WRITTEN FINDINGS OF THE
DRAFT WASHINGTON STATE NOXIOUS WEED CONTROL BOARD
Proposed noxious weed for 2016

Scientific Name: *Taeniatherum caput-medusae* (L.) Nevski

Synonyms: *Elymus caput-medusae* L., *Taeniatherum asperum* Nevski, *Taeniatherum caput-medusae* subsp. *caput-medusae*, Taeniatherum asperum auct. non (Simonkai) Nevski, Taeniatherum crinitum (Schreb.) Nevski, Taeniatherum crinitum (Schreb.) Nevski var. caput-medusae (L.) Wipff

Common Name: medusahead, medusahead wildrye, medusahead rye

Family: Poaceae

Legal Status: Proposed noxious weed listing for 2016

Images: left, pulled mature plants with seedheads, image by Steve Dewey, Utah State University, Bugwood.org; center, monoculture of medusahead, image by John M. Randall, The Nature Conservancy, Bugwood.org; right, green medusahead inflorescence, image by Barry Rice, sarracenia.com, Bugwood.org.

Description and Variation:

Overall habit:

Taeniatherum caput-medusae, commonly called medusahead, is a nonnative, winter annual grass that can grow up to 2 feet (60 cm) tall. Plants bloom in the spring after other nonnative annual grasses. Inflorescences are a dense spike with long awns that can be somewhat spreading and twisting, and are covered in small barbs. The mature spike with its spreading awns is said to roughly resembling medusa's head, hence its common name.

Roots:

Medusahead roots are fibrous and begin as a shallow roots system and later in its lifecycle are able to grow deeper and access deep soil moisture (DiTomaso and Healy 2007). Growth studies by Hironaka (1961) found roots reached around 40 inches deep by mid-June during the 1956-1957 and 1957-1958 growing seasons.

Stems:
Medusahead stems, called culms, grow 0.33 to 2 feet (10 to 60 cm) tall, though sometimes up to 2.3 feet (70 cm) tall (Wipff 2007). The stems are thin, ascending to erect, usually puberulent, and round in cross section (DiTomaso and Healy 2007, WTU 2015). Stems have 3 to 6 nodes and have evenly distributed leaves (Wipff 2007).

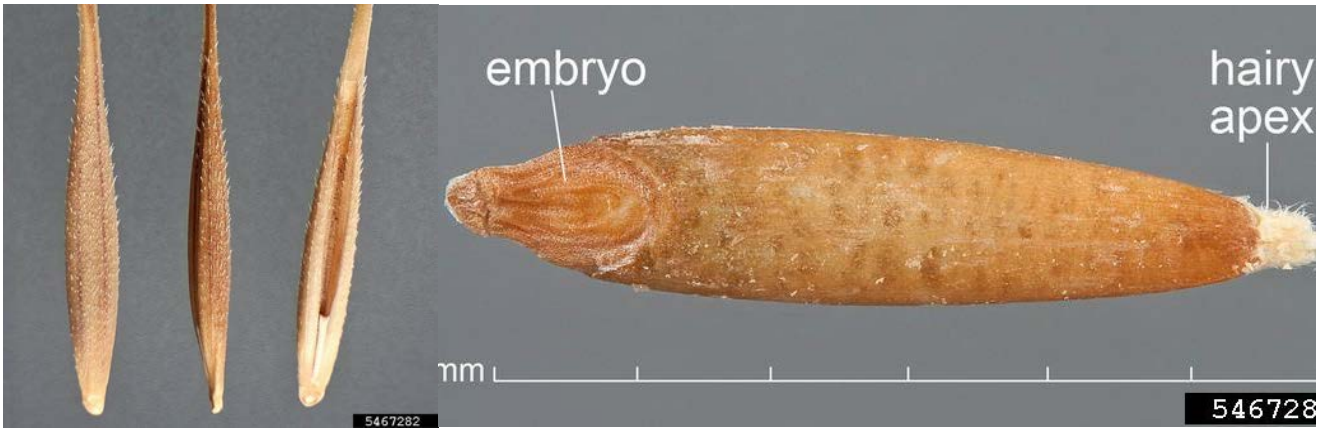
Leaves:
Plants have open leaf sheaths which may be covered with soft short hairs and a collar region that is sparsely hairy (DiTomaso and Healy 2007). Auricles are 0.1 to 0.5 mm long (rarely absent) and are glabrous (DiTomaso and Healy 2007). Leaf ligules are membranous and truncate, 0.2 to 0.8 mm long (Wipff 2007). The leaves are rolled while in bud and later are flat to inrolled (involute) 3.9 to 11.8 inches (10 to 30 cm) long by 0.7 to 3 mm wide (DiTomaso and Healy 2007, Wipff 2007). The leaves may be glabrous or covered with short hairs and often appear glassy under magnification (DiTomaso and Healy 2007).

