DRAFT WRITTEN FINDINGS OF THE WASHINGTON STATE NOXIOUS WEED CONTROL BOARD

SCIENTIFIC NAME: *Lupinus arboreus*

COMMON NAMES: Tree lupine, yellow bush lupine, coastal bush lupine

FAMILY: Pea family, Fabaceae

LEGAL STATUS: Recommended for Class B listing

DESCRIPTION AND VARIATION:

OVERALL HABIT:



Ben Legler

Lupinus arboreus is a perennial evergreen shrubby legume (Kittelson and Maron, 2000; Mackay *et al*., 2001). It typically exhibits a small, erect, and multi-branched growth habit (Francis, 2004). Individual shrubs generally grow to heights of less than 2 meters (Francis, 2004; Wozniak, 2000). Under favorable conditions, the plant is characterized by rapid vegetative growth, allowing it to form a dense, closed canopy (the leafy cover formed by the tops of the shrubs) that heavily shades the ground beneath (Maron and Jefferies, 1999; Pickart *et al.,* 1998). It is considered a short-lived perennial, with individuals typically dying after 5 to 7 years in wild conditions due to mass die-offs, pathogenic outbreaks, and severe environmental stresses, though individual plants may rarely live up to 10 years (Francis, 2004; Maron, 1997).

STEMS:

The stems are highly branching and feature an upright, spreading form. The lower central trunk and base quickly develop lignification (persistent woody tissue), giving the plant strong structural support in windy, coastal environments. The upper branches, however, remain relatively green and succulent, which renders them susceptible to deformation, breakage, and necrosis under the duress of insect

herbivory or certain fungal infections (Dick, 1994; Wozniak, 2000). Young stems are succulent but are prone to characteristic "crooking" (bending or curving) during the early stages of fungal infection (Dick, 1994). The hypocotyl (the stem of a germinating seedling below the embryonic leaves) can develop glassy, rapidly spreading lesions when exposed to pathogens (Dick, 1994). Mature stems are distinctly woody, frequently developing distorted cankers (swollen, cracked, or diseased areas of woody tissue) and brown internal staining near ground level under disease pressure (Dick, 1994). Under low-light conditions, the stems adapt by producing longer internodes (the stem segments between adjacent leaves) and becoming less lignified (Sprent, 1973).

LEAVES:



David Giblin

The leaves of *L. arboreus* are cauline (growing along the stem) and alternate, positioned on petioles (leaf stalks) measuring 2 to 3 cm in length (Francis, 2004). The leaf structure is palmately compound, meaning it is composed of 5 to 12 leaflets radiating outward from a central point like the fingers of a hand (Francis, 2004). Each leaf stalk is accompanied at its base by stipules (small, leaf-like appendages) measuring 8 to 12 mm in length (Francis, 2004). Leaf surfaces vary in texture and appearance, ranging from smooth and green (glabrous) to silver and densely pubescent (covered with fine, soft hairs) (Francis, 2004). The leaves have high transpiration rates (the release of water vapor through plant pores) and are easily shed under extreme shade or severe moisture stress (Sprent, 1973).

FLOWERS:

The flowers are arranged in terminal racemes (elongated, unbranched flower clusters where individual flowers are attached by short stalks along a central axis) measuring 10 to 30 cm in length (Francis, 2004). Flowers within the inflorescence (flower cluster) are sometimes arranged in distinct whorls (circular patterns surrounding the stem) (Francis, 2004). Individual flowers are fragrant and measure 14 to 18 mm in length, with an upper lip (the banner petal) of 5 to 9 mm and lower lips (the wing and keel petals) of 5 to 7 mm (Francis, 2004). The petals are typically bright yellow and highly fragrant (Wozniak, 2000), though populations in northern California can exhibit lilac to purple petals due to hybridization with native, blue-flowered lupines (Francis, 2004). Variants with lilac to white flowers have also been reported from the San Juan Islands, and are unlikely to be hybrids (Peter Zika, iNaturalist). A significant feature is their lack of nectar; instead, the blooms offer dense quantities of pollen to foragers (Molina-Montenegro *et al.,* 2008). The flowers are protandrous (a reproductive strategy where the male anthers release pollen before the female stigma becomes receptive, preventing self-pollination within the same flower) (Kittelson and Maron, 2000). Pollen release requires a mechanical "tripping" mechanism,

wherein the weight of a heavy insect depresses the wing and keel petals, forcing a string of pollen out of the keel tip (Stout *et al.,* 2002).

