DRAFT: WRITTEN FINDINGS OF THE
WASHINGTON STATE NOXIOUS WEED CONTROL BOARD
2018 Noxious Weed List Proposal

Scientific Name:	*Tussilago farfara* L.
Synonyms:	*Cineraria farfara* Bernh., *Farfara radiata* Gilib., *Tussilago alpestris* Hegetschw., *Tussilago umbertina* Borbás
Common Name:	European coltsfoot, coltsfoot, bullsfoot, coughwort, butterbur, horsehoof, foalswort, fieldhove, English tobacco, hallfoot
Family:	Asteraceae
Legal Status:	Proposed as a Class B noxious weed for 2018, to be designated for control throughout Washington, except for in Grant, Lincoln, Adams, Benton, and Franklin counties.

Images: left, blooming flowerheads of *Tussilago farfara*, image by Caleb Slemmons, National Ecological Observatory Network, Bugwood.org; center, leaves of *T. farfara* growing with ferns, grasses and other groundcover species; right, mature seedheads of *T. farfara* before seeds have been dispersed, center and right images by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Description and Variation:
The common name of *Tussilago farfara*, coltsfoot, refers to the outline of the basal leaf being that of a colt's footprint.

Overall habit:
Tussilago farfara is a rhizomatous perennial, growing up to 19.7 inches (50 cm tall), which can form extensive colonies. Plants first send up flowering stems in the spring, each with a single yellow flowerhead. Just before or after flowers have formed seeds, basal leaves on long petioles grow from the rhizomes, with somewhat roundish leaf blades that are more or less white-woolly on the undersides.

Roots:
Plants have long creeping, white scaly rhizomes (Griffiths 1994, Chen and Nordenstam 2011). Rhizomes are branching and have fibrous roots (Barkley 2006). They are also brittle and can break easily (Pfeiffer et al. 2008).

Images: left, dug of flowering stems with attached rhizomes and fibrous roots, image by, Leslie J. Mehrhoff, University of Connecticut, Bugwood.org; center, *Tussilago farfara* basal leaves; right, underside of *T. farfara* basal leaf, center and right images by Zoya Akulova 2014, Creative Commons Attribution-NonCommercial 3.0 (CC BY-NC 3.0) license.

Stems:

Stems are erect and unbranched, arising from the ground before the basal leaves and terminate in a flowerhead (Barkley 2006). Stems grow in small clusters.

Leaves:

Tussilago farfara has two types of leaves: stem leaves and basal leaves.

Leaves on the flowering stems are alternately arranged, small and scale or bract-like, and can have a purple tinge. Ranging in size from 0.2 to 1 inch (5 to 25 mm), they have parallel veins, entire margins, are lance-ovate to linear shaped, with sparse long hairs and purple-tipped glands (Douglas et al. 1998, Barkley 2006).

Basal leaves develop after flowering stems, on petioles 1.2 to 13.8 inches (3 to 35 cm) long, and grow from the rhizomes in rosettes (Webb et al. 1988, Douglas et al. 1998). The leaf blades are 2 to 11.8 inches (5 to 30 cm) long, palmately nerved, heart-shaped to orbicular to triangular with narrow indentation at base and possibly, shallowly 5 to 12 lobed or angled with irregularly denticulate (small-toothed) margins (Douglas et al. 1998, Barkley 2006). Topside of leaves is hairless (glabrous) or with some hairs, with undersides more or less white and woolly (gray-tomentose).

Images: left, flower stem with bract-like leaves having a purplish tinge; center, flowerhead *of Tussilago farfara* with yellow ray and disk flowers; right, open flowerheads and nodding flowerheads of *T. farfara*, all images by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Flowers:

Flowerheads are upright during flowering, and nodding before and after (Chen and Nordenstam 2011). The yellow daisy-like flowerhead is solitary, at the terminus of the stem. The involucre (collection of bracts at base of flowerhead) 8 to 15 mm tall, with the bracts in one to two series (Douglas et al. 1998, Chen and Nordenstam

2011). The bracts are linear-lanceolate to lanceolate or oblanceolate, mostly hairless above and sparsely to somewhat long-hairy below, and with purple-tipped glands (Douglas et al. 1998). The bracts may have a purple tinge (Griffiths 1994).

