DRAFT WRITTEN FINDINGS OF THE WASHINGTON STATE NOXIOUS WEED CONTROL BOARD

SCIENTIFIC NAME: *Digitalis purpurea*

SYNONYMS: *Digitalis amandiana Samp; Digitalis miniana Samp.; Digitalis nevadensis Kunze; Digitalis tomentosa Hoffmanns. & Link*

COMMON NAMES: Purple foxglove, common foxglove, foxglove

FAMILY: Plantain family, Plantaginaceae

LEGAL STATUS: Considered for monitor list, Class C, or Class B

DESCRIPTION AND VARIATION:

OVERALL HABIT:

Digitalis purpurea is a monocarpic perennial (a plant that flowers, sets seed, and dies only once) or a facultative biennial (a plant that usually completes its life cycle in two years but can delay flowering for several seasons depending on size and environmental conditions) (Sletvold & Grindeland, 2007; Verboven *et al.,* 2012). During its first year of growth, the plant exists as a low-lying vegetative rosette (a circular cluster of leaves situated close to the ground) (Sletvold & Grindeland, 2008). In the second or subsequent years, once a specific threshold size is reached, it produces one or occasionally several upright flowering stalks ranging from 1 to 2 meters in height (Sletvold, 2002; Verboven *et al.,* 2012).



STEMS:

The reproductive stem of *D. purpurea* is erect, robust, and typically unbranched (Zahid & Rizwani, 2016). It is covered in soft, gray, felt-like hairs (tomentose) and bears leaves that become progressively smaller as they ascend toward the flowering spike (Zahid & Rizwani, 2016; Rana *et al.,* 2022).



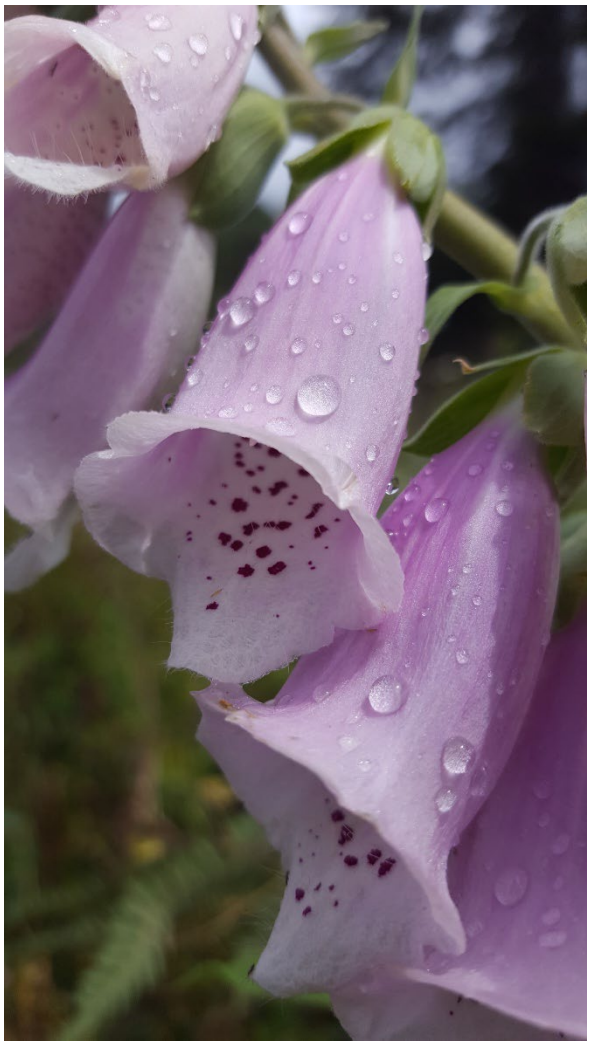
Ben Legler

LEAVES:

In its first year of life, the plant grows a basal rosette, which is a circular arrangement of foliage resting flat on the ground. During the second year, the central stem bolts upward. Leaves arranged along the stem are alternate and diminish in size moving upward. The leaf blades are ovate to lanceolate (broadly oval and tapering to a point), generally measuring 10–25 cm in length, with distinctly crenate (scalloped or rounded-tooth) margins. The surfaces are visibly rough, featuring both non-glandular hairs and glandular trichomes (small, specialized hair-like appendages) that give the leaf a distinctly hairy texture (Zahid & Rizwani, 2016).

