

Identifying and Preventing Plant Extinction Events in the USA and Canada

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Research Note | [Open Access](#) |

Vascular plant extinction in the continental United States and Canada

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Article impact statement: : The number of presumed extinct plants from the continental United States and Canada is much greater than previously recognized.

 SECTIONS



PDF



TOOLS



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Abstract

EN ES

Extinction rates are expected to increase during the Anthropocene. Current extinction rates of plants and many animals remain unknown. We quantified extinctions among the vascular flora of the continental United States and Canada since European settlement. We compiled data on apparently extinct species by querying plant conservation databases, searching the literature, and vetting the resulting list with botanical experts. Because taxonomic opinion varies widely, we developed an index of taxonomic



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Figures



References



Related



Information

Metrics

Citations: 11



Details

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Background



RARE,

THREATENED,

AND ENDANGERED

PLANTS OF MARYLAND

Maryland Department of Natural Resources
Wildlife and Heritage Service
Natural Heritage Program

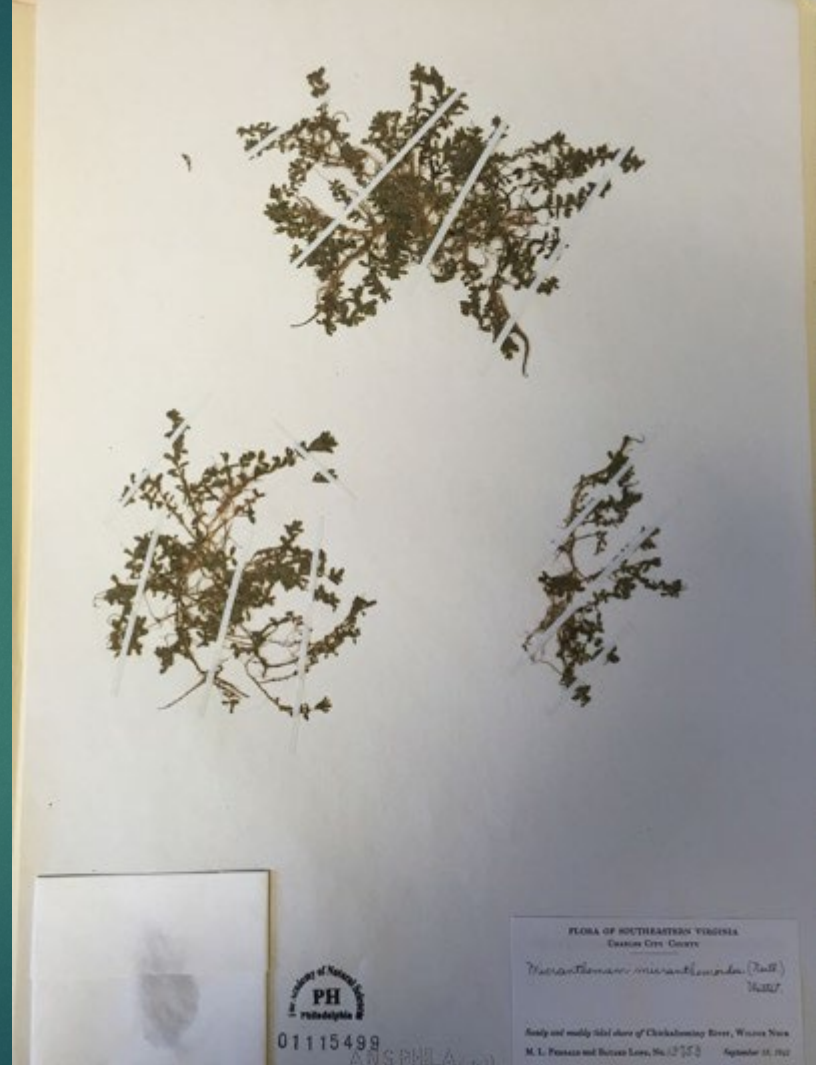
December 2003

2010 Rare, Threatened and Endangered Plants of Maryland