FRUITS/SEEDS:

The fruit of *L. arboreus* is a densely pubescent (hairy) pea pod that turns brown or black at maturity, measuring 4 to 7 cm in length (Francis, 2004). Each pod typically contains 8 to 12 seeds (Francis, 2004). The seeds are small, measuring 4 to 5 mm in length, and are colored black, tan, or with distinct stripes (Francis, 2004). The seeds possess a hard, thick, and impervious testa (seed coat) that prevents water absorption, enforcing a state of physical dormancy (Mackay *et al.,* 2001). Upon reaching maturity, the pods undergo explosive dehiscence (the sudden, violent splitting open of the pod along built-in seams to fling the seeds away from the parent plant) (Kittelson and Maron, 2000). These seeds require significant environmental disturbance, high summer heat variations, or mechanical scarification (scratching or breaking the seed coat) combined with moisture before they can efficiently imbibe water to germinate (Mackay *et al.,* 2001; Wozniak, 2000). Herbivores, such as mice, actively hunt and eat large percentages of these highly nutritional seeds once dropped (Maron and Simms, 1997; Wozniak, 2000). Seed pods can be expelled forcefully when fully ripened, leading to the seed being able to spread several feet away from the parent plant (Waxwing, 2026).

ROOTS:

L. arboreus develops a long, stout, and dominant central taproot that penetrates deeply into the sandy substrate, supplemented by a sparse system of lateral (side-growing) roots (Wozniak, 2000; Hetherington and Wilson, 2018). The roots have many specialized biological nodules, swellings on the roots that house *Rhizobium* bacteria, which convert atmospheric dinitrogen gas, in exchange for carbohydrates, into plant-available ammonium (Hetherington and Wilson, 2018). The roots are strictly nonmycorrhizal (lacking symbiotic associations with beneficial mycorrhizal soil fungi) (Lambers *et al.,* 2013). To acquire essential nutrients in poor soils, they utilize a phosphorus-mining strategy based on carboxylate exudation (the active release of organic acid anions, such