The flowerhead receptacle is flat or slightly convex and is daisy-like, having yellow ray and disk flowers (Webb et al. 1988). The ray flowers are numerous in 4 to 5 rows, with corollas (petals fused together to look like one petal) that are narrow, 8 to 12 mm long, and functionally female (Myerscough and Whitehead 1966, Douglas et al. 1998). There are a lesser number of disk flowers in the center of the flowerhead that are yellow and functionally male, with corollas 10 to 12 mm long (Myerscough and Whitehead 1966).

Fruit:
The fruit is called a cypsela (plural cypselae)--a single-seeded achene with a pappus attached (Harris and Harris 2001). The cypselae are narrowly cylindric, 3 to 4 mm long, glabrous, and have 5 to 10 ribs (Chen and Nordenstam 2011). The pappus is made of numerous white, hair-like bristles, 8 to 12 mm long (Douglas et al. 1998). Only ray flowers are fertile and can produce cypselae.

Image: left, *Tussilago farfara* cypselae, with white pappus, image by Steve Hurst, USDA NRCS PLANTS Database, Bugwood.org; center, stems with developed and dispersed seed with emerged basal leaves, image by Richard Old, rold@xidservices.com; right, stems with developed seed prior to basal leaves emerging, image by Ohio State Univ Ohio Ag. Research & Development Center, Bugwood.org.

Similar species:
Tussilago farfara is the only accepted species in the genus, though it is closely related to the genus *Petasites,* and they were at one time placed in the genus *Tussilago* together (USDA ARS 2017).

Name	Habit	Leaves	Flowers	Fruit
Tussilago farfara; European coltsfoot	Perennial growing from rhizomes, growing up to 19.7 inches (50 cm); flowering stems develop before basal leaves emerge.	Basal leaves emerge after flowering; stem leaves scale-like; basal leaves heart-shaped to somewhat rounded, white-woolly on undersides.  Image by Patrick Sowers 2014	Solitary yellow flowerhead of ray and disk flowers at terminus of stem; develop and bloom before basal leaves emerge. 	Fruit (cypselae) 3 to 4 mm long, 5 to 10 ribs; pappus is made of numerous white, 8 to 12 mm.  Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

			Leslie J. Mehrhoff, University of Connecticut, Bugwood.org	
Taraxacum officinale; common dandelion	Perennial from a taproot; with milky juice; flowering stems up to 19.7 inches (50 cm) tall.  Robert Vidéki, Doronicum Kft., Bugwood.org	Leaves in a basal rosette, wider toward the tip, 2.4 to 15.7 inches (6 to 40 cm) long, leaf lobes angled backward, tapering to base. No leaves or bracts on flowering stem.  Bruce Ackley, The Ohio State University, Bugwood.org	Flowerhead of yellow ray flowers.  Bruce Ackley, The Ohio State University, Bugwood.org  Image by Mary Ellen (Mel) Harte, Bugwood.org	Fruit 2 to 4 mm, with slender beak, has 4 to 12 ribs, with white pappus 5 to 8 mm  Image by Joseph Berger, Bugwood.org
Petasites frigidus var. *palmatus*; sweet coltsfoot, alpine or arctic butterbur	Rhizomatous perennial, 4 to 19.7 inches (10 to 50 cm) tall	Basal leaves on long petioles, palmately veined, up to 15.7 inches (40 cm) wide, glabrous above, loosely white-woolly below, lobed or somewhat toothed or both, stem with several parallel-veined bracts, 2.5 to 6 cm 	Several flowerheads in somewhat congested inflorescence, flowers whitish  Image © 2003, Ben Legler	Fruit (cypselae) 1.7 to 3.5 mm with pappus, 7 to 17.3 mm  Image by Walter Siegmund, CC BY-SA 3.0
Adenocaulon bicolor; pathfinder or trailplant	Plants grow from fibrous roots; stems to 35.4 inches (90 cm); moist, shady woods.	Alternate on stem, clustered near base, winged petioles, blades deltoid to cordate; nearly glabrous above, white woolly below	Flowers in open, paniculiform array; flowers whitish.	Fruit (cypselae) with glandular hairs that are sticky and cling readily to animals, people and other objects to aid in dispersal.

By Mount Rainier National Park, Public Domain, https://commons.wikimedia.org/

(WTU Herbarium 2017 and Barkley 2006).