SCIENTIFIC NAME	COMMON NAME	Global Rank	State Rank	State Status	Federal Status
<i>Mecardonia acuminata</i>	Erect Water-hyssop	G5	S1	E	
<i>Melanthium latifolium</i>	Broad-leaved Bunchflower	G5	S1	E	
<i>Melanthium virginicum</i>	Virginia Bunchflower	G5	S3		
<i>Melica mutica</i>	Two-flowered Melicgrass	G5	S1	T	
<i>Melica nitens</i>	Three-flowered Melicgrass	G5	S2	T	
<i>Melothria pendula</i>	Creeping Cucumber	G5?	S1	E	
<i>Merynanthes trifoliata</i>	Buckbean	G5	S1	E	
<i>Micranthemum micranthemoides</i>	Nuttall's Micranthemum	GH	SH	X	
<i>Milium effusum</i>	Millet Grass	G5	S3		
<i>Minuartia caroliniana</i>	Carolina Sandwort	G5	S1	E	
<i>Minuartia glabra</i>	Mountain Sandwort	G4	S1	E	
<i>Minuartia michauxii</i>	Rock Sandwort	G5	S2	T	
<i>Moehringia lateriflora</i>	Grove Sandwort	G5	S1	E	
<i>Monarda cinopodia</i>	Basal Bee-balm	G5	S3		
<i>Monarda media</i>	Purple Bergamot	G4?	SU		
<i>Monotropsis odorata</i>	Sweet Pinesap	G3	S1	E	
<i>Morella carolinensis</i>	Evergreen Bayberry	G5	S1	E	
<i>Muhlenbergia capillaris</i>	Long-awned Hairgrass	G5	S1	E	
<i>Muhlenbergia glaberrima</i>	Hair Grass	G4?	SU		
<i>Muhlenbergia glomerata</i>	Marsh Muhly	G5	SU		
<i>Muhlenbergia sylvatica</i>	Woodland Dropseed	G5	S3		
<i>Muhlenbergia torreyana</i>	Torrey's Dropseed	G3	S1	E	
<i>Myosotis macrocarpa</i>	Large-seeded Forget-me-not	G5	S2S3		

Micranthemum micranthemoides Nuttall

- Intertidal mudflat specialist
- Opposite of charismatic megafauna
- Last observed 13 Sep 1941
- Three duplicates, GH, PH, VPI



