

Appendix A

Species Listing PROPOSAL Form:

Listing Endangered, Threatened, and Special Concern Species in Massachusetts

Scientific name: *Lupinus perennis*
Common name: Wild Lupine

Current Listed Status (if any): Watch-list

Proposed Action:

Add the species, with the status of: Special Concern

Proponent's Name and Address:

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Date of Submission: March 03, 2023

Association, Institution or Business represented by proponent:

Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife

Justification

Justify the proposed change in legal status of the species by addressing each of the criteria below, as listed in the Massachusetts Endangered Species Act (MGL c. 131A) and its implementing regulations (321 CMR 10.00), and provide literature citations or other documentation wherever possible. Expand onto additional pages as needed but make sure you address all of the questions below. The burden of proof is on the proponent for a listing, delisting, or status change.

(1) Taxonomic status. Is the species a valid taxonomic entity? Please cite scientific literature.

Yes, *Lupinus perennis* is a valid taxonomic entity (Haines, 2011).

(2) Recentness of records. How recently has the species been conclusively documented within Massachusetts?

Several known occurrences of *Lupinus perennis* have been observed in Massachusetts as recently as 2022 (MA NHESP data).

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(3) Native species status. Is the species indigenous to Massachusetts?

Yes, *Lupinus perennis* is native to Massachusetts, as well as the other five New England States (Kartesz, 2015).

(4) Habitat in Massachusetts. Is a population of the species supported by habitat within the state of Massachusetts?

Yes, in Massachusetts, as throughout its range, *Lupinus perennis* is associated with dry, sandy openings such as sandplain grassland communities and sandy woodland clearings (Meyer 2006). Edaphic features that are well drained and slightly-to-moderately acidic (Curtis, 1959, Zaremba & Pickering, 1994) appear to be a key feature of sites that support *Lupinus perennis*. Surface soil disturbance also appears to play an important role in the germination of *Lupinus perennis* seed (Leach, 1993). Open canopy conditions are important for *Lupinus perennis*, with minimum canopy cover being an optimal situation (Greenfield 1997, Smallidge et al. 1996, Smith 2002). Conversely, a closing canopy has been shown to greatly reduce or eliminate *Lupinus perennis* (Grundel et. al. 1998, Grigore et. al. 1996, Hack 1993).

These habitat qualities are present throughout much of Massachusetts, as indicated by: the state's surficial geology (Massachusetts Bureau of Geographic Information); the current and historic distribution of known *Lupinus perennis* occurrences (NHESP data 2018); and documented examples of natural communities that are capable of supporting *Lupinus perennis*, such as Pitch Pine-Scrub Oak Woodlands, Sandplain Grasslands, and Pitch Pine-Oak Woodlands (Swain and Kearsley 2000).

(5) Federal Endangered Species Act status. Is the species listed under the federal Endangered Species Act? If so, what is its federal status (Endangered or Threatened)? No.

(6) Rarity and geographic distribution.

(a) Does the species have a small number of occurrences (local populations) and/or small size of populations in the state? Are there potentially undocumented occurrences in the state, and if so, is it possible to estimate the potential number of undocumented occurrences?

- a) The MA NHESP has documented a total of 81 occurrences of *Lupinus perennis* in Massachusetts (NHESP data 2018). Of these 81 occurrences, 39 are considered to be current (observed within the past 25 years). The majority of occurrences occur in known areas of significant glacially derived substrates, such as Cape Cod, the Connecticut River Valley (Springfield area and Montague Delta), and the Nashua River Valley (see Figure 01). There are likely some undocumented occurrences of *Lupinus perennis* in the state, but because the plant is showy and its habitat is somewhat specialized and decreasing due to succession, these undocumented populations are likely not significant.

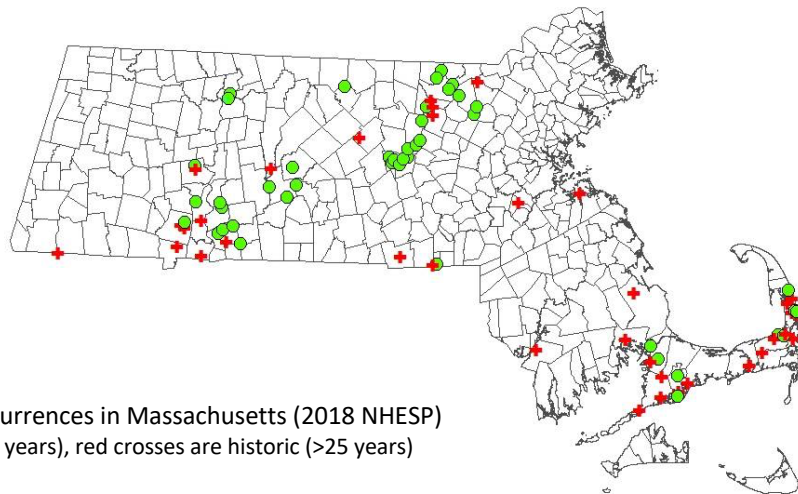


Figure 01: Total *Lupinus perennis* occurrences in Massachusetts (2018 NHESP)
Green Dots are current occurrences (≤25 years), red crosses are historic (>25 years)