FLOWERS:

The flowers are arranged in long, hanging, one-sided terminal racemes (flower clusters along a central stem where the lowest flowers bloom first) (Zahid & Rizwani, 2016; Rana *et al.,* 2022). The flowers are zygomorphic (bilaterally symmetrical) and bell-shaped (campanulate), measuring approximately 4 to 6 cm in length (Rana *et al.,* 2022). The fused petals form a tubular, two-lipped (bilabiate) corolla with a rounded upper lip and an ovate lower lip (Zahid & Rizwani, 2016). Corolla colors range from deep purple or violet (derived from anthocyanin pigments) to pink and white (Lozada-Gobilard *et al.*, 2026).



The inside of the lower lip features dark violet spots bordered in white, which act as nectar guides (visual patterns directing pollinators to food rewards) and potentially as anther mimics (structures that resemble pollen-bearing organs) (Lozada-Gobilard *et al.*, 2026). The flowers are protandrous (where the male organs release pollen before the female organs become receptive) (Best & Bierzychudek, 1982). The pollen-releasing anthers open sequentially over several days before the female stigma lobes open and curl backward to expose their receptive surfaces (Stead & Moore, 1977) thereby limiting self-fertilization (Verboven *et al.,* 2012; Percival & Morgan, 1965).



Henry Brisse

FRUITS/SEEDS:

The fruit of *D. purpurea* is an ovoid (egg-shaped), two-valved, glandular, and hairy capsule measuring approximately 1.5 cm in length (Zahid & Rizwani, 2016; Rana *et al.,* 2022). Each capsule contains numerous tiny, lightweight seeds, with an average seed mass of 0.07 to 0.09 mg and a length of 0.5 mm (Sletvold, 2002; Bruelheide & Heinemeyer, 2002). The seeds are unwinged and have a pitted, net-like (reticulate) surface (Rana *et al.,* 2022). A single capsule can yield more than 1,000 seeds, leading to 33,000 and half a million seeds per plant (Sletvold, 2002).

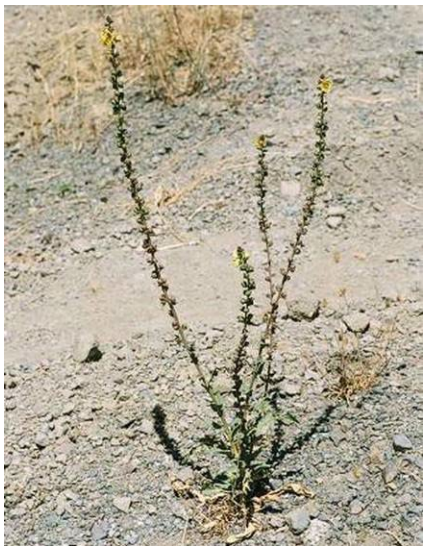
ROOTS:

The plant anchors itself with a robust, branched taproot supported by an extensive network of fine, fibrous roots (Zahid & Rizwani, 2016). These roots provide anchorage on sloped surfaces but are susceptible to physical damage and uprooting during severe geological disturbances (Bruelheide & Heinemeyer, 2002; Sletvold, 2005).

SIMILAR SPECIES:

Digitalis purpurea is a distinct species when in flower and is unlikely to be confused with other species (DiTomaso and Healy 2007). A few plant species, such as *Symphytum officinale* (common comfrey), *Verbascum thapsus* (common mullein) and *Verbascum blattaria* (moth mullein) and *Verbascum virgatum* (purplestamen mullein), may be confused with *D. purpurea* before plants have flowered (DiTomaso and Healy 2007). Due to the toxicity of *D. purpurea,* proper identification is important, especially if ingesting similar-looking species. Lin et al. (2010) report on a case of accidental ingestion of *D. purpurea* when nine people mistakenly used it to make tea, thinking it was common comfrey, *S. officinale*. The nine patients suffered a range of symptoms (see toxicity information below) but were able to recover with treatment.

Species	Vegetative growth	Flower	Image
Digitalis purpurea (foxglove) Image credits: left, Tom Heutte, USDA Forest Service, Bugwood.org; right, © Ben Legler, 2005	Biennial, short-lived perennial; stems up to 1.8 m; covered in gray-white matted hairs; leaves with toothed or round-toothed margins (scalloped)	Open raceme; tubular-bell-shaped flowers; 4 to 6 cm long; purple, pink or white; inside of flower with spots and some long hairs 	
Symphytum officinale (common comfrey) Image credits: left, Tom Heutte, USDA Forest Service, Bugwood.org; right, Caleb Slemmons, National Ecological Observatory Network, Bugwood.org	Perennial: stems grow up to 1.2 m; covered in stiff hairs; leaves have smooth margins	Flowers in small clusters; purple to dull blue, no spots inside flower; 1.5 cm long; bell-shaped 	
Verbascum thapsus (common mullein) Image credit: left, Mary Ellen (Mel) Harte, Bugwood.org; right, Karan A. Rawlins, University of Georgia, Bugwood.org	Biennial; stems up to 2 m; with dense covering of white-woolly, branched hairs; leaves with nearly smooth margins	Dense, elongate spike of flowers; typically yellow, 1 to 2 cm wide; 5 stamens 	