Images: left, current year's medusahead inflorescence (above) in June pictured with an old spike, having only glumes, without any seeds remaining; right, dense medusahead infestation with green inflorescences in near horizontal position, images by WSNWCB.

Flowers:
Inflorescences are erect spikes, 0.5 to 2 inches (1.2 to 5 cm) long excluding awns, and have 4 to 28 nodes, with each node having typically sessile spikelets (Wipff 2007). Each spikelet has 2 (sometimes 3) florets with the lowest floret being bisexual and the upper (distal) floret(s) being highly reduced and sterile (Wipff 2007).

Spikelets disarticulate above the glumes, with the pair of glumes at the base of the spikelet being unequal, 1 to 4 cm long, awnlike and are straight to somewhat reflexed, each divided into 2 segments that are fused at the base (DiTomaso and Healy 2007, Wipff 2007). The fertile floret lemma is narrowly lanceolate, around 0.2 to 0.3 inches (5 to 8 mm) long, has 3 veins and the hard surface is covered with silica barbs and papillae (DiTomaso and Healy 2007). The lemma tip has a 1.2 to 2.8 inches (3 to 7 cm) long, flattened awn that has upward pointing barbs on the margins (DiTomaso and Healy 2007). The fertile floret has 3 yellow to purple anthers (Wipff 2007).

When inflorescences are mature, they often bend in an almost horizontal position (DiTomaso and Healy 2007). As the awns dry and turn tan, they may twist and spread, reminiscent of the snake-covered head of Medusa (Bossard et al. 2000). The main axis of the inflorescence does not break apart when spikelets disarticulate (DiTomaso and Healy 2007).



Images: left, medusahead florets—dorsal view (left), lateral view (middle), and ventral view (bottom); right, caryopsis in dorsal view, both images: D. Walters and C. Southwick, Table Grape Weed Disseminule ID, USDA APHIS ITP, Bugwood.org.

Fruit:
The fruit is a narrowly elliptic caryopsis, 0.16 to 0.22 inches (4 to 5.2 mm) long, with an adaxial groove and pubescent apex (Wipff 2007). The caryopsis has small barbs of silica (Wipff 2007).

Similar species:
Medusahead, *Taeniatherum caput-medusae*, is the only species in its genus and is fairly distinct from other species at maturity. It is sometimes confused with *Hordeum* or *Elymus* species like foxtail barley, *Hordeum jubatum,* or squirreltail, *Elymus elymoides*. *Hordeum* and native *Elymus* species have 5-veined lemmas (compared to medusaheads 3-veined lemmas) and their main spike axes typically break apart in fruit (while medusahead spikes does not) (DiTomaso and Healy 2007). Also, *Hordeum* species have 3 florets per spikelet, with the central floret being the largest, while medusahead has 2 florets with the lower floret being larger (DiTomaso and Healy 2007).

Medusahead matures later than other annual grasses, so it can often be recognized by its green color when other grasses have turned brown (Bossard et al. 2000).

Image: both images of squirreltail, *Elymus elymoides* ssp. *elymoides*, both images by Dave Powell, USDA Forest Service (retired), Bugwood.org.

Image: all images of foxtail barley, *Hordeum jubatum*, left image by, Elizabeth Bella, USDA Forest Service, Bugwood.org; center and right image by Joseph M. DiTomaso, University of California - Davis, Bugwood.org.

Habitat:
Medusahead is well-known as a rangeland invader and grows in a variety of conditions. Medusahead thrives on soils with a high content of clay and where deep soil moisture is available late growing season (DiTomaso and Healy 2007). It will also grow on loamy soils and is less of an invader, though it can be found, on well-drained, sandier soils (Sheley et al. 2008, Stromberg and Griffin 1996, Miller 1996, Dahl and Tisdale 1975 all in Nafus and Davies 2014). It grows in areas receiving 9.8 to 39.3 inches (25 to 100 cm) inches of precipitation, falling between autumn to spring with a dry summer (Major et al. 1960, Sharp et al. 1957, Torell et al. 1961 all in Nafus and Davies 2014). Beside rangelands, habitats medusahead invades include grassland, sage brush communities, chaparral openings, oak woodlands and savannah, disturbed sites and occasionally agronomic fields (DiTomaso and Healy 2007, Bossard et al. 2000).