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(b) What is the extent of the species' entire geographic range, and where within this range are Massachusetts populations (center or edge of range, or peripherally isolated)? Is the species a state or regional endemic?

b) *Lupinus perennis* is native to all states east of the Mississippi River, with the exception of Tennessee, Arkansas and Missouri. Texas is the only state west of the Mississippi that supports native *Lupinus perennis*. In Canada, *Lupinus perennis* is only native to Ontario (USDA 2018). Massachusetts could be considered to be near the northeastern edge of the range of *Lupinus perennis*, but Massachusetts would not be considered to be on the periphery to, or isolated from, the overall species' range.

(7) Trends.

(c) Is the species decreasing (or increasing) in state distribution, number of occurrences, and/or population size? What is the reproductive status of populations? Is reproductive capacity naturally low? Has any long-term trend in these factors been documented?

Lupinus perennis is listed in the 2013 Flora Conservanda as Division 3a (... "taxa that have documented decline in a substantial portion of their range in New England) (Brumback and Gerke 2013). *Lupinus perennis* is currently listed as Endangered in Vermont, Threatened in New Hampshire, Special Concern in Rhode Island, and is considered to be extirpated in Maine (NEWFS 2018). The status of *Lupinus perennis* in Connecticut is SNR (not ranked). NatureServe has estimated a 10-30% range wide short-term population decline, and suggests that Eastern declines are more severe (NatureServe 2017).

Lupinus perennis is ranked S3S4 in Massachusetts (vulnerable-to-apparently secure). This assessment is based upon "Rapid decline, due to woody succession and fire suppression" (MassWildlife 2015). Of the documented 81 occurrences in Massachusetts, only 38 occurrences are considered to be current (observed within the last 25 years) (see Table 01). While it is possible that some of these 44 historic occurrences are still extant, it is expected that the majority of these occurrences no longer exist because of habitat loss due to either development or habitat succession. Further, of the remaining 38 current occurrences: two were reported to support zero plants during their last visit; nine occurrences were reported to support 10 or fewer plants; and nine occurrences supported only between 13 and 50 plants. This leaves less than half of the state's current occurrences (n=18), and less than a quarter of the total documented occurrences in Massachusetts, supporting more than 50 plants.

Of these remaining 18 current occurrences, on their last date of observation: five supported between 51 and 100 plants; four supported between 101 and 200 plants; seven supported between 250 and 500 plants; and two supported roughly 1,000 plants. It should be noted that, of this group, approximately half occur on protected open space (approximately 10), and therefore have the potential to be perpetuated through management. That said, the remaining occurrences (approximately 8) are currently neither protected from development, nor are likely candidates for long-term management.

It should also be noted that Table 01 and the above text rely upon population sizes for each occurrence that were generated during the last recorded visit to the site, and that the majority of current occurrences have last observation dates 10 years old or older (N=31), with 6 of these current occurrences with last observation dates greater than 20 years. This is an important consideration because, as an early successional species (Savignano 1994, USFWS 2003), it would be expected that these numbers would decline over time if the site did not experience some form of management or other successional disturbance, or worse, if the site was lost to development or otherwise permanently impacted. In the 16 instances where there are multiple years of observations for an occurrence, evidence of declining populations is shown: 12 of these sites showed dramatic declines (all with losses of 80 to ~2,500 plants), while only two held more or less steady (including Montague Plains, which is experiencing direct augmentation by seeding).