Verbascum blattaria (moth mullein) Image credit: left, John Cardina, The Ohio State University, Bugwood.org; right, Bruce Ackley, The Ohio State University, Bugwood.org	Biennial: stems grow up to 1.5 m, occasionally branched below inflorescence; leaves with unevenly rounded teeth and basal leaves often slightly lobed	Raceme of flowers; flowers yellow or white; 2 to 3 cm long; not bell-shaped, slightly irregular; 5 stamens 	
Verbascum virgatum (purplestamen mullein) Image credit: both images by Joseph M. DiTomaso, University of California - Davis, Bugwood.org	Annual, biennial; stems to 1.2 m, branched just below inflorescence; rosette leaves margins with unevenly rounded teeth, sometimes slightly lobed; upper leaf surface distinctly veined or crinkled; with some branched hairs	Open raceme, 1 to 4 flowers per node; yellow flowers around 2.5 cm wide; 5 stamens 	

HABITAT:

D. purpurea is primarily a colonizer of naturally or anthropogenically (human-caused) disturbed soils (Van Baalen, 1982). It thrives in high-light, open habitats such as forest clearings, clearcuts, poor pastures, stony riverbeds, roadsides, and track sides (Bruelheide & Heinemeyer, 2002; Verboven *et al.,* 2012). The species exhibits a preference for acidic, nutrient-poor soils with a low pH, such as podzols and dystric cambisols (Bruelheide & Heinemeyer, 2002). It can be highly shade-intolerant but cannot typically persist in deep forest interiors because the closed tree canopy blocks out required sunlight (Watterson, 2004).



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BIOLOGY

GROWTH AND DEVELOPMENT:

Freshly deposited seeds show varying degrees of dormancy and generally require an exposure to sunlight combined with soil contact to break this dormancy, ensuring they only germinate in soil gaps resulting from disturbances (Van Baalen, 1982). Seedlings first dedicate resources to growing a strong vegetative rosette. Due to a mechanism called an obligate vernalization requirement, the plant must be subjected to a period of winter cold before it will trigger the physiological process needed to generate a flowering stem (Sletvold & Grindeland, 2007). If a rosette fails to reach the minimum size threshold, it will delay flowering and remain vegetative for multiple seasons (Bruelheide & Heinemeyer, 2002). Sugar and protein contents of flowers peak immediately at bloom, alongside vibrant anthocyanin pigment production, which begins degrading alongside increased ethylene production as the flower ages (Stead & Moore, 1977).



Joseph M. DiTomaso, University of California, Davis

The species exhibits a highly size-dependent growth strategy (Sletvold, 2002). Seedlings often emerge in exceptionally dense cohorts (groups of plants of the same age) following soil disturbances, with densities sometimes reaching 500,000 individuals per square meter (Sletvold, 2002; Sletvold, 2005). Relative growth rates are negatively affected by local plant density due to intense crowding and competition (Sletvold, 2005). During winter, plants commonly undergo size reductions and experience high mortality from frost and soil instability (Bruelheide & Heinemeyer, 2002; Sletvold, 2005).