Geographic Distribution:
According to the USDA GRIN database, (USDA ARS 2015), *Taeniatherum caput-medusae* is native to the Mediterranean region, parts of Asia, Europe and North Africa, specifically:

- North Africa: Algeria, Egypt, Libya, Morocco and Tunisia
- Asia: Afghanistan, Cyprus, Iran, Iraq, Israel, Jordan, Lebanon, Syria, Turkey, Armenia, Azerbaijan, Georgia, Russian Federation, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Pakistan
- Europe: Hungary, Ukraine, Albania, Bulgaria, Croatia, Greece, Italy, Macedonia, Romania, Serbia, France, Portugal, Spain

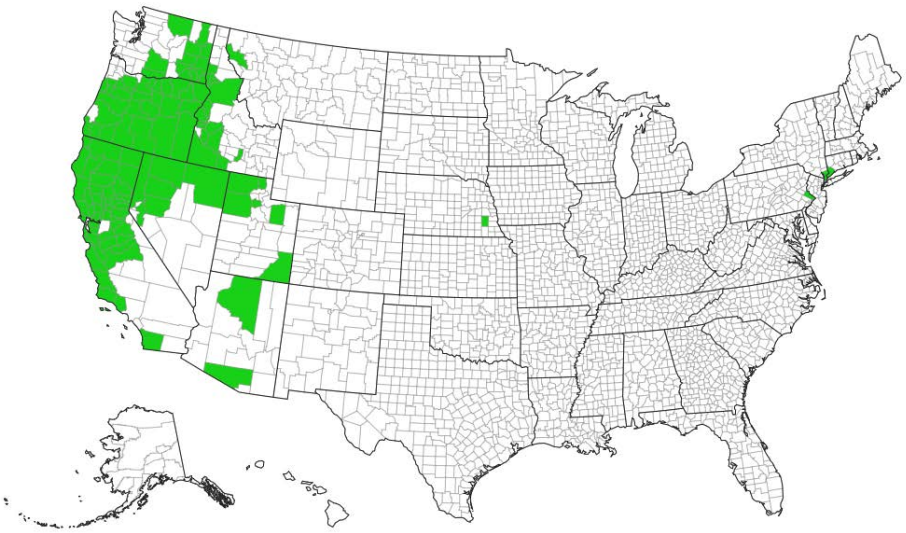
Currently, USDA GRIN database (USDA ARS 2015) lists *Taeniatherum caput-medusae* naturalized in:

- Australia
- North America: western United States
- South America: Chile

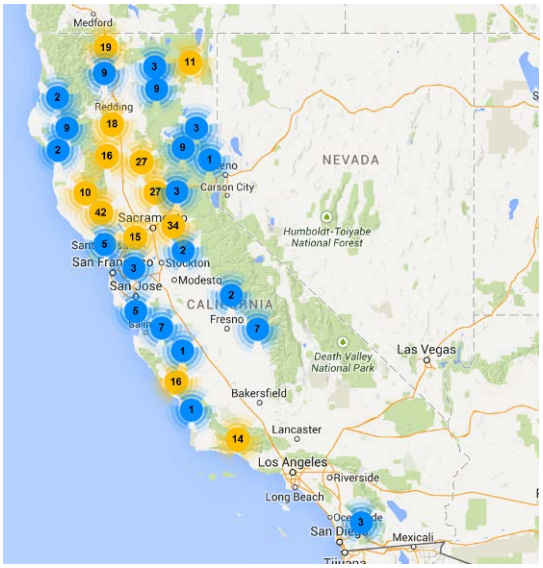
In the United States, the exact mode of introduction is not known but is thought to have been by seeds stuck to livestock fur or less likely as a grain seed contaminant (George 1992, Hilken and Miller 1980 both in Kyser et al. 2014). Medusahead has been calculated as expanding its range in the U.S. by around 12% per year and in a 2005 publication, its range was estimated at +2.4 million acres in 17 western states (Rice 2005 in Kyser et al. 2014). California annual grasslands and the intermountain west are the two main epicenters identified of medusahead invasion (Nafus and Davies 2014). Medusahead has also been documented as an occasional occurrence at a few sites in the eastern U.S. (Wipff 2007).