Habitat:

Tussilago farfara commonly grows in open to shaded disturbed environments (Ogden 1974). Plants appear to favor moist to wet soils but can also survive in drier conditions. In the British Isles, *T. farfara* occurs over a wide array of soil types, including nutrient-poor types such as sand and gravel, and diverse community types (Myerscough and Whitehead 1966, Namura-Ochalska 1993c). Disturbed open sites where anthropogenic or natural disturbances take place, and where vegetation has been removed, provide suitable habitat for *T. farfara* including ditches, gravel pits/stockpiles, slopes, roadsides, along trails and cultivated fields (Namura-Ochalska 1993a, Hendrickson et al. 2005). Other noted habitats in which plants grow well are the edges of rivers, lakes, ponds, wetlands, in forests and other bottomland communities (Innes 2011).

Tussilago farfara has been found more in lowland locations in Washington and southwest British Columbia, while in China plants grow from 600 to 3400 meters elevation (Douglas et al. 1998, Chen and Nordenstam 2011).

Tussilago farfara favors growing on neutral to alkaline soils (Myerscough and Whitehead 1966). In Newfoundland, Canada, plants were found growing in disturbed areas with a pH of 6.8 to 8.3 (Hendrickson et al. 2005). Experiments in cultured solutions found *T. farfara* able to germinate effectively at pH levels between 4.5 and 6.5, but at pH levels of 4.0 and lower, germination was either slow or did not occur (Olsen 1923 in Myerscough and Whitehead 1966). Further work by Bakker (1952) in soil and acidified distilled water found nearly complete germination at pH levels above 4.25 (Myerscough and Whitehead 1966). Hendrickson et al. (2005) found when studying disturbed areas, *T. farfara* abundance correlated to increases in pH and light level, though the correlation was weaker with pH. Plants were most abundant where the canopy had been opened up and groundcover species and duff were removed (Hendrickson et al. 2005).

Image: *Tussilago farfara* leaves sprouting (left) and flowering stems and rhizomes (right) on an actively eroding bank by the Snoqualmie River, photos by Matt Below 2017.

Image: *T. farfara* growing on a sandy gravel soils in a disturbed area, image by Patrick Sowers; right, *Tussilago farfara* growing in the understory at Three Forks Natural Area, Snoqualmie River 2015, image by King County NWCB.

Geographic Distribution:

According to the USDA GRIN database, (USDA ARS 2017), *Tussilago farfara* is native to parts of northern Africa, Asia and Europe. Specifically the database lists:

- Northern Africa: Algeria and Morocco
- Asia: Armenia, Azerbaijan, Georgia, Russian Federation, China, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Afghanistan, Cyprus, Iran, Lebanon, Syria, Turkey, India, Nepal, and Pakistan.
- Europe: Belarus, Estonia, Latvia, Lithuania, Moldova, Russian Federation (European part), Ukraine, Austria, Belgium, Czech Republic, Germany, Hungary, Netherlands, Poland, Slovakia, Switzerland, Denmark, Faroe Islands, Finland, Ireland, Norway, Sweden, United Kingdom, Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Macedonia, Montenegro, Romania, Serbia, Slovenia, France, Spain.

USDA GRIN database, (USDA ARS 2017), lists *Tussilago farfara* naturalized in: New Zealand, Iceland, and North America. In the United States, USDA PLANTS database (USDA NRCS 2017), USDA GRIN database, (USDA ARS 2017), and EDDMapS (2017) documents *Tussilago farfara* having a higher number of records in the northeast. Specifically records of *T. farfara* in:

- Canada: New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, Quebec, St. Pierre and Miquelon, and British Columbia.
- United States: Illinois, Minnesota, Wisconsin, Connecticut, Indiana, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Delaware, District of Columbia, Vermont, West Virginia, Maryland, North Carolina, Tennessee, Kentucky, Virginia, Idaho, and Washington.