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Table 01: Summary of current (observed with last 25 years) *Lupinus perennis* occurrences (NHESP data 2018)

EO	# Plants	Last Year	High #/Year	Location	Comments
136	1000	2017	-	Barnes	Threatened by invasives
23	1000	2017	-	Westover	Secure and growing
10	500	2007	1995: 3000+	Cape Cod Canal	
33	486	2005	-	Groton Dump	
17	417	2000	-	CCNSS	
153	400	2022	2010: 1000	Ware River Airport	Small, fragmented and land for sale
20	390	2009	2000: 470	South Hadley	
30	350	2022	2009: 1471	Eastwood Cemetery	Has since declined, but now managed
151	250	2006	-	Brewster	
22	200	2005	-	Florence	
135	200	2006	-	Paxton	
27	130	2007	1995: 100	Wachusett	
12	110	2022	2022: 150	Montague Plains	Population being augmented
11	100	2004	1995: 125	Turners Falls Airport	Needs management
18	90	2005	-	Millers Falls RR	
4	79	2009	2001-500	Wachusett	
15	66	2000	-	CCNSS	
152	60	2009	-	Wachusett	
101	50	2000	-	Easthampton H.S.	Unsure about actual number
142	45	2008	-	Ware River Rail Trail	
31	39	2006	-	Acton Water Department	
32	38	2010	1997:600	Groton RR	
141	30	2007	-	Clinton High School	
16	23	2000	-	CCNSS	
7	15	2004	-	Nickerson	
129	15	2005	-	Quashnet	
29	13	2009	2001: 400	Wachusett	
14	10	2003	2000: 100+	Pocasset	
40	10	2007	-	Devens	
137	7	2006	-	Marconi	
-	3	2017		Quabbin Park	Habitat quickly succeeding
-	4	2017		Lake pleasant	
38	3	2010	2000:100	Red Line Trail, Westford	
128	2	2007	2004:80	Millville Lock Trail	
24	1	2013	2001:8	Ashley Ponds	
140	1	2007	-	Gardner Bike Path	
28	0	2001	1995: 100	Scar Hill, Wachusett	
36	0	2010	1995: 110	East Street, Pepperell	

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(8) Threats and vulnerability.

(d) What factors are driving a decreasing trend, or threatening reproductive status in the state? Please identify and describe any of the following threats, if present: habitat loss or degradation; predators, parasites, or competitors; species-targeted taking of individual organisms or disruption of breeding activity.

The primary factor in the decline of *Lupinus perennis* is habitat loss and habitat degradation, both from development and from disruption of natural disturbance regimes; primarily fire (NHESP 2015, NatureServe 2017). This can be directly observed through NHESP data where the majority of known Massachusetts occurrences that have been tracked over time have greatly declined in the absence of management/natural disturbance (see section 7: *Trends*; paragraph 3). As an early successional species and a species that thrives in a metapopulation structure (U.S. Fish and Wildlife Service. 2003), regularly occurring disturbance is critical for the perpetuation of both individual *Lupinus perennis* occurrences and to the persistence of *Lupinus perennis* as a species on the greater landscape (Corry et al. 2008). Direct impacts of fire on individual *Lupinus perennis* occurrences include an increase in: germination rates (Boyonoski 1992); seedling survival rates (Pavlovic 2008); seed production (Grigore 1996); plant biomass (Grigore 1996); and flowering (Boyonoski 1992). Perhaps more important to the long-term survival of individual *Lupinus perennis* occurrences are the indirect impacts of fire on community structure, such as canopy reduction and the reduction of generalist competition (see section 4: *Habitat in Massachusetts*).

The positive impacts of fire, and the subsequent negative impacts of fire suppression on individual *Lupinus perennis* occurrences (Smallidge et al. 1996; Forrester et al. 2005), compound when considering the greater *Lupinus perennis* population across the landscape. *Lupinus perennis* is considered to be a species that thrives in a metapopulation structure (USFWS 2003), and thus, its life history has evolved to adapt to the shifting mosaic of natural community structure (Corry et al. 2008) that results from regularly occurring fire on the landscape (Baker 1994). Historically, most of the natural communities that supported *Lupinus perennis* in Massachusetts occurred a traditionally fire-influenced landscape that featured a shifting mosaic of appropriate habitat types (Patterson 1998, Nowacki & Abrams 2008), with individual *Lupinus perennis* populations extinguishing and recolonizing as landscape conditions cycled with periodic fire (Nowacki & Abrams 2008). In recent times, fire suppression has essentially eliminated this pattern of shifting habitat mosaic on the landscape (Nowacki & Abrams 2008), and as a result, individual *Lupinus perennis* occurrences are now generally only extinguishing in the absence of fire because habitat is not being made available again for recolonization (Givnish, Menges, & Schweitzer 1988; Schweitzer 1994). This one-directional trend toward decline and extinguishment within the metapopulation can be observed in the Massachusetts population where *Lupinus perennis* occurrences that have been monitored over time have mostly decreased or disappeared in the absence of disturbance events (see section 3: *Trends*, paragraph 3). Conversely, in *Lupinus perennis* occurrences where disturbance has been introduced through habitat management, populations have shown significant growth (see section 9.2: *Conservation Goals; Active Management*), reinforcing the critical role that the historical fire regime played in perpetuating *Lupinus perennis* metapopulations, as well as the serious threat to metapopulations that results from fire suppression.