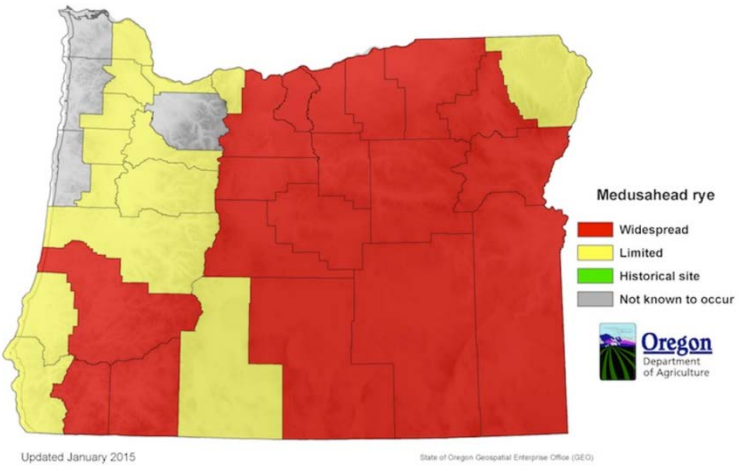
Listings:

Medusahead is listed as a noxious weed or on a regulated weed list in California, Colorado, Nevada, Oregon, Utah, and Wyoming (USDA GRIN 2015, National Plant Board 2015). Medusahead was listed as a Class B noxious weed in Washington State in 1988 and 1989.



Map: County presence/absence map of medusahead, *Taeniatherum caput-medusae*, in the United States, map by EDDMapS 2015.

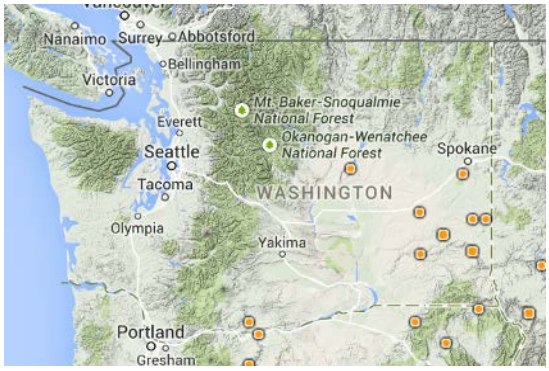




Maps: left, map of medusahead herbarium records in California (Consortium of California Herbaria 2015); right, Oregon state county distribution map (Oregon Department of Agriculture 2015).

Oregon:

In the United States, medusahead was first collected in Douglas County, Oregon, in 1884 (OSC ORE13121) and 1887 (WTU 25551JWT) by T. Howell in the Umpqua Valley, Douglas County, Oregon (Consortium of PNW Herbaria 2015). Since its introduction, medusahead has spread widely over the state, expanding in burned areas and low moisture rangelands as well as persisting in high moisture areas of western Oregon (Oregon Dept. of Agriculture n.d.).



Map of medusahead herbarium specimens in Washington State (orange dots) (Consortium of PNW Herbaria 2015).

Washington:

According to herbarium records, medusahead has populations documented in east-central and east-southern Washington (WTU 2015). The earliest herbarium record of medusahead in Washington is from 1901, noted as being near Steptoe, and collected by G. R. Vasey (WS 3276) (Consortium of PNW Herbaria 2015). The next earliest herbarium records in Washington are a collection from near Goldendale in Klickitat County in 1938 (OSC OSC39525); a collection from an old rock quarry in Whitman County from 1952 (WS 25801); a Klickitat County collection from 1953, west of Centerville (WS 16976); a Whitman County collection from a dry, grassy hillside in 1957 (ID 37810, ID037021); and a Spokane County collection from a roadside, near Cheney in 1964 (EWU 2067, 2365) (Consortium of PNW Herbaria 2015).

Medusahead is more common throughout Oregon than in Washington, on both sides of the Cascades (WTU 2015).

Growth and Development:

Medusahead seeds require an after-ripening period of about 3 to 4 months (DiTomaso and Healy 2007). The awns contain a germination inhibitor that must degrade for germination to begin (Young 1992, DiTomaso and Healy 2007). Seeds typically germinate in the fall (October and November in California) with fall rains but can also germinate through the winter and spring (Young 1992). The seeds are adapted to and germinate better from under medusahead thatch than on bare soil (Evans and Young 1970). They can germinate within the thatch under low moisture conditions (DiTomaso and Healy 2007). Seeds are also able to germinate in soil as deep as 8 cm (DiTomaso and Healy 2007). Roots grow quickly, faster even than another weedy grass cheatgrass (*Bromus tectorum*), and can continue growth through the winter months (Hironka 1961). Seedlings can survive desiccation of their primary root by the development of adventitious roots when moisture is available (DiTomaso and Healy 2007). Early on, roots can deplete upper soil moisture and then grow deep in the soil, to around 40 inches, accessing deep soil moisture later in the season (DiTomaso and Healy 2007, Hironka 1961).

