grazing animal should be removed from the area for one year prior to the burn to allow build up of fuel. Alternatively burning on windy or dry days, or attempting to back the fire downhill can increase a fire's heat (DiTomaso & Johnson 2006 in Niederer 2008). A secondary control option such as mowing or spraying may be needed the second year (Niederer 2008).
In all cases where burning is used, follow-up monitoring and plans for retreatment are required. For maximum effectiveness, in most cases, fire should be integrated with other control methods. The ultimate net effects of any treatment plan on the entire plant community, higher tropic levels, and ecosystem properties need to be considered before a treatment plan is implemented (DiTomaso *et al*. 2006).
Chemical:The grass-specific herbicide Envoy (clethodim) has been used with highly effective results on Coyote Ridge, California. After two years of treatment no plants were found along the monitoring transect (Niederer 2008). Envoy does not impact native forbs, including the rare most beautiful jewelflower, and is effective against all grasses. This herbicide should be applied to non-stressed plants in spring after germination and before seedheads emerge (Niederer 2008).
Roundup (glyphosate) is also effective against barb goatgrass, but is nonspecific and will kill desirable native forbs. It may be considered for spot-spraying (Niederer 2008).
Mechanical control:Hand pulling is time consuming and labour intensive, although plants are easy to pull. It is effective in small areas of low goatgrass density where roots can be removed, but treated areas must be revisited as individuals mature at different times. Hand pulling is a particularly effective method when used as a follow up to mowing and spraying, or to treat small outlier popultions (Niederer 2008).
Carefully timed mowing may also be effective in controlling annual grasses such as barb goatgrass. Mowing should be done before flowering, but before the seeds reach the "soft dough stage" (seeds are fully formed, but soft and immature). Mowing too early promotes tillering, while mowing too late spreads seeds. This method is most likely to be effective when combined with other control methods. Mowing with thorough handpulling as follow up is suggested (Niederer 2008).
Replacement with natives:Barb goatgrass remains active later in spring than many grasses, a contributing factor to its dominance in California grasslands. Thus restoration of grasslands with native perennial grasses with a later season phenology has been suggested as a method of competitively suppressing barb goatgrass. However initial tests found that barb goatgrass suppressed natives. *Lolium multiflo-rum*, a later season annual is suggested as a potential candidate for suppressing this weed (Eviner *et al*. 2009).
Other: Hydromechanical obliteration may be used to control barb goatgrass in the future. This technique involves removing plants using pure water shot through a high pressure nozzle. The water vaporizes almost immediately on contact, leaving the ground barely damp and with little to no soil disturbance on most soils (Niederer 2008). It can be used selectively, or on a large scale and the pressure can be adjusted to affect annuals but not native plants (Cal-IPC 2008).

Pathway
Seeds can contaminate vehicles and equipment (DiTomaso *et al*. 2001).

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ALIEN RANGE

[1] JAPAN

[5] UNITED STATES

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