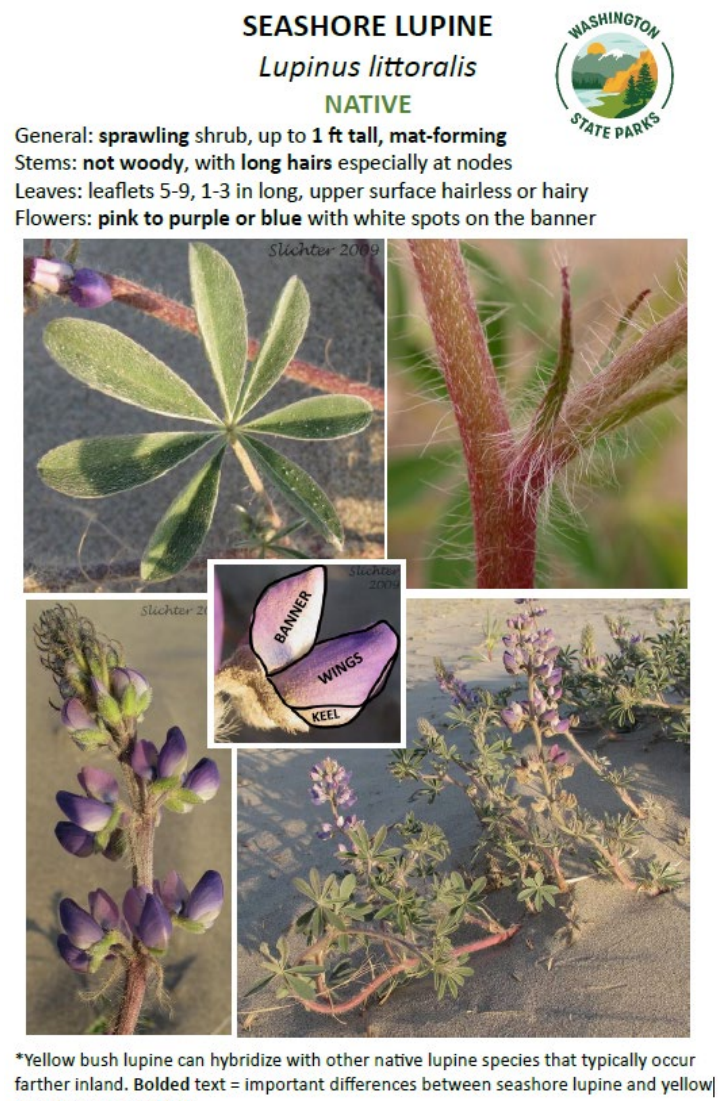
Stella Waxwing infographic

as citrate and malate, from non-specialized roots to chemically dissolve and release bound soil phosphorus) (Lambers *et al.,* 2013).

SIMILAR SPECIES:

Lupinus littoralis is a native lupine that grows in dune habitats of Washington's coast. They are generally smaller than *L. arboreus*, and have blue-purple and white flowers (Burke Herbarium). However, it is known that *L. littoralis* and *L. arboreus* can hybridize, creating blue, purple, white, and yellow flowers and growing to intermediate heights (Waxwing, 2026; Wozniak, 2000).

Lupinus rivularis is another native lupine that can grow in dune habitats, but generally grows in gravely woods, prairies, and riverbanks. They have similar flower colors to *L. littoralis*, but are larger, almost or the same size as *L. arboreus* (Burke Herbarium). *L. arboreus* can also hybridize with *L. rivularis* (Waxwing, personal communication; Wozniak, 2000).



Stella Waxwing infographic

Lupinus sabinianus and *Lupinus sulphureus* are both native lupines that can have yellow flowers, however they are only known to grow in Eastern Washington, where they thrive in grassland, sagebrush steppe, and open forest areas (Burke Herbarium).

Thermopsis montana is a shrub in the pea family, which also have yellow flowers and palmate leaflets. Their leaflets are in 3s, rather than the 5-10 of *L. arboreus*. While their habitat can include sand, *T. montana* do not generally grow on the outer coast or in dune systems (Burke Herbarium).

HABITAT:

Yellow bush lupine natively inhabits demanding, low-nutrient terrestrial sites deeply influenced by the coast: exposed sandy shorelines, raw coastal dunes, well-drained loams, coastal scrub, and seaside bluffs (Francis, 2004; Wozniak, 2000). Within coastal dune systems, it is most abundant on stable back dunes, which provide protection from direct salt spray and high winds (Wozniak, 2000). It is highly adapted to nutrient-poor, porous, and sterile sandy substrates that naturally lack significant organic

matter or nitrogen (Marrs *et al.,* 1982; Hetherington and Wilson, 2018). The species thrives in maritime environments characterized by wet winters, dry summers, and frequent coastal fog (Maron and Jefferies, 1999; Cipra, 2006).

BIOLOGY

GROWTH AND DEVELOPMENT:

Development initiates concurrently with seasonal winter rains. In the first year, emergent lupine seedlings face acute interspecific competition (competition between different species) from rapid-growing annual grasses fighting for sunlight space in grassy environments. In successful candidates, initial maturation is fast—*L. arboreus* rarely blooms during its first summer but routinely hits full size and reproductive maturity in its second spring (Wozniak, 2000; Maron, 1997). Its growth is highly sensitive to light; experimental shading dramatically reduces relative growth rates, dry weight, nodule number, and nitrogen-fixing capacity while increasing the shoot-to-root ratio (Sprent, 1973). Under heavy shade, such as forest canopy closure, the plants undergo leaf shedding and rapid mortality (Sprent, 1973; Dick, 1994). It is also sensitive to moisture stress, which significantly restricts nodule activity and general growth (Sprent, 1973). Over the span of just two to four years, thick masses of interlocking bush canopy rapidly dominate an unwooded setting. This rapid metabolism creates extreme biomass cycling, mature specimens continuously drop nutrient-dense, easily decomposed leaf-litter underneath their own canopy until mass-senescence occurs in roughly half a decade (Maron and Jefferies, 1999). The maximum lifespan is approximately 5 to 7 years in both its native and naturalized ranges (Francis, 2004; Dick, 1994).