Aside from the direct threats of outright habitat loss and the indirect threats posed by disruption in historic disturbance regimes, several other factors threaten *Lupinus perennis* in Massachusetts. White-tailed deer (*Odocoileus virginianus*) browse has been cited as playing a major role in the reduction or elimination of some *Lupinus perennis* occurrences (Schweitzer 2002 & 1994, Wagner, et al. 2003). Depredation of *Lupinus perennis* seed by mice (*Peromyscus spp.*) has also been shown to be a limiting factor in some occurrences, especially occurrences that have a buildup of leaf litter due to fire suppression (Reed et al. 2005, Maron 2005, Kaufmann 2006, Kollmann and Buchard 2002). Incompatible mowing practices that prevent *Lupinus perennis* from setting seed can be an important limiting factor (NHESP 2015), especially in less natural occurrences such as airfields and cemeteries. Finally, inadvertent impacts from herbicide application can also play an important role in reducing or eliminating *Lupinus perennis* occurrences, especially those in managed areas such as transmission rights-of-way and roadsides.

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(e) Does the species have highly specialized habitat, resource needs, or other ecological requirements? Is dispersal ability poor?

Lupinus perennis is somewhat of a specialist, relying upon open, early successional structure with well-drained, moderately acidic soil. Seed dispersal is somewhat limited, with the primary mode of dispersal being gravity (Dirig 1994) of up to 5m (Grigore 1996).

(9) Conservation goals.

What specific conservation goals should be met in order to change the conservation status or to remove the species from the state list? Please address goals for any or all of the following:

- (a) State distribution, number of occurrences (local populations), population levels, and/or reproductive rates
- (b) Amount of protected habitat and/or number of protected occurrences
- (c) Management of protected habitat and/or occurrences

Conservation actions for recovering *Lupine perennis* in Massachusetts should include four primary strategies, each with specific objectives:

- 1) Complete surveys of all current sites: All current sites (and some historic sites where appropriate habitat still exists) should be resurveyed by the end of field season 2025. Surveys should include the collection of population data, information on the supporting natural community, and the assessment of management potential, restoration potential, the need/opportunity of seed collection or population augmentation, and immediate threats to the occurrence.
- 2) Active management on extant sites: *Lupinus perennis* responds very well to active management, as observed at several managed occurrences in Massachusetts (ex. Westover AFB, Muddy Brook WMA, Turners Falls Airport, Montague Plains WMA), as well as at sites such as Albany (New York) Pine Bush and Concord (New Hampshire) Pine Barrens. Objectives for active management should include the development of management strategies for each occurrence on protected conservation land, as well as for unprotected occurrences that are deemed to either be a high priority or to have willing landowners. From this group, a subset of sites, based upon priority and opportunity, should be chosen for implementation of management. Ideally, two to three sites from the three major population centers (Cape Cod, Connecticut River Valley, and the Nashua River Valley), as well as at least one site in important peripheral areas, should be initiated. In many cases, the management of *Lupine perennis* can or will coincide with other rare species management (ex. Frosted Elfin, *Callophrys irus*, Special Concern) or a larger natural community management initiative, especially on state-owned barrens natural communities.
- 3) Protection of extant occurrences through MESA: The Massachusetts Endangered Species Act can play an important role in conserving and recovering the state's *Lupinus perennis* population through occurrence protection and through on-or-offsite mitigation. MESA can also play a role in protecting occurrences on already protected land by ensuring that all activities, including habitat management, are not detrimental to *Lupinus perennis* occurrences. It is recommended that non-regulatory Species Habitat be generated for each known current *Lupinus perennis* occurrence, and that Regulatory Habitat be generated for all current occurrences that are deemed to be biologically viable.
- 4) Establishment, Augmentation or Reintroduction: *Lupinus perennis* seed is relatively easy to collect and relatively easy to germinate, and in certain cases, establishment, augmentation or reintroduction can play an important role in the conservation of this species in Massachusetts. Augmentation may be appropriate at occurrences where the site is protected and management is likely, but the current population is low. Depending on the current size of the population, augmentation should be done with seed from the actual occurrence, or supplemented with seed from other occurrences in the immediate area. Reintroduction may be appropriate for historic occurrences at protected sites where management is likely and there is a nearby extant population to

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collect seed from. Establishment may be appropriate at large protected sites with appropriate habitat that will be actively managed. Origin may be slightly less restrictive in establishment situations, but material still should be collected from sources at least within the same major watershed.

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