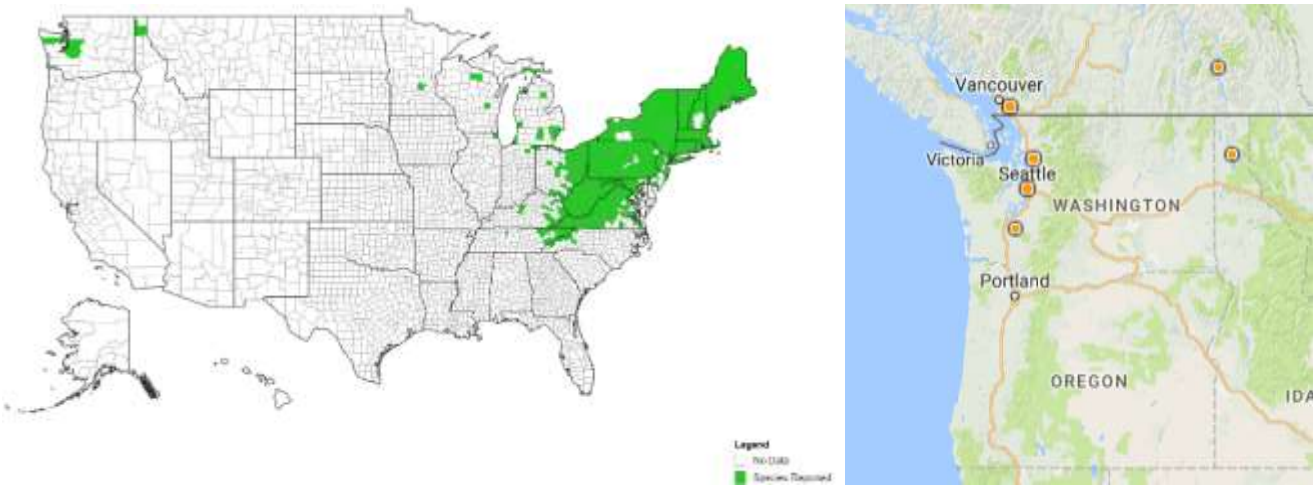

Image: EDDMapS (2017) County distribution data of *Tussilago farfara*; right, map of herbarium records of *Tussilago farfara* in Washington, Oregon, southern British Columbia and western Idaho (Consortium of Pacific Northwest Herbaria 2017).

Nearby to Washington:

There are four herbarium records of *Tussilago farfara* in southern British Columbia (UBC: V240473, UBC: V233531, UBC: V27426, UBC: V205794) (Consortium of Pacific Northwest Herbaria 2017). Three of these collections, from 1992, 1993, and 2007, are from the Vancouver area with plants growing in disturbed locations: in bare, stony clay landfill margin bordering *Polygonum cuspidatum*; in a landfill on sand dredged from the Fraser River; and under a bridge near a ditch in a cement culvert. The fourth collection, from 2012, is farther east in the Selkirk Mountains, along Highway 31A, 3 km due west of Kaslo, documents plants growing along a highway roadside on slumping gravelly clay, forming an alluvial fan.

There is one collection of *Tussilago farfara* in Idaho (WTU: 368582) collected in 2005 in the town of Sandpoint, naturalized along railroad tracks near an old railroad depot (Consortium of Pacific Northwest Herbaria 2017).

Currently, there are no known populations of *Tussilago farfara* in Oregon, but historical records indicate the plant was found in three counties: Josephine, Hood River, and Washington (Oregon Department of Agriculture 2015).

Listings:

Tussilago farfara is listed as a noxious weed or on a regulated list as follows: Class A noxious weed, quarantined in Alabama; is an A listed noxious weed and quarantined in Oregon; Connecticut prohibited noxious weed; prohibited plant in Wisconsin; Massachusetts prohibited plant (National Plant Board 2017, Massachusetts Dept. of Agricultural Resources 2017).

Washington:

Herbarium and database records document *Tussilago farfara* occurring at a limited number of locations in western Washington, with one early specimen from the 1930's and the rest from 1990's to the 2016. Herbarium records of *Tussilago farfara* in Washington are from: 1932 in King County, Seattle, on wet ground at

a nursery location (WTU 6777JWT); 1994 from Clallam County growing along the bank of Morse Creek in hard-pan soil (WWB: 22328); 1999 from King County, Seattle, at the Union Bay Natural Area near water on rough ground (WTU 338903P); 2004 and 2006 from Snohomish County at Twin Rivers park in a deciduous riparian forest, growing in sand along river bar (WTU 382745); 2009 in Thurston County near the town of Rainier growing in a logged and burned pile (WTU 376087); and 2016 in Snohomish County along the Stillaguamish River on gravel and cobble bars (WTU, database ID 2814754) (Consortium of Pacific Northwest Herbaria 2017).

EDDMapS West (2017) has reports of additional locations of *Tussilago farfara* in King, Pierce and Jefferson Counties. In Jefferson County, *T. farfara* is documented twice from the University of Montana INVADERS database—but this database is not currently accessible online. In Pierce County, *T. farfara* is documented growing in Mount Rainier National Park, in a roadside population that was first reported in May, 2016. After the original discovery of *T. farfara*, four additional sites have been found at the National Park, all small in size, around 3 feet by 3 feet (with some small variation) (K. Popek, pers. comm.). Plants are not overly aggressive in appearance yet, and it is unknown how plants were introduced to the area (K. Popek, pers. comm.). An additional population in Pierce County has also been observed next to a rock quarry at Eatonville (K. Popek, pers. comm.).