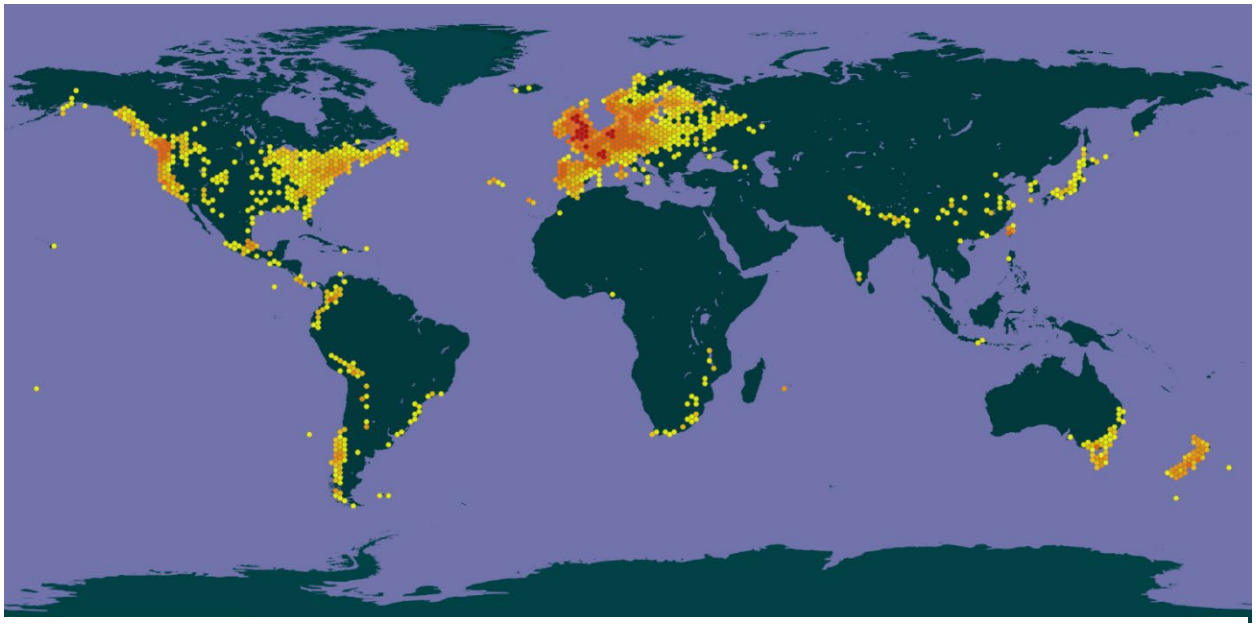
REPRODUCTION:

D. purpurea is fully reliant on sexual reproduction via seed; it does not replicate vegetatively (Watterson, 2004). Though physically capable of self-pollination, it relies overwhelmingly on outcrossing facilitated by insect pollinators. The combination of protandry and acropetal flowering (where flowers open sequentially from the bottom of the stem upward) separates male and female phases in both space and time (Grindeland *et al.,* 2005). Because nectar volume and sugar concentrations are highest in the lower, older, female-phase flowers, foraging bumblebees are induced to start at the bottom of the stalk and move upward, which significantly reduces self-pollination (geitonogamy) (Best & Bierzychudek, 1982; Grindeland *et al.,* 2005). Size greatly determines fecundity as large maternal plant makes up for thousands of perished seedlings by producing high-quality, larger seeds with rapid germination capability (Sletvold, 2002; Verboven *et al*., 2012).

GEOGRAPHIC DISTRIBUTION:

NATIVE DISTRIBUTION

D. purpurea is native to West, South-West, and West-Central Europe, as well as parts of North-West Africa (including Morocco) and Macaronesia (such as the Canary Islands and Madeira) (Zahid & Rizwani, 2016; Rana et al., 2022).



Global Biodiversity Information Facility

NON-NATIVE DISTRIBUTION

Due to its global popularity as an ornamental garden plant, *D. purpurea* has escaped cultivation and naturalized extensively (Rana *et al.,* 2022). It has established wild populations across North America (specifically the Pacific Northwest, California, and coastal Alaska), South America (notably in the Andean