Seedlings can develop leaves several inches long before cold weather stops growth, which will then start up again in the spring (Young 1992, Sharp et al. 1957 in Nafus and Davies 2014). Inflorescences typically develop in May to June (Wipff 2007). Seedlings germinating from all seasons can produce inflorescences in late spring to early summer (Wipff 2007, Young 1992). The root system reaches its full development around the time the full inflorescence has occurred (Hironaka 1961). Flowerheads turn from green to reddish tinged to a straw color as they mature, form seed, and disperse (Kyser et al. 2014). Most inflorescences develop seed and reach maturity by July (Sharp et al. 1957 in Nafus and Davies 2014). Research on native and invasive medusahead populations have found plants to be almost entirely self-pollinated (Prior et al. 2013 in Kyser et al. 2014).

After seeds have released from the inflorescence, the old spike with glumes will remain intact and not break apart (DiTomaso and Healy 2007). A few florets may remain attached to the spike after the plants have matured (DiTomaso and Healy 2007). After seeds are released, the old stems, leaves and spikes will form or add to a layer of thatch (Nafus and Davies 2014).

Medusahead infestations can be dense, with plants tolerating densities of up to 3000 plants per square meter (DiTomaso and Healy 2007). Plants have variable growth with 1 plant per square foot, not competing with

others, being able to exceed the seed production of 1000 plants per square foot (unpublished research, ARS, Reno, Nevada in Young 1992).

Reproduction:
Plants reproduce by seed. Most medusahead seeds appear be viable up to 2 years (DiTomaso et al. 2013). Medusahead generally begins maturing 2 to 4 weeks later in the season than most other annual grasses and continues through much of the summer (DiTomaso et al. 2008, Laca 2009 both in Kyser et al. 2014, DiTomaso and Healy 2007). On average, a plant will produce 3 to 5 seedheads (matured inflorescences) with an average of 5.6 seeds/seedhead in dry areas and 8.7 seeds/seedhead in moist areas, with higher production in ideal conditions (Sharp et al. 1957 in Kyser et al. 2014). Estimates have ranged up to 10,000 seeds produced/square meter in ideal conditions (Clausnitzer et al. 1999) and 5.7 to 243 million seeds per acre (Kyser et al. 2014).

Seeds typically drop near the parent plant with 75% of seeds landing less than 1.7 feet (0.5 m) from the invasion front and most not traveling more than 6.6 feet (2 m) (Davies 2008 in Nafus and Davies 2014). Dispersal of seeds can happen locally by wind, mud, soil movement, humans, equipment, animals, and occasionally by water (DiTomaso and Healy 2007). The awns attached to seeds are covered in barbs and readily adhere to fur/hair, clothing and other materials, facilitating dispersal (Davies 2008, Davies and Sheley 2007a, Furbush 1953, Miller 1996 all in Kyser et al. 2014).

Economic Importance:
Detrimental:
Medusahead causes many detrimental impacts where it invades, including the alteration of an ecosystem to favor its own survival and competing with and reduction of native and forage plants, resulting in the degradation of wildlife habitat.

Medusahead is a highly competitive species. Its roots grow through the fall, winter and spring, depleting upper soil moisture early in growing season (DiTomaso et al. 2013). Medusahead seedlings have a higher growth rate than native grass seedlings, allowing it to have an advantage acquiring soil resources, even under low nutrient conditions (James 2008a, 2008b, Mangla et al. 2011, Monaco et al. 2003b, Young and Mangold 2008 all in Nafus and Davies 2014).

Its invasion is associated with significant reductions in native vegetation and plant diversity (Davies 2011). Research by Davies (2011) found that plant species diversity was negatively correlated with medusahead density, and native vegetation cover decreased with increasing medusahead density. Also, species diversity, most native plant functional groups, as well as biological soil crust, declined exponentially with increasing medusahead density (Davies 2011). The loss of plant diversity at a site also decreases the probability and possibility of restoring invaded communities to their pre-invaded state, as commercial seed sources are not always available for many native forbs found in some of plant communities (Davies and Svejcar 2008).

The silica content of medusahead slows the decomposition of the old plant parts, resulting in the formation of a thick, persistent layer of thatch (George 1992, Young 1992 both in Kyser et al. 2014). This dense thatch layer alters soil temperature and moisture dynamics, creating an environment in which medusahead seed are adapted to germinate but at the same time limits the germination of other species (HilleRisLambers et al. 2010, James et al. 2011b both in Nafus and Davies 2014, DiTomaso and Healy 2007). The thatch layer also provides and increases the amount of fine fire fuels (Davies and Svejcar 2008, Torell et al. 1961, Young 1992, Young et al. 1972 all in Nafus and Davies 2014), resulting in an increased frequency of fire (Nafus and Davies 2014). The increase in fire frequency detrimentally impacts native plants not adapted the shortened time between fires, and promotes further medusahead dominance (D'Antonio and Vitousek 1992 in Nafus and Davies 2014). The medusahead-dominated site then facilitates the invasion of neighboring non-invaded sites (D'Antonio and Vitousek 1992 in Davies 2011).