In King County, EDDMapS West (2017) documents *Tussilago farfara* growing on a floodplain at the Three Forks Natural Area in 2014 by the Snoqualmie River. The plants were growing in scattered distribution for about a half mile along the river, mostly in the floodplain (Sowers 2017). Another infestation is documented from 2010 to 2014 in King County growing at the Howard Hanson Dam, with one acre infested.

Growth and Development:
Tussilago farfara is a perennial plant that can spread by rhizomes and seeds. Flowering stems are produced before *T. farfara* leafs in the spring. *Tussilago farfara* is described as having two growth forms—clumping growth of flowering stems (phalanx growth), and a spreading form from its rhizomes, spacing out the vegetative growth of the plant (guerilla growth) (Namura-ochalska 1993b).

Unless otherwise noted, the following description of *Tussilago farfara*'s general lifecycle is from Ogden (1974): Seeds germinate soon after they disperse from the plant in April or May. A taproot will develop quickly if the seedling is in a suitable environment. Young plants will have their taproot until about the 5-leaf stage, reached about 6 weeks after germination (Bakker 1952 in Ogden 1974). During the summer, contractile adventitious roots on the lowest stem nodes and rhizomes develop. The contractile roots pull the plant further into the soil, and the rhizomes develop from the buried axillary buds (Myerscough and Whitehead 1966). By autumn, several large leaves have grown, the rhizomes are well developed, and flower buds have formed. Over the winter, the leaves die back and all that is visible at the soil surface is a cluster of flower buds. By early January, most of the flowers are fully developed (Myerscough and Whitehead 1966). In early spring, the flower stem rapidly elongates and the flowers open. While flowering, leaves grow from rhizome tips that were formed the previous year. Leaves can sprout before the last flowers fade, but they mainly grow after flowers and do not reach full size until well after flowering is through (Everett 1981).

The flowerheads are protogynous (female reproductive organs mature before the male reproductive organs) with the ray flowers maturing about 2 days before the functionally male disk flowers (Myerscough and Whitehead 1966). Male disk flowers offer small amounts of nectar along with pollen grains to pollinators (Wild et al. 2003). The number of ray and disk flowers in a flowerhead is variable. Torices and Méndez (2011) found on average from two wild populations in Spain that flowerheads had 10 times more female (ray) flowers than male (disk) flowers (Torices and Méndez 2011). Wild et al. (2003) determined a mean of of 266.2 ray flowers and 37.5 disk flowers in flowerheads they studied. *Tussilago farfara* flowerheads remain open around 7 to 11 days and close at night (ray corollas roll inward) (Wild et al. 2003, Barkley 2006). Pollination has been reported by a variety of insects including bees and relatives, hoverflies, flies and beetles (Hegi 1987 in Pfeiffer et al.

2008). Pollinators observed on flowerheads during a study in Europe included the family Apidae as the main visitor group, with *Apis mellifera* (European honeybees) being most common, followed by nitidulid beetles and then other bees and flies (Wild et al. 2003). While it has been speculated *T. farfara* may be able to self-pollinate, at least one study did not find evidence of this occurring (Wild et al. 2003).

After the seeds are formed and finish dispersing, the old flowering stems will die, leading to fragmentation of the rhizomes. The new vegetative plants follow the same development cycle. Rhizomes typically follow a three-year cycle of year one: rhizomes initiated and grow; year two: rhizomes produce leafy stocks (though sometimes this can occur in year one); year three: these stocks produce flowers; then they typically die, leaving further growth to new rhizomes. From the time of initiation to the formation of flowering stems, rhizomes can grow a meter or more in length. How deep rhizomes grow and their amount of branching depend on the habitat conditions. Rhizome branching in open areas is higher without sod development than if sod is present (Namura-Ochalska 1993a). During their first year of growth, rhizomes have been measured at shallow depths of less than 6.3 inches (16 cm), with the maximum of 24 inches (61 cm) deep (Leuchs 1961 in Boström et al. 2013). Mehrhoff et al. (2003) note that rhizomes can grow as deep as 9.8 feet (3 meters).

Reproduction:

Tussilago farfara is able to reproduce by seed as well as spread vegetatively through the fragmentation of rhizomes. Seeds are dispersed by the wind and can establish new populations that develop rhizomes and spread.