Stella Waxwing

REPRODUCTION:

Reproduction in *L. arboreus* is entirely sexual and governed by a mixed mating system (a reproductive strategy combining self-fertilization and cross-fertilization) (Kittelson and Maron, 2000). The species has an estimated outcrossing (cross-fertilization between different plants) rate of approximately 78% under natural conditions (Kittelson and Maron, 2000). Autonomous self-pollination (selfing without animal assistance) is rare (~2%), meaning that the remaining 22% of seeds are produced via facilitated self-pollination mediated by insect visitors moving within the same shrub (Kittelson and Maron, 2000). The species experiences significant inbreeding depression (reduced biological fitness in offspring resulting from self-fertilization), which primarily manifests as a 49% reduction in mature seed set (the proportion of ovules that successfully develop into seeds) in selfed pods compared to outcrossed pods (Kittelson and Maron, 2000). To germinate, the dormant seeds require scarification (the physical scratching, cracking, or chemical softening of the seed coat) to permit water uptake, with optimal germination occurring at temperatures between 21°C and 24°C (Mackay *et al.*, 2001).

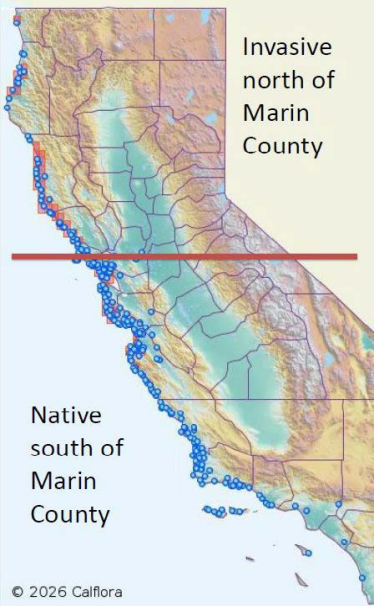
GEOGRAPHIC DISTRIBUTION:

NATIVE DISTRIBUTION

L. arboreus is endemic to the coastal bluffs and dune systems of central and southern California, USA, with a historical range extending from Ventura County northward to Sonoma County (Francis, 2004; Wozniak, 2000).

NON-NATIVE DISTRIBUTION

The species has naturalized widely outside its native range. In North America, it has spread northward along the coast of northern California (such as Humboldt County), Oregon, Washington, and Vancouver Island in Canada (Francis, 2004). The plant is heavily naturalized and wildly problematic worldwide, invading Europe, France, the coastal habitats of the UK, the coasts of Chile, and massive coastal spans of mainland Australia, Tasmania, and New Zealand (Francis, 2004; Doody, 2013; Stout *et al.*, 2002; Molina-Montenegro *et al.,* 2008).



Stella Waxwing infographic

HISTORY:

The earliest record, in the Pacific Northwest, outside of California, of *L. arboreus* is on the coast near Victoria, British Columbia area, in 1913. The next record is in the Siskiyou Forest of coastal Oregon, in 1920. The earliest record in Washington State is from Whidbey Island, in 1934 (Consortium of Pacific Northwest Herbaria). The first record in Washington that is not near the coast or in an urban area is along the Nisqually River, in Tahoma Woods, from 2023 (Burke Herbarium).

WASHINGTON:

L. arboreus has the most records around the San Juan Islands, Whidbey Island, and along the coast of Clallam, Jefferson, Snohomish, Skagit, Whatcom, and Grays Harbor counties (Burke Herbarium).

NEARBY TO WASHINGTON:

OREGON:

Outside of urban areas, *L. arboreus* is primarily found along the outer coast of Oregon, including on remote beaches (Consortium of Pacific Northwest Herbaria).