Franklinia alatamaha

Collected a single time in the wild: 1 Oct. 1765

Banks of the Altamaha River, GA

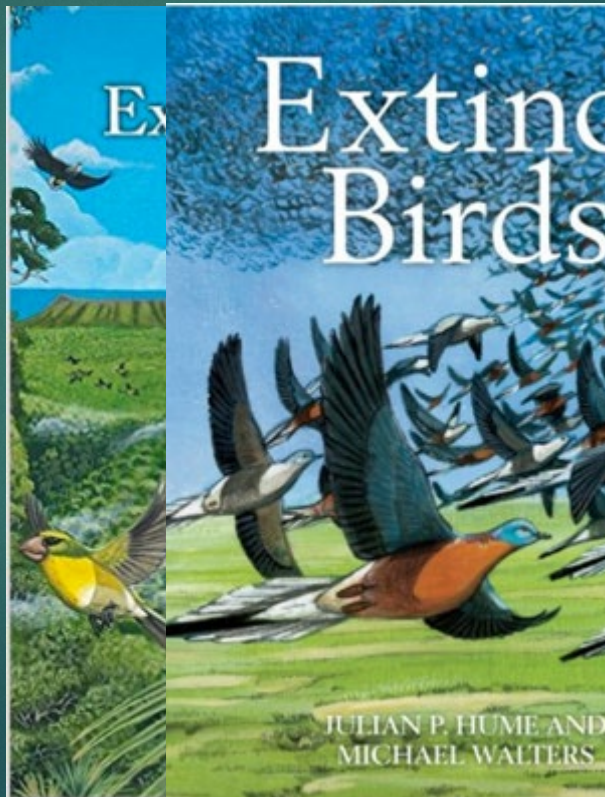
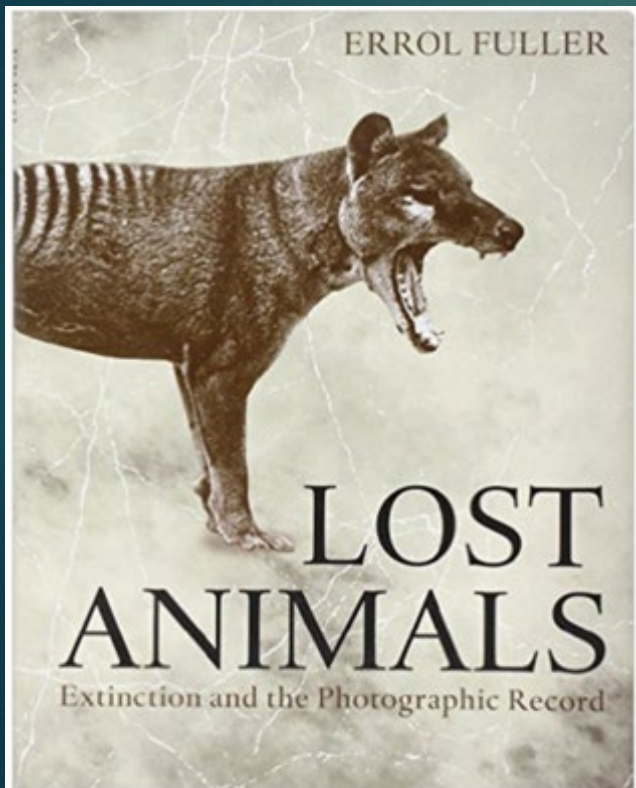
William Bartram's "*Bartram's Travels*"

Named in honor of Benjamin Franklin

Now known only from horticultural trade



Knowledge Gap



Extinction Rates of North American Freshwater Fauna

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Abstract. Since 1900, 123 freshwater animal species have been recorded as extinct in North America. Hundreds of additional species of fishes, mollusks, crayfishes, and amphibians are considered imperiled. Using an exponential decay model, we derived recent and future extinction rates for North American freshwater fauna that are five times higher than those for terrestrial faunas. Assuming that imperiled freshwater species will not survive throughout the next century, our model projects a future extinction rate of 4% per decade, which suggests that North America's temperate freshwater ecosystems are being depleted of species as rapidly as tropical forests.

Taux de l'extinction de Faune de l'Eau Douce en Nord-Amérique

Resumen. Desde 1900, 123 especies animales de agua dulce han sido reportadas como extintas en Norteamérica. Cientos de especies adicionales de peces, moluscos, langostinos y anfibios están consideradas como amenazadas. Utilizando un modelo exponencial de disminución, derivamos tasas de extinciones recientes y futuras para la fauna de agua dulce de Norteamérica, mismas que son cinco veces mayores que aquellas para la fauna terrestre. Asumiendo que las especies de agua dulce en peligro no sobrevivirán a lo largo del próximo siglo, nuestro modelo proyecta una tasa de extinción futura de 4% por década, lo cual sugiere una disminución de especies en los ecosistemas templados de agua dulce de Norteamérica tan rápida como la que ocurre en bosques tropicales.