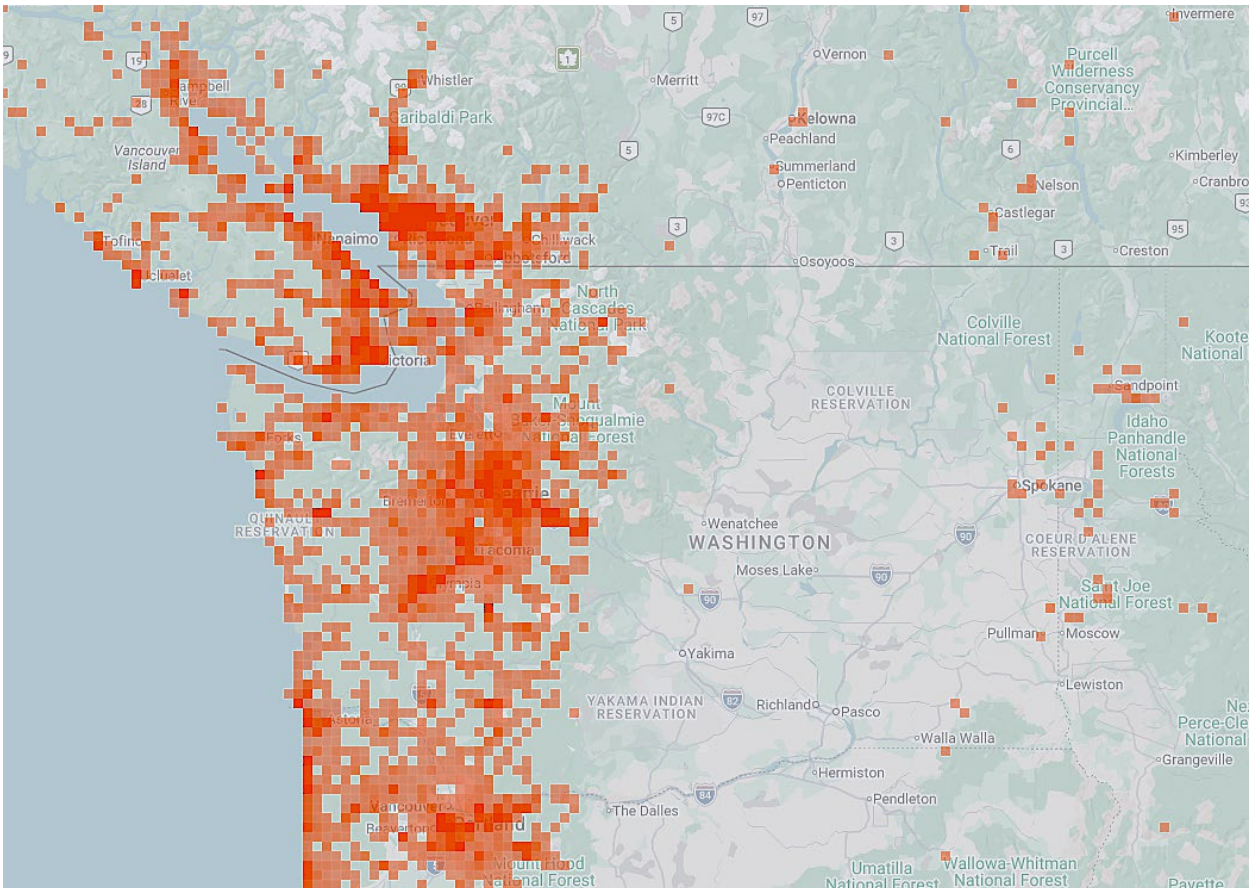
Yungas region of Bolivia), Australia, New Zealand, and mountainous regions of Asia and India (Rapp, 2006; Verboven *et al.,* 2012; Lozada-Gobilard *et al.,* 2026).

HISTORY:

The first herbarium collection of *D. purpurea* in Washington State is from Klickitat County, a garden collection by Wilhelm N. Suksdorf in 1882. There is a long history of *D. purpurea* collections in Washington with early specimens including a collection from Grays Harbor County in 1898, a collection from near Montesano in 1898, a collection from Snohomish County at Hall's Lake in 1908, a collection from Island County in 1909, a collection from Wahkiakum County, a collection from Pacific County at Fort Columbia, a collection from Whatcom County at Lake Samish in 1910, a collection from Puget Sound in 1911, and a collection from King County in the Cascade Mountains from 1918 (Consortium of PNW Herbaria)

WASHINGTON:

D. purpurea is commonly found across Western Washington, primarily in open and disturbed areas (iNaturalist, Burke Herbarium). However, several of its records in Eastern Washington are in or near sensitive habitats, showing worrying invasiveness, and still at manageable levels (Thurman Johnson, personal communication).



iNaturalist

NEARBY TO WASHINGTON:

OREGON:

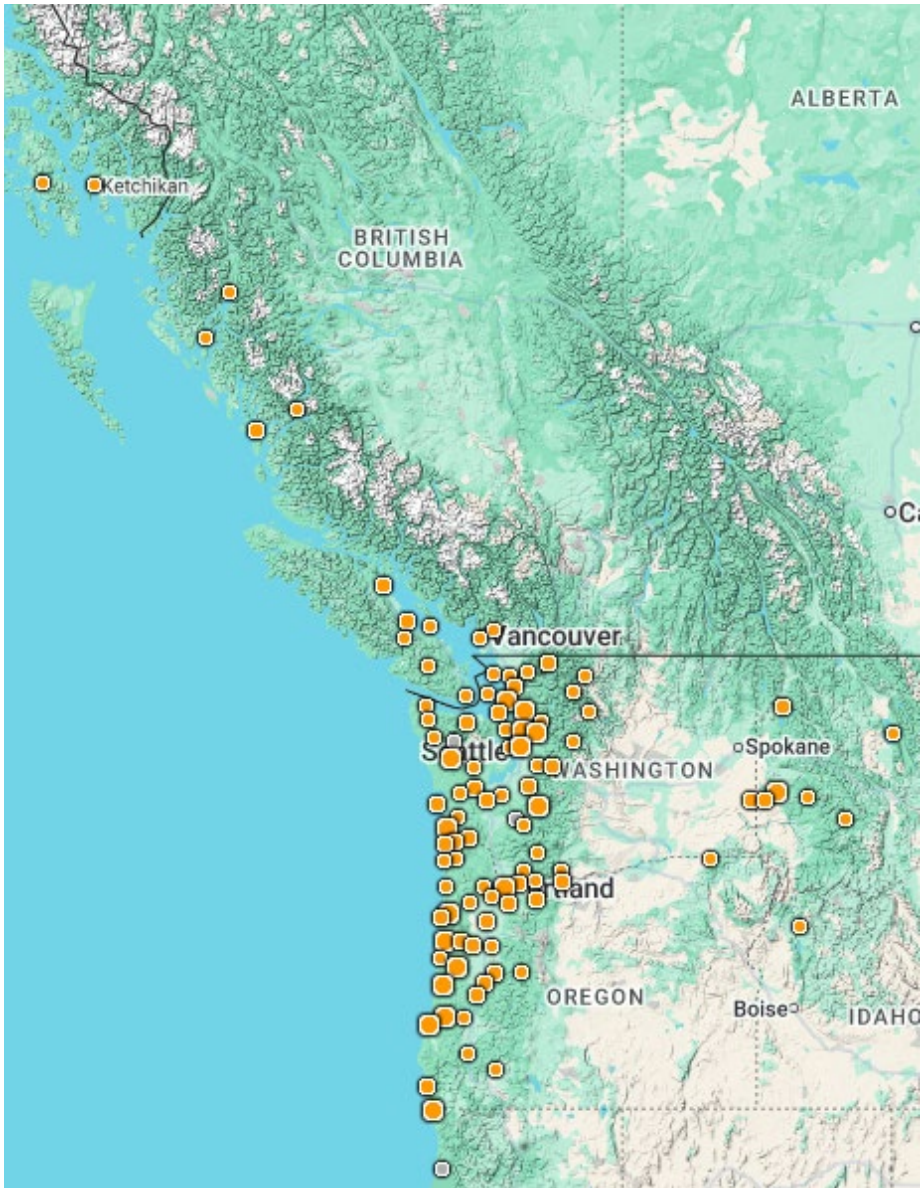
Similarly to its Washington distribution, *D. purpurea* is in high numbers in Western Oregon, but only a few records in Eastern Oregon (Consortium of Pacific Northwest Herbaria).

IDAHO:

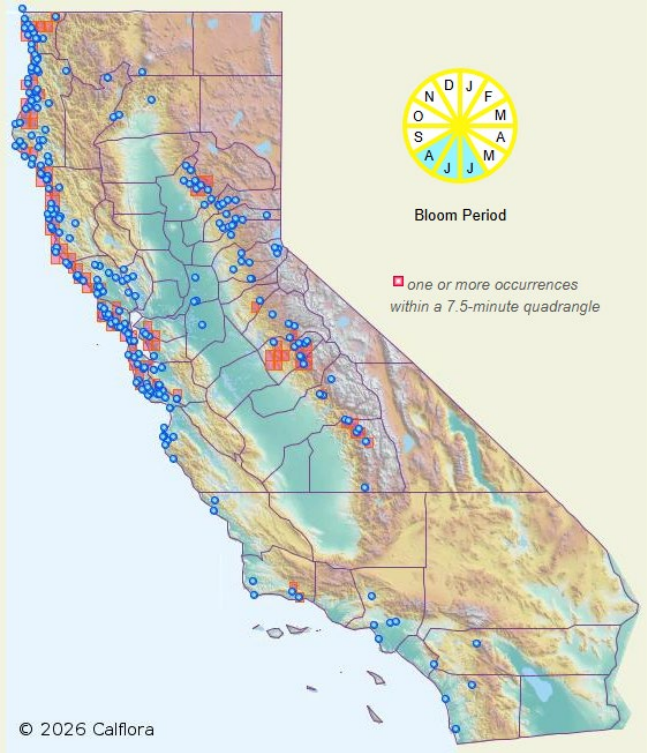
There are several records of *D. purpurea* in the forested and mountainous areas of Northern Idaho (Consortium of Pacific Northwest Herbaria, iNaturalist).