Seed production can be highly variable among different environments as well as being variable from year to year within the same population (Namura-Ochalska 1987). Estimates range from 3500 seeds produced per plant (Wright 1997) to 157 seeds per flowerhead (Bostock 1980). Seed production can depend on factors including weather as well as competition from other plants, with higher production occurring in areas of suppressed competition (Namura-Ochalska 1987). Seeds appear to be transient and not lasting in the seedbank. They exhibited their greatest viability up to 3 months old, with only a few seeds germinating at 5 months and none at 6 months (Bakker 1952 in Myerscough and Whitehead 1966, Namura-Ochalska 1987).

Though plants growing in favorable conditions can produce many seeds in a year, many to most seedlings may not make it to the end of the first growth season, dying before they are able to develop rhizomes. (Namura-Ochalska 1993a) found a seedling and juvenile survival rate of about 10% in a population as it recovered over a number of years from a large disturbance. Namura-Ochalska (1993c) studied the survival of seedlings and juvenile plants and also found that the higher the seedling density, the sooner and higher a percentage of them will die. Once a percentage of the seedlings died, the remaining surviving individuals had accelerated development. Seeds sown on the soil surface were found to have a 100% germination, and those that were buried 1 cm had a mortality of 50% while those buried to a depth of 2 cm had a death rate of 88%. Seeds buried too deeply will prevent seedlings from emerging aboveground. Seedlings and juveniles can survive in a variety of soils, with even 30% of juveniles surviving on sand or gravel and sand, both nutrient deficient substrates. The high fertility and germination rate, low weight, and ability to survive on low-nutrient soils allows *T. farfara* to be a successful pioneering species.

Seeds are dispersed by the wind, allowing *Tussilago farfara* to colonize new areas (Namura-Ochalska 1987). Though the wind may carry them farther, seeds are typically carried by their pappus around several hundred meters from a fruiting individual (Bakker 1960 in Namura-Ochalska 1987).

Tussilago farfara can spread effectively from rhizome fragments (Namur-Ochalska 1993c). Though some seedlings can survive on nutrient-poor soils, plants typically favor vegetative reproduction from rhizomes over seeds in these conditions (Ogden 1974). Rhizome fragments having just one node are able to survive and grow to produce plants (Namura-Ochalska 1993c). Depths at which fragments are buried can affect emergence of

shoots, as the deeper fragments are buried in the ground, the less shoots emerged (Namura-Ochalska 1993c). No vegetative shoots emerged from fragments with one node that were buried at a depth of 30 cm in an experiment by Namura-Ochalska (1993c). However, Leuchs (1961) noted a rhizome fragment buried in 75 cm of soil compost was able to resprout (in Hendrickson et al. 2005). Seedlings growing in favorable conditions can develop rhizomes in their first season, with certain rhizome tips growing upward to produce leaves (Ogden 1974).

Rhizomes break apart naturally in the soil to form new clones, and fragments can also be spread through soil disturbance and by water from eroding riverbanks and shorelines. Fragments have been spread to new agricultural fields and other locations on farming equipment (Wright 1997). Rhizome fragments and possibly seeds have also been dispersed in gravel from gravel pits (Wright 1997). At gravel pits in Canada, piles of aggregate that remained for years on site were contaminated with *T. farfara* and then moved to new locations that were ideal for *T. farfara* to establish and spread (Hendrickson et al. 2005). In the Great Smoky Mountains National Park in Tennessee, contaminated gravel quarries were found to be the source of *T. farfara* when plants came up in gravel used along a transmountain highway and a recently graveled driveway (West and Dickman 2011).

Economic Importance:
Detrimental:
Tussilago farfara is a weed in agricultural systems. It has been noted as a particular problem in the Scandinavian region in Europe and in organic crops (Boström et al. 2012, Nkurunziza and Streibig 2011 in Liew et al. 2013). *Tussilago farfara* is observed to have substantially increased on organic farms in the last 20 years in Sweden (author observation and reports from farmers and advisers in Dalbato et al. 2014). The growth cycle, reproduction and preference for disturbed environments, allows *T. farfara* to invade, spread and reproduce in cultivated fields and be very difficult to control (Namura-Ochalska 1993b). For example, plants that underwent ploughing in the spring and summer harvest over a four-year period had an increase in the number of vegetative shoots each year (Namura-Ochalska 1988). Also, rhizome depth is frequently observed below the ploughing depth at 1.0 to 1.6 feet (30 to 50 cm) (author observation in Dalbato et al. 2014).