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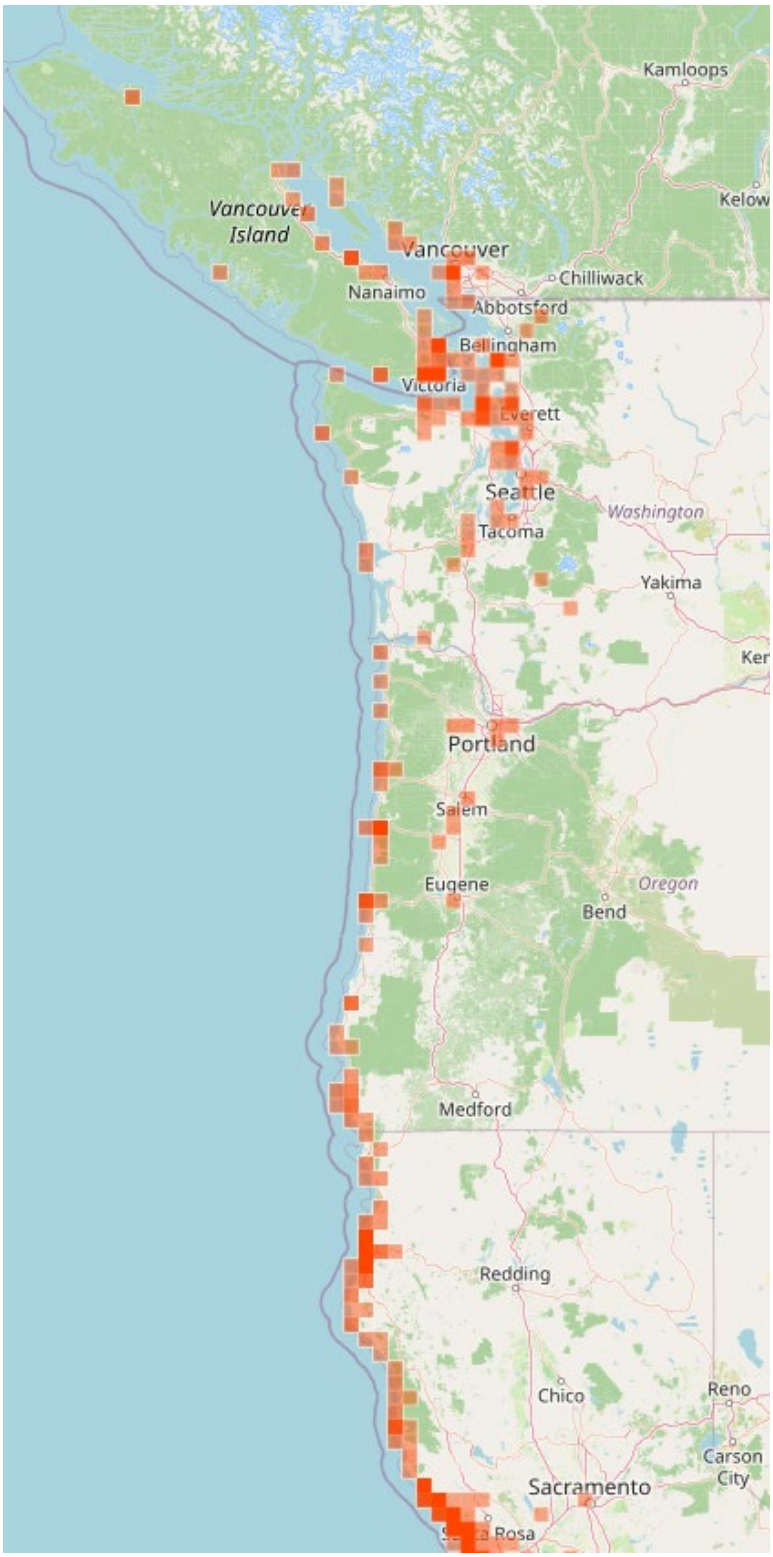
The only records of *L. arboreus i*n Idaho are in urban and suburban areas (Consortium of Pacific Northwest Herbaria).

BRITISH COLUMBIA:

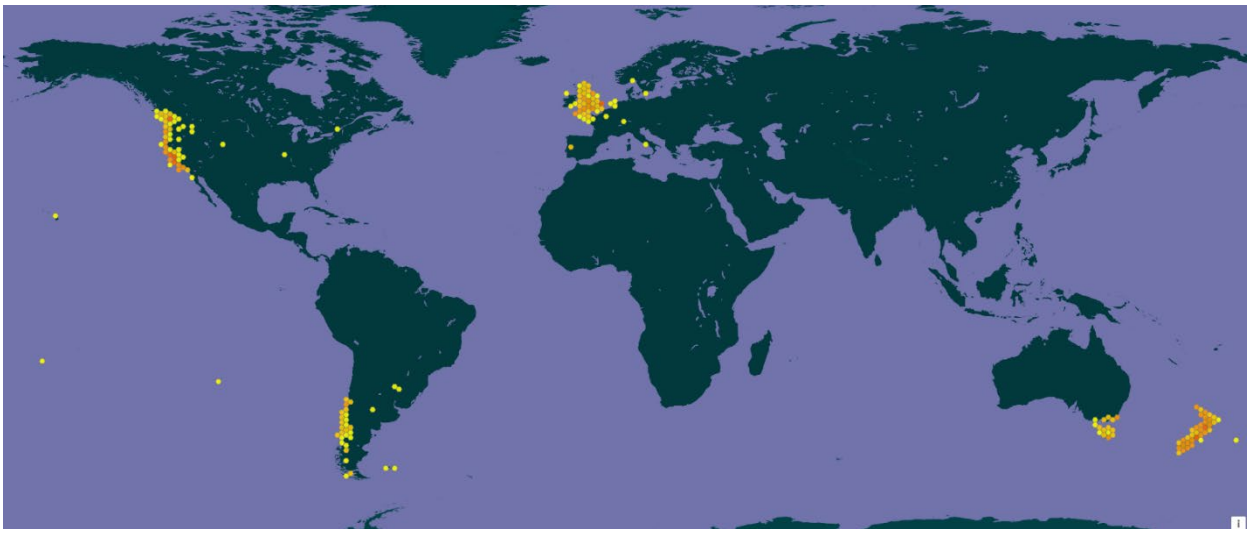
L. arboreus is found along the coast of the southern half of Vancouver Island, especially near Victoria, British Columbia. There are also several records around Vancouver, BC, and one along the coast, in a remote area far from Vancouver (E-Flora BC).

CALIFORNIA

L. arboreus is recorded along California's coast (Calflora), but is only considered native south of Marin County (California Invasive Plant Council).



iNaturalist



Global Biodiversity Information Facility

LISTINGS:

L. arboreus is listed as an environmental weed in New Zealand (New Zealand Plant Conservation Network) and considered an environmental weed in Australia (Weeds of Australia).

ECONOMIC AND ECOLOGICAL IMPORTANCE:

DETRIMENTAL:

As an invasive weed, *L. arboreus* can overrun coastal grazing lands, reducing available pasture for livestock (Doody, 2013). Its presence generates persistent alterations to soil chemistry and biological communities that hinder dune restoration, requiring highly expensive, multi-year management programs to control (Nsikani *et al.,* 2018). Where uncontrolled expansion converts tourism sites, coastal infrastructure dunes, or biodiversity reserves into alien shrubland, the resulting clearing mechanisms require costly perpetual oversight.

L. arboreus acts as an aggressive "gateway invader" (an exotic species that alters ecosystem processes to facilitate further invasions by other weeds) (Cipra, 2006). Its canopy suffocates and obliterates critical light reserves native organisms rely on (Pickart *et al.,* 1998; Wozniak, 2000). By fixing large amounts of nitrogen and dropping nitrogen-rich leaf litter, it enriches the naturally sterile, nitrogen-poor dune soils (Maron and Jefferies, 1999; Nsikani *et al.*, 2018). This soil enrichment allows fast-growing exotic annual weeds and nitrogen-loving grasses, such as *Lolium multiflorum* (Italian ryegrass), *Bromus diandrus* (ripgut brome), *Vulpia bromoides*, and *Briza maxima*, to establish and dominate, crowding out and shading out slow-growing native dune plants (Maron and Jefferies, 1999; Cipra, 2006). *L. arboreus* and these other invasive plants cause dune stabilization. Such stabilizations directly remove the essential migrating sandy-nature unique invertebrates, such as the sand verbena moth (*Copablepharon fuscum*, candidate for endangered listing), demand for residency (Hetherington and Wilson, 2018; Lacey, et al., 2024). This process directly threatens endangered native species, such as *Layia carnosa* (beach

layia) and *Erysimum menziesii* (Menzies' wallflower) in California, and *Ficinia spiralis* (pingao) in New Zealand (Wozniak, 2000; Thomas *et al.,* 2018). Additionally, it hybridizes with native lupines, such as *L. rivularis* and *L. littoralis*, causing genetic swamping (the loss of unique native genotypes due to cross-breeding with a more abundant non-native) (Wozniak, 2000).