Sagebrush steppe that is invaded by medusahead contains less desirable habitat for most intermountain wildlife species compared to uninvaded areas (Davies and Svejcar 2008). Habitat for the sage grouse (*Centrocercus* spp.) is severely impacted by medusahead invasion, as plants that the grouse uses for food and shelter are crowded out by medusahead or burned in the higher frequency of fires (Kyser et al. 2014). Other birds, rodents and animals have been found to prefer native species and avoid feeding on medusahead (Goebel and Berry 1976, Longland 1994 in Kyser et al. 2014).

Medusahead is does not provide good forage for livestock. Due to its high silica content and rough texture, livestock selectively avoid grazing medusahead (Kyser et al. 2014). Through its dominance and ability to form monocultures, medusahead can reduce livestock grazing capacity by 50 to 80% or more in some cases, within a period of a few years (Davies and Svejcar 2008, Hironaka 1961). Heavily invaded communities produce only around 13% of the native plant biomass of non-invaded communities, greatly reducing potential forage (Davies and Svejcar 2008). Only the early growth stages of medusahead are palatable for livestock as mature plants contain too much silica (DiTomaso and Healy 2007). The mature plants stiff awns and florets can also harm the eyes, mouths, and throats of grazing animals (DiTomaso and Healy 2007).

Beneficial:
There are no known benefits of medusahead.

Control:
"Medusahead Management Guide for the Western States" (Kyser et al. 2014) is a recent publication that provides in-depth and updated recommendations for medusahead management. This resource is available online at: http://wric.ucdavis.edu/publications/MedusaheadManagementGuide_pub_2014.pdf
Selective information from this resource is included below, but please refer to the link for detailed information. Also, check with your local county noxious weed board for further information and recommendations on how to control medusahead. Controlling medusahead will usually include a combination of control methods and the establishment of a desirable, competitive plant community. Tables detailing possible integrated weed management plans can be found in the guide.

Early detection of new medusahead infestations followed by a rapid control response will prevent the establishment and spread of infestations, which would lead to greater impacts and higher management costs if allowed to spread. Focus monitoring for new and recurring infestations on transportation corridors and other areas that may be susceptible to invasion, such as areas with soil disturbance. The prevention and early detection should be a top priority due to the cost of control and revegetation, as well as the loss of species diversity (Davies 2011 in Nafus and Davies 2014).

Regardless of the management methods used, medusahead must be prevented from producing new seed for 2 to 3 years in order to deplete and prevent addition to the soil seedbank (Kyser et al. 2014). Selection of control methods and timing will depend on location, climate, soil, plant community characteristics, land use, and management objectives (Nafus and Davies 2014). Another important point to keep in mind when considering your management plan and control techniques is whether you have a low or high elevation site as management on low-elevation foothill rangeland is very different than management on high elevation rangeland in the intermountain region (Kyser et al. 2014).

Also, make sure to clean equipment, clothes and livestock of medusahead seed to prevent the spread and introduction of medusahead into new sites. Cleaning livestock may not be possible, so try to avoid moving livestock from infested sites directly to clean sites. If animals are moved, try to hold animals a few days between sites to allow seed to shed (Kyser et al. 2014).

Mechanical Control:
Individual plants and small infestations can be effectively hand-pulled or removed with a hoe. Remove plants when they are large enough to identify but before they have set seed (Kyser et al. 2014). While hand removal is selective, it is only practical on a very small scale.

The following information on mechanical control is from Kyser et al. (2014) unless otherwise noted:

- Mowing low-elevation sites in the late spring, when flowering has begun (emergence of awns to emergence of floret anthers) but prior to seed development, can provide effective control.
- Mowing is generally not as successful for high-elevations sites given the difficulty of access, fuel costs, rough terrain and the native plant communities that may not respond well to being mowed.
- Early-season mowing may harm other species and not effectively control medusahead while mowing later in the season, when inflorescences are just starting to form to early flowering stage, can be effective (DiTomaso et al. 2013). Do not mow after seeds have matured as it will just help disperse the seed (DiTomaso et al. 2013).
- Evaluate your landscape to see if tillage would be a good management option. Cons to tillage include potential soil erosion, loss of organic matter and soil moisture and loss of microbiotic crusts. Pros to tillage include control of medusahead plants, burying seed, breaking up medusahead thatch that can prevent other plants from growing, and prepping a site for reseeding.
- Tillage can be used for medusahead control where the terrain permits and where it will not detrimentally harm desired existing plant communities, like sagebrush steppe, which are not adapted to deep tillage.
- It is important to follow up tillage with reseeding.
- Removing thatch by harrowing can prep a site for reseeding or a preemergent herbicide, but it does not control existing medusahead plants.