BRITISH COLUMBIA:

D. purpurea shows a similar distribution in British Columbia as it does in Oregon and Washington, with high infestation levels in Southwestern British Columbia, but many sightings and records in Southeastern British Columbia (Consortium of Pacific Northwest Herbaria, iNaturalist).



Consortium of Pacific Northwest Herbaria



Calflora

CALIFORNIA

D. purpurea occurs in high numbers along the California coast from just south of the Bay Area, all the way north to the border with Oregon, with a few records in the southern half of California's coast. There are also large amounts of records throughout the mountains east of California's central valley (Calflora).

LISTINGS:

D. purpurea is listed on California's and Oregon's state weed lists (EDDMapS). It is also listed as a weed by the New Zealand Department of Conservation (New Zealand Plant Conservation Network), and as a pest under Australia's Biosecurity Act of 2019 (Department of Natural Resources and Environment Tasmania).

ECONOMIC AND ECOLOGICAL IMPORTANCE:

DETRIMENTAL:

As an aggressive rangeland weed, *D. purpurea* invades pastures and forest margins, where its high density can reduce forage availability (Rana et al., 2022). All parts of the plant contain toxic cardiac glycosides that are poisonous to livestock, including cattle, sheep, and horses; ingestion of wild plants can cause severe cardiac arrest and death (Zahid & Rizwani, 2016; Rana *et al.*, 2022). Managing and controlling established infestations in public parks and conservation lands also requires substantial public funding and labor (Rapp, 2006). Additionally, where *D. purpurea* forms dense monoculture colonies in the understory of logging parcels, the ensuing thickets compete heavily with forestry seedlings and negatively impact reforestation operations (Gray, 2005).

These monoculture stands shade out and displace native herbaceous species, potentially hindering natural forest succession (Rapp, 2006). In susceptible woodland terrains, road construction operations enable vehicular-aided and water-aided (hydrochorous) invasions into deeply secluded forest and riparian systems. Debris and mudflows routinely transport invasive seedbanks directly into stream bottoms where populations disrupt native successional structures along floodplains, overtaking ground space generally meant for native flora recovery (Parendes, 1997; Watterson & Jones, 2006). Because of its large, attractive floral displays, it can alter local pollination networks by competing with native plants

for generalist pollinators (Grindeland *et al.,* 2005). Furthermore, it is documented as an alternate host for several plant viruses and nematode pests that affect agricultural crops (Zahid & Rizwani, 2016).



BENEFICIAL:

The species is of great economic and medical importance as the primary commercial source of digoxin and digitoxin, which are highly valued cardiac medicines used to manage congestive heart failure and atrial fibrillation (Zahid & Rizwani, 2016; Rana *et al.,* 2022). Additionally, it supports a global horticultural market as a popular ornamental garden flower and cut floral crop (Rana *et al.,* 2022).

Extensive naturalized stands provide a large influx of sugar-rich nectar and abundant pollen resources directly assisting the foraging ecologies of various native insects, principally acting as an important wild resource for regional bumblebees (*Bombus* spp.) (Grindeland *et al.,* 2005) as well as for other native wild bees and other insect pollinators, helping to sustain local pollinator populations (Verboven *et al.,* 2012).

CONTROL:

MECHANICAL:

For small or localized infestations, manual hand-pulling is highly effective (Rapp, 2006). Since the plant lacks vegetative reproductive structures such as creeping rhizomes, physical removal of the entire root system prevents regeneration from underground parts (Watterson & Jones, 2006). Due to the long-lived nature of the seed bank, treated sites must be monitored for 5 to 10 years to pull emerging seedlings (Rapp, 2006).

Mowing or cutting the flowering stalks prior to seed maturity can prevent the introduction of new seeds into the soil (Rapp, 2006). However, because cut plants can sprout new shoots from the root crown, mechanical cutting alone is rarely sufficient for eradication and must be repeated or combined with chemical treatments (Bruelheide & Heinemeyer, 2002). Tilling or plowing is generally discouraged, as disturbing the soil exposes buried seeds to light, triggering mass germination (Van Baalen, 1982).

CULTURAL:

Maintaining a closed, intact forest canopy is the most effective barrier against invasion, as *D. purpurea* cannot germinate or establish in deep shade (Parendes & Jones, 2000). Minimizing human-



Jorg Hempel

caused disturbances along roads and trails prevents the creation of bare-soil gaps required for seedling establishment (Watterson & Jones, 2006). Planting competitive native ground cover in recently thinned or cleared forest stands can also prevent foxglove from establishing dominant populations (Rapp, 2006).