Josh Houston

Unpredictable hybridization alongside con-genetics native lupines threatens total genetic swarm-swamping, jeopardizing isolated distinct strains. By deploying enormous masses of extremely attractive yellow blooms it also operates globally as a disruptive “Magnet Species”; by over-enticing roaming local and non-native pollination insect loads toward themselves, they subsequently boost localized pollination, thus dramatically aiding heavy seeding capabilities in simultaneously growing proximate companion invaders, completely unbalancing traditional environments (Molina-Montenegro *et al.,* 2008). The invasion also increases fuel loads, altering natural fire regimes by increasing the frequency and intensity of wildfires (Francis, 2004).

BENEFICIAL:

In its native and naturalized ranges, the species is cultivated commercially as an ornamental plant due to its showy, fragrant yellow flowers (Francis, 2004). Historically, it was widely planted as a sand stabilizer to prevent erosion around coastal infrastructure (Dick, 1994). In New Zealand, it was successfully utilized as a nurse crop, providing critical physical wind protection, and organic nitrogen to assist in the early establishment of commercial *Pinus radiata* timber plantations on raw sand dunes (Dick, 1994). In Great Britain, the species has been used to restore and develop soils on extremely barren industrial waste sites, such as clay mining wastes, rapidly building up nitrogen pools and organic matter (Marrs *et al.,* 1982).

In coastal sand dune ecosystems, *L. arboreus* stabilizes shifting sand, preventing wind erosion and allowing initial soil formation on completely barren substrates (Dick, 1994). In its native range in California, it provides critical structural shelter, nesting sites, and food for native birds, reptiles, insects, and rodents (Francis, 2004). In areas where it has naturalized, such as Chile, its showy flowers act as a highly attractive plant that draws in abundant insect pollinators, thereby indirectly increasing the pollinator visitation rates and seed output of less attractive neighboring plants (Molina-Montenegro *et al.*, 2008). High quantities of pollen actively provision enormous regional and specialist bumblebees and

hymenoptera guilds early throughout respective seasons spanning late spring until heightening summer transitions (Doody, 2013; Maron, 1997; Francis, 2004).

CONTROL:

MECHANICAL:



L. arboreus x L. littoralis hybrid. Stella Waxwing

Hand-pulling of seedlings and young plants is highly effective (Wozniak, 2000). For larger shrubs, using a hand-operated weed wrench (a tool that grips the stem base and uses leverage to pop the roots out) is recommended, as the entire root system must be extracted to prevent plant survival (Wozniak, 2000). If the roots cannot be pulled, cutting the main stem at ground level with a handsaw is effective because the species rarely crown-sprouts (sends up new shoots from the root crown) (Francis, 2004; Hetherington and Wilson, 2018). To prevent weed re-establishment, manual weeding must include the physical removal of the nitrogen-rich litter and duff (partially decayed organic matter on the soil surface) to prevent secondary weed invasion (Pickart *et al.,* 1998). Since 2023, *L. arboreus* has been being removed by hand or weed wrenching, at Fort Worden, in Jefferson County, Washington. The moss mats underneath are then removed to restore the dune architecture. There is an initial flush of seedlings after the initial removal, but populations can be greatly reduced after three years of treatments, with two more years expected to be needed for fuller control (Waxwing, 2026).

Mechanical control involves utilizing heavy machinery or motorized equipment. On flat, accessible terrain, dense stands of mature lupine are cleared using a tractor fitted with a brush rake (a specialized attachment designed to rip up shrubs and roots) (Wozniak, 2000). This primary treatment is most effective when followed by using a plow blade or bucket to scrape away and remove the accumulated leaf litter and duff layer and subsequently laying down heavy weed tarps for 1 to 2 years to suppress seed bank germination (Wozniak, 2000). Tractor-pulled chokers (steel cable loops tightened around stems to pull them out) are also used, though these mechanical methods are highly expensive, labor-intensive, and cause severe soil disturbance (Francis, 2004). Major agricultural restoration frequently resorts strictly introducing commercial level soil churning through scraping brush rakes along back dunes

then immediately plunging sub-level top layers with loaders separating the deep soil contamination duff strata physically out, preventing nutrient spread further horizontally onto innocent terrain completely (Pickart *et al.,* 1998; Nsikani *et al.,* 2018).