Cultural Control:
Controlled Burns
Controlled burns can reduce infestations, though burn conditions and timing are important as in some cases fire can enhance plant populations (DiTomaso and Healy 2007).

The following information is from Kyser et al. (2014):

- Burns in the late spring when medusahead seed are still held in the inflorescence and other species have dropped their seeds can provide some selective control. Besides killing the seeds that are in the grass canopy, fire can also remove the thatch from a site and provide site prep for other control methods and/or reseeding.
- Controlled burns may not provide control at every site. Burning at low elevation sites with warm-winters and high annual grass biomass production may be more successful than burns at high elevation sites with cooler winters. Some communities, such as high-elevation shrubland, are poorly adapted to fire, and fire may allow further invasion of medusahead.
- Obtaining permits for controlled burns can be difficult due to liability and air quality issues. You must contact your county officials for information about controlled burns and permits.

Competitive plants:
Information from Kyser et al. (2014) unless otherwise noted:

- Maintaining and establishing a healthy, vigorous resident plant community is critical when controlling and preventing medusahead infestations. Medusahead is more competitive in the seedling stage than perennial bunchgrasses, so successful control of medusahead is often needed first before establishment of desired vegetation

- Also, medusahead thatch will need to be reduced or removed for most desirable species to establish. If possible, wait for initial control methods to provide some control of medusahead plants and thatch, and then follow with the seeding of desired plants species.
- Seeding a mix of annual and perennial species may provide a competitive plant community at sites where medusahead control is taking place.
- Although it is often desirable to seed with native species, they can be more difficult to establish and nonnative, non-invasive species may be used instead for revegetation.
- Native squirreltail species (*Elymus multisetus* and *E. elymoides*) and bluebunch wheatgrass (*Elymus spicatus*) are native bunchgrasses that establish well after medusahead control, though do not compete well directly with medusahead. Other perennial grasses sometimes used in restoration projects include: thickspike wheatgrass (*E. lanecolatus*), slender wheatgrass (*E. trachycaulus*), basin wildrye (*Leymus cinerus*), beardless wildrye (*L. triticoides*), and western wheatgrass (*Pascopyrum smithii*).
- Besides perennial grass species, native annual grass and forbs may be suitable species to seed on site as they can compete with medusahead. Uselman et al. (2014) found the native bristly fiddleneck (*Amsinckia tessellata*), an early seral forb species, to be an effective competitor with medusahead in two different soils, reducing medusahead biomass and seed production by 16 and 17%.
- Rangeland drill seeding tends to have a higher rate of establishment than broadcast seeding.

Image: controlled burn of medusahead, image by Steve Dewey, Utah State University, Bugwood.org

<u>Biocontrol Control</u>:
There are currently no approved biological control agents for medusahead but research is ongoing.

Naturally occurring soil bacteria have been found to be suppressive to medusahead and other nonnative annual grasses cheatgrass (*Bromus tectorum*) and jointed goatgrass (*Aegilops cylindrical*). Currently research and testing of a native rhizobacterium, *Pseudomonas fluorescens* strain D7 (Pf D7) is underway as it is showing promise in reducing medusahead infestations (Ann Kennedy pers. comm. in Nafus and Davies 2014).

Grazing information from Kyser et al. (2014) unless otherwise noted:

- At its early stages, medusahead is palatable and its protein content is comparable to other annual grass species (Bovey et al. 1961, Lusk et al. 1961, Torell et al. 1961 all in Kyser et al. 2014). Grazing plants at this stage is desirable as it will help prevent plants maturing and developing seed. As it ages, medusahead accumulates silica and becomes less palatable, and animals eventually avoid grazing it.
- Grazing with sheep can provide control benefits, with high density, short duration, mid-spring grazing providing good control on a California grassland (DiTomaso et al. 2008). Cattle may also provide some control with similar timing.