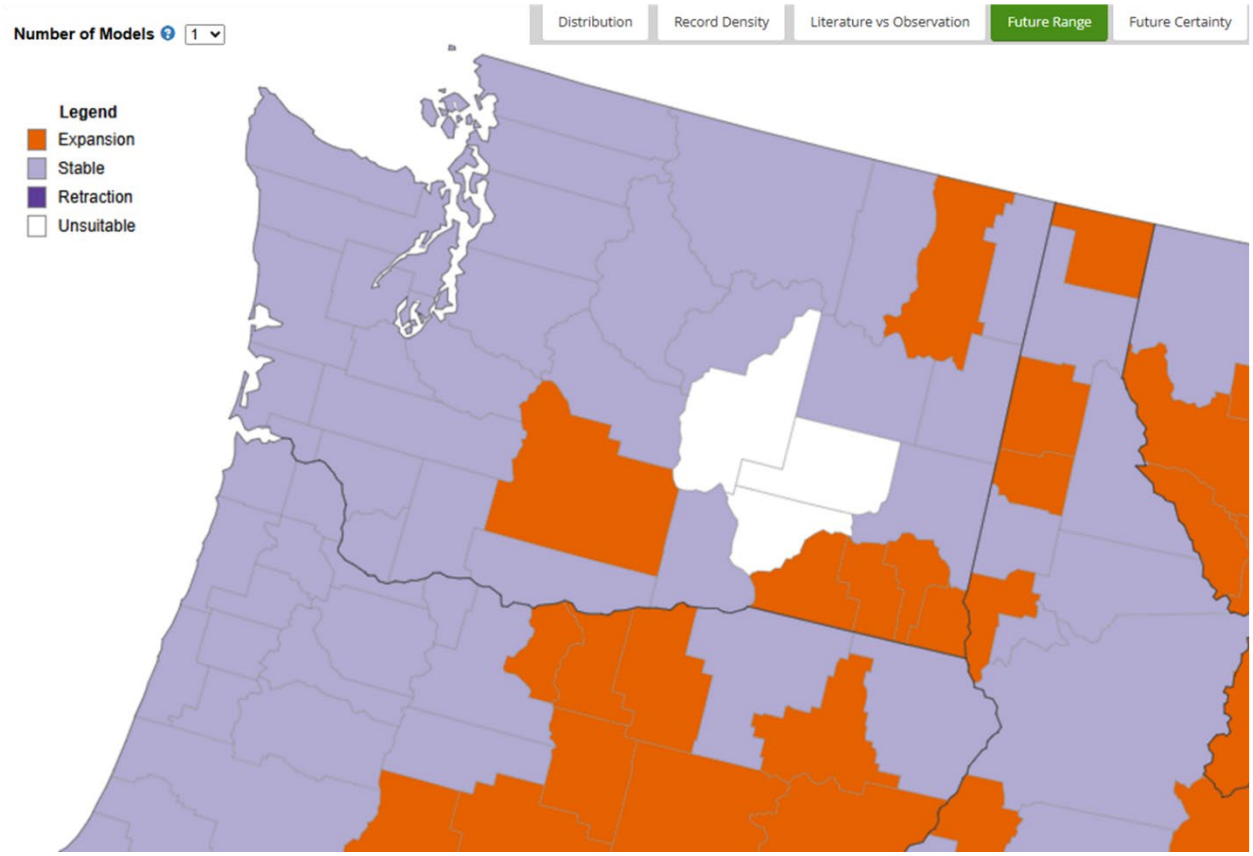
BIOLOGICAL:

Classical biological control has not been widely implemented because of the plant's high ornamental and medical value (Rapp, 2006). However, historical research in New Zealand evaluated the use of the host-specific moth *Eupithecia pulchellata*, the foxglove pug moth (Tillyard, 1927). The larvae of this species feed on the stamens and ovaries inside the developing flower buds, effectively reducing seed set to zero in attacked flowers (Sletvold & Grindeland, 2008).

CHEMICAL:

Chemical control is highly effective for managing large infestations (Rapp, 2006). Herbicide trials demonstrate that *D. purpurea* is highly sensitive to foliar applications of dicamba and metsulfuron-methyl. It is moderately sensitive to glyphosate and pendimethalin (Boutin *et al.,* 2004). Additionally, preemergence herbicides (chemicals applied to prevent seed germination) such as napropamide have been shown to cause significant stunting in young foxglove plants (Staats & Klett, 1998).

RATIONALE FOR LISTING:



Prediction of future range expansion. EDDMapS.

To be filled in with a listing recommendation.

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