CULTURAL:

Prescribed burning (controlled fires) can be used to clear aboveground biomass and burn off the nitrogen-rich litter layer, which volatilizes (turns into gas and releases into the atmosphere) a portion of the accumulated soil nitrogen pool (Nsikani *et al.,* 2018). However, the heat of the fire breaks seed coat dormancy and triggers mass germination of the soil seed bank, which must be immediately followed by manual or chemical treatments to destroy the emerging seedlings before they can set seed (Francis, 2004; Nsikani *et al.,* 2018). Soil carbon addition (applying labile carbon sources such as sawdust or sucrose/sugar to the soil) is used to temporarily immobilize excess soil nitrogen; the carbon stimulates soil microbes to consume the available nitrate and ammonium, reducing the nutrient availability that favors exotic weeds (Nsikani *et al.,* 2018). Finally, active revegetation (planting native, shade-producing dune-mat species or establishing native "nurse plants" adapted to low-nitrogen soils) is a critical cultural method to naturally shade out and suppress emerging lupine seedlings, which are highly shade-intolerant (Nsikani *et al.,* 2018; Maron and Jefferies, 1999). Controlled grazing by sheep or goats can also be deployed to consume emerging annual weeds after lupine clearance (Nsikani *et al.*, 2018).

BIOLOGICAL:

In California, natural biological regulators include the caterpillars of the western tussock moth (*Orgyia vetusta*), which feed heavily on leaves and can cause complete defoliation, and the caterpillars of the subterranean ghost moth (*Hepialus californicus*), which tunnel into and destroy the root system (Maron, 1997; Maron and Jefferies, 1999). In New Zealand, the accidental introduction of the host-specific fungal pathogen *Colletotrichum gloeosporioides* (causing lupin blight) in 1988 resulted in a massive epidemic, causing rapid mortality of seedlings and severe stem cankering and dieback in mature plants, which reduced North Island populations by 90–95% (Dick, 1994). In Great Britain, populations have been successfully suppressed following the accidental introduction of the lupin aphid (*Macrosiphum albifrons*) from North America, which feeds heavily on the sap of the plant (Doody, 2013).



Orange is *L. arboreus*, yellow is *Abronia latifolia,* the only host plant for the critically imperiled sand-verbena moth (*Copablepharon fuscum*), at Fort Worden State Park, from Washington State Parks.

CHEMICAL:

L. arboreus is highly susceptible to clopyralid-based herbicides, which specifically target legumes (Konlechner *et al.,* 2015; Peterson *et al.,* 2024). Chemical applications can be administered as a foliar spray, spraying the herbicide directly onto the leaves of the plant (Peterson et al., 2024). For mature individuals, a cut-stump treatment—where the shrub is felled and a 2% solution of clopyralid or glyphosate is painted directly onto the freshly cut cambium (the active growth layer of the stem) within one minute of cutting, is highly effective at preventing resprouting (Hetherington and Wilson, 2018). Chemical applications must be carefully managed to avoid non-target drift onto sensitive native dune plants, and herbicides are restricted near open water to prevent environmental contamination (Peterson *et al.,* 2024). At Fort Worden State Park, in Jefferson County, WA, cut stump treatments are applied to plants that are too large to remove by hand or weed wrench (Waxwing, 2026).



Before & after herbicide treatments of L. arboreus at a gravel pit in Clallam County, WA.

Clallam County reports success with foliar treatments of *L. arboreus* using a solution of 1.5% Aquaneat (aquatic glyphosate), 0.25% Milestone (aquatic aminopyralid, a broadleaf pre-emergent), and 0.5% Syl-tac EA (surfactant) (St. John, 2026).

RATIONALE FOR LISTING:

Sand dune habitats are a critically imperiled and heavily impacted habitat type along Washington's coast. They house several endemic and endangered species, which rely on sparsely vegetated, shifting sands in order to persist. *L. arboreus* stabilizes dunes (Hetherington and Wilson, 2018), alters nutrients (Maron and Jefferies, 1999; Nsikani *et al.*, 2018), and pushes out native rare dune-obligate species (Maron and Jefferies, 1999; Cipra, 2006). Additionally, they hybridize with some native lupines, reducing their genetic stability (Wozniak, 2000).



L. arboreus x L. littoralis hybrid. Stella Waxwing

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