- Grazing management with precision grazing can be an effective method of medusahead control, even increasing the cover of native plant species, but there are some cases where sites are prone to invasion even with proper grazing management (DiTomaso et al. 2008, Griggs 2000, Reiner and Craig 2011 all in Kyser et al. 2014).
- It is important to prevent the overgrazing of desirable plant species that provide competition to medusahead.

Herbicide Control:
A challenge with herbicide use is to selectively control medusahead without damaging desirable plants and also the cost of large-scale control. See Chapter 7 of "Medusahead Management Guide for the Western States." (Kyser et al. 2014) for detailed information on herbicide use, timing, treatment considerations, and rates. http://wric.ucdavis.edu/publications/MedusaheadManagementGuide_pub_2014.pdf

The Pacific Northwest Weed Management Handbook has some information on medusahead control; look under the headings for imazapic and imazapic + glyphosate at this webpage:
http://pnwhandbooks.org/weed/other-areas/non-cropland-and-right-way/vegetation-control

Always read and follow the herbicide label instructions. Check with your local county noxious weed control board to discuss treatment options.

Rationale:

References:

Bossard, C. C., J. M. Randall, M. C. Hoshovsky, Eds. 2000. Invasive Plants of California's Wildlands. University of California Press. 360 pp.

Consortium of California Herbaria. 2015. *Taeniatherum caput-medusae*. Access online June 2015 at: http://ucjeps.berkeley.edu/consortium/

Consortium of Pacific Northwest Herbaria. 2015. *Taeniatherum caput-medusae*. Accessed online June 2015 at: http://www.pnwherbaria.org

Davies, K. W. 2011. Plant community diversity and native plant abundance decline with increasing abundance of an exotic annual grass. Oecologia 167: 481-491.

Davies, K. W. and T. J. Svejcar. 2008. Comparison of medusahead-invaded and noninvaded Wyoming big sagebrush steppe in southeastern Oregon. Rangeland Ecology and Management. 61:623-629.

DiTomaso, J. M., G. B. Kyser et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California. 544 pp.

DiTomaso, J. M. and E. A. Healy. 2007. Weeds of California and Other Western States. University of California Agriculture and Natural Resources. Publication 3488.

EDDMapS. 2015. Early Detection and Distribution Mapping System. The University of Georgia-Center for Invasive Species and Ecosystem Health. Available online at http://www.eddmaps.org/ access online June 2015.

Evans, R. A. and J. A. Young. 1970. Plant Litter Establishment of Alien Annual Weed Species in Rangeland Communities. Weed Science. 18 (6): 697-703.

Hironaka, M. 1961. The Relative Rate of Root Development of Cheatgrass and Medusahead. Journal of Range Management 14:263-267.

Kyser, G. B., J. M. DiTomaso, K. W. Davies, J. S. Davy, B. S. Smith. 2014. Medusahead Management Guide for the Western States. University of California, Weed Research and Information Center, Davis. 68 pp. Available at: wric.ucdavis.edu.

Nafus, A. M. and Davies, K. W. 2014. Medusahead Ecology and Management: California Annual Grasslands to the Intermountain West. Invasive Plant Science and Management 7: 210-221.

National Plant Board. 2015. State Law and Regulations. http://nationalplantboard.org/

Oregon Department of Agriculture. 2015. Medusahead rye distribution map. Accessed online June 2015 at: https://data.oregon.gov/views/e6w7-6c5g/files/8EN1Gl2dN32NyeNibp5MPR9oqbfedCSIjELchAq7zdk

Oregon Department of Agriculture. n.d. Medusahead rye Profile. Accessed online June 2015 at: www.oregon.gov/oda/shared/.../Weeds/MedusaheadRyeProfile.pdf

USDA, ARS. 2015. National Genetic Resources Program. *Germplasm Resources Information Network - (GRIN)* [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov.4/cgi-bin/npgs/html

Uselman, S. M., K. A. Snyder, E. A. Leger, and S. E. Duke. 2014. First-year establishment, biomass and seed production of early vs. late seral natives in two medusahead (*Taeniatherum caput-medusae*) invaded soils. Invasive Plant and Science Management. 7: 291-302.

Wipff, J. K. 2007. Taeniatherum, published in Barkworth et al. (eds.), Flora of North America vol. 24, viewed at http://herbarium.usu.edu/webmanual on 6.8.2015.

WTU. 2015. University of Washington Burke Herbarium. Accessed online June 2015 at: http://www.burkemuseum.org/herbarium

Young, J. A. 1992. Ecology and Management of Medusahead (*Taeniatherum caput-medusae* ssp. *asperm* (Simk.) Melderis). Great Basin Naturalist 52 (3): 245-252.