Tussilago farfara can disrupt the restoration of native plant communities. During the restoration of a fen after peat mining in Quebec Canada, *T. farfara* spread from ditches where it already occurred into a lower terrace being restored (Cobbaert et al. 2004). In Washington, *T. farfara* has established in riparian areas after knotweed species, (*Polygonum* species) control. Along the Snoqualmie River, after *Polygonum* x *bohemicum* (Bohemian knotweed) control work, a population of about 14,000 square feet at 30% cover of *T. farfara* established by 2014, and so far control efforts have not made any significant impact on its size (Sowers 2017). *Tussilago farfara* is capable of rapid colonization of pioneer or disturbed habitats (Namura-Ochalska 1987). Knotweed control efforts take place all over the state, providing bare areas that are potentially prime habitat for *T. farfara*. The ability of *T. farfara* to colonize disturbed areas quickly is also a concern in native communities where natural disturbances take place and native plants species cannot establish as fast (Rose and Hermanutz 2004). In a study of natural disturbance in a boreal forest, Rose and Hermanutz (2004) found that *T. farfara* was able to colonize and persist in remote disturbed locations. The long-term impacts of *T. farfara* invasion are unknown. Rose and Hermanutz (2004) speculated *T. farfara* may impact recovery of forested areas after disturbance by slowing the establishment of dominant tree species or in altering resource availability as plant litter with *T. farfara* would have different chemical ratios, decomposition rates and nutrient immobilization than native plant litter. Further research is needed on the impacts of *T. farfara* in native plant communities.

Toxicity
While *Tussilago farfara* is used medicinally for a number of ailments (see Beneficial below), plants are known to contain toxic pyrrolizidine alkaloids (PA), mainly senkirkine and traces of senecionine (Cao et al. 2016). The

PA found in *T. farfara* are known to be heptotoxic (damaging to the liver) and could potentially cause liver cancer or chronic liver disease (Gorman et al. 2005, Xia et al. 2013 in Cao et al. 2016). These PA might be present in a small enough amount to not cause harm if the quantity of *T. farfara* used is closely monitored (Nedelcheva et al. 2015, Cao et al. 2016). There are cases where another plant was mistakenly used instead of *T. farfara* and that led to toxic effects and disability in patients (Nedelcheva et al. 2015). For example, in a report of poisoning an infant from a tea containing *T. farfara*, it was later discovered that the leaves of *Petasites* had mistakenly been used (Roulet et al. 1988 in Frohne and Pfander 2005).

Beneficial:

Tussilago farfara is cultivated in Chinese medicinal gardens and has been used as a medicinal plant for centuries. The immature flowerheads, before emerging from the ground, and leaves have many medicinal uses (Chinese Herbs Healing n.d., Chen and Nordenstam 2011). *Tussilago farfara* is commonly used for the relief of coughs and other respiratory diseases, and as an expectorant platelet-activating factor and anti-inflammatory (Cao et al. 2016). The crushed leaves are used externally for a number of treatments including wounds, burns, injuries, and inflammation of the eye, based on the antibacterial and anti-inflammatory properties of the plant (Nedelcheva et al. 2015).

In China and Europe, the plants are also used as honey plants (Chen and Nordenstam 2011, Nedelcheva 2015). *Tussilago farfara* is rarely used as an ornamental plant by gardeners due to its aggressive growth (Everett 1981). Everett (1981) also notes the species, and a variegated variety, may sometimes have been used to stabilize banks and was included in herb and medicinal gardens.

Control:

Removing invasive species can open up a habitat to reinvasion if follow up management does not occur, and *Tussilago farfara* prefers these newly-disturbed open areas for establishment (Namura-Ochalska 1993a). Disturbed locations such as roadsides, trails, pond and river edges and areas that have undergone invasive plant removal, may be more vulnerable to invasion. It is important to plant and/or seed a variety of desirable species to provide competition for *T. farfara* and shade weed seedlings. These species will also serve as a food source for pollinators. Since *T. farfara* thrives in disturbed environments; where locations allow, minimize soil disturbance during management. When possible, carry out control methods when pollinators are not active on plants. Also, make sure to clean shoes, clothing, and equipment when leaving infestations to prevent spreading seeds and rhizome fragments to new locations.

Manual and Mechanical Control:

Young plants and very small infestations may be able to be carefully dug out of the ground. All rhizome fragments will have to be carefully removed, as a fragment with even one node can form a new plant. Rhizomes are brittle and easily break off in the soil so this method may have limited success. Since fragments left in the soil may quickly resprout, the area will need to be visited multiple times each growing season to check and remove any resprouts. Careful repeated hand removal of rhizomes of a roadside population in Mount Rainer National Park still did not eliminate a small infestation during 2016, though plants were reduced in number (EDDMaps West 2017). Since seeds are not viable after 5 months, only rhizome resprouts will need to be monitored for after the first year. Rhizomes should be bagged and put in the trash.

If a *Tussilago farfara* infestation is large, hand removal will likely not be possible. The frequent and systematic defoliation of plants (without digging out the roots) can cause a depletion of nutrients stored in the rhizomes and can eventually lead to death of the plant (Namura-Ochalska 1993b). The key to this method is repeatedly defoliating the plants during each growing season, frequently monitoring and controlling aboveground growth, as leaves will quickly resprout from the rhizomes. Along with defoliating plants, it is critical to establish non-invasive plants on site to provide competition. Also, cutting inflorescences in the spring to stop seed

production can be effective, though typically more than one cutting may be needed as there are some flowering stems that are delayed in development (Namura Ochalska 1993b).

Experiments have shown that *T. farfara* is resistant to cutting, burying and fragmentation. Typically, burying *Tussilago farfara* by ploughing will not provide control of plants (Namura-Ochalska 1993b). Burying flower stems with intact inflorescences will stimulate stem internodes to elongate, causing flowerheads to re-emerge aboveground (Namura-Ochalska 1993b). Burying vegetative shoots also stimulates growth and leads to the emergence of new leaves aboveground (Namura Ochalska 1993). The rhizome depth can also make it difficult to control plants with stubble cultivation, ploughing, or hoeing as these methods may not reach the entire rhizome system (Boström et al. 2013).

Cultural Control:
Tussilago farfara distribution depends on competition from other species and the availability of light and open space. In an experiment comparing agricultural fields and fields that were left to go fallow over a 4-year period of time, *T. farfara* was eliminated in 85% of the fallow field plots and down to 15% cover in the remaining ones. During this time in the agricultural plots, *T. farfara* abundance remained high (Namura-Ochalska 1988). Increasing the degree of sodding at the surface, and providing competition below and above ground by grasses, restricted clonal growth (Namura-Ochalska 1993a). Establishing competition as part of management will be key in eliminating *T. farfara*.

Deep burial of rhizomes by cultivation alone is not enough to control *T. farfara*. Dalbato et al. (2014) make the case that in a field situation, fragments buried 18-20 cm or deeper took at least 20 days to emerge, providing enough time for a crop to establish and suppress *T. farfara* resprouts with shade (Bakker 1960 and Leuchs 1961 in Dalbato et al. 2014).

Biological Control:
There are no approved biological control agents for *Tussilago farfara*.

Puccinia poarum, the coltsfoot rust gall or meadow grass rust, is a plant pathogen of *Tussilago farfara*. *Tussilago farfara* and *Poa* species serve as alternate hosts for the fungus (McGee 1973). The sexual phase (aecial and pycnial) of the fungus takes place on *Tussilago farfara*, while its asexual host phase (telial) are occurs on *Poa* species (De Nooij and Paul 1992). In a study of using rust-necrotroph (plant pathogen that invades and kills plant tissues) combinations, damage in *T. farfara* was restricted to individual inoculated leaves and failed to become systemic and effect rhizomes (De Nooij and Paul 1992).

Herbicide Control:
Early detection is key when controlling *Tussilago farfara* as populations can be difficult to control once they establish. Medium to large *T. farfara* infestations may need chemical control for management.

Tussilago farfara is not currently included in The Pacific Northwest Weed Management Handbook, but check back as this resource is continually updated: https://pnwhandbooks.org/. For questions about specific herbicide use, please contact your county noxious weed control board.

Wright (1997) reports no control of established *T. farfara* populations with the following herbicides: 2,4-D, MCPA, 2-4DB, Kil-Mor, Banvel, Basagran, atrazine up to 2 kg/ha active in corn, and ppi and pre herbicides registered in soybeans have not provided control. Plants sprayed with triclopyr and imazapyr in King County had varying results with small patches reducing in size and large patches still covering the same footprint (Sowers 2017). Glyphosate, a non-selective herbicide, is recommended as it has been reported to provide good control of *T. farfara* (Wright 1997). Poor control may occur if it is applied too early in the season, so make sure to apply when leaves are fully emerged, coating the leaves but not dripping off (Wright 1997).

In general, use herbicide control in combination with other control methods to reduce usage when possible. If using a foliar spray, treat plants when pollinators are not present or are the least active.

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