Introduction

Continually cited warnings of an impending mass extinction have focused on declining species in terrestrial habitats, particularly tropical forests (e.g., Myers 1988, Wilson 1992, Mace 1994, Pimm et al. 1995, Brooks et al. 1997, Reid 1997). By contrast, relatively little media attention has been given to species loss in freshwater ecosystems, presumably because their terrestrial counterparts are perceived to be in greater peril. This view persists despite several recent studies that demonstrate a growing number of freshwater extinctions (Miller et al. 1989, Williams et al. 1993, Taylor et al. 1996, Neves et al. 1997), including a survey by the Nature Conservancy which first drew attention to the disproportionate imperilment of North

American fishes, mollusks, crayfishes, and amphibians (Moser 1990). Direct comparisons of rates of species loss in freshwater and terrestrial ecosystems would shed stronger light on this issue and help set conservation priorities. Such analyses are hampered by the lack of extinction-rate estimates for freshwater fauna.

Exponential Decay Model

Extinction intensities for taxa or biomes of differing diversity can be compared by means of rates that are standardized according to the size of the species pool (Jablonski 1994). For each of several common North American faunal groups, we have modeled the proportional species loss per decade, r , as an exponential decay process expressed by the equation $r = 1 - P^{1/n}$, where P is the proportion of extant native fauna and n is the number of decades over which the extinctions have occurred. Our use of an exponential decay model as

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1228

Conservation Biology, Pages 1228–1232
Volume 13, No. 5, October 1999

Goals



- Compile a comprehensive list of plant taxa believed extinct in the continental United States and Canada
- Calculate extinction rates to set baseline for the Anthropocene
- Draw attention to these species to drive future conservation efforts
- What can we learn?
- How do we prevent future extinction events?

Presumed Extinct vs Globally Historic



- Extinction is a hypothesis
- Extinct from the wild
 - Defined as: no naturally occurring populations
- No confirmed sightings >25 years
- Extinctions since European settlement
- Not talking about extirpations

Study Area

- Artificial Study Area
- Range largely parallel to Flora of North America Project
- Bryophytes not included:
 - *Neomacounia nitida*
- Central America Flora still relatively poorly understood
- Excludes Hawai'i, Puerto Rico,...etc

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Volume 1	Introduction
Volume 2	Pteridophytes and Gymnosperms 31 families
Volume 3	Magnoliophyta: Magnoliidae and Hamamelidae 32 families
Volume 4	Magnoliophyta: Caryophyllidae, Part 1 10 families
Volume 5	Magnoliophyta: Caryophyllidae, part 2 3 families
Volume 6	Magnoliophyta: Cucurbitaceae to Droseraceae 19 families
Volume 7	Magnoliophyta: Salicaceae to Brassicaceae 11 families
Volume 8	Magnoliophyta: Paeoniaceae to Ericaceae 19 families
Volume 9	Magnoliophyta: Picramniaceae to Rosaceae 4 families
Volume 19	Asteraceae (with volumes 20 and 21) 1 family
Volume 20	Partial, Enter from Volume 19 1 family
Volume 21	Partial, Enter from Volume 19 1 family
Volume 22	Magnoliophyta: Alismatidae, Arecidae, Commelinidae (in part), and Zingiberidae 30 families
Volume 23	Magnoliophyta: Commelinidae (in part): Cyperaceae 1 family
Volume 26	Magnoliophyta: Liliidae: Liliales and Orchadales 11 families
Volume 27	Bryophytes: Mosses, part 1 33 families
Volume 28	Bryophytes: Mosses, part 2 48 families



Malephora crocea

Credit: John R. Hosking

Primary Resources

- Flora of North America Web Site
- Dr. Theodore "Ted" M. Barkley

[List All](#)

Methods

- ▶ Literature Review
 - ▶ Floras
 - ▶ Primary Literature
- ▶ Polled botanists across US & Canada
- ▶ NatureServe Database Query looking for GH & GX taxa



Methods (NatureServe Database Query)

	Global	National	Subnational
<u>Unrankable</u>	GU	NU	SU
Extinct	GX	NX	SX
Historic	GH	NH	SH
Critically Imperiled	G1	N1	S1
Imperiled	G2	N2	S2
Vulnerable	G3	N3	S3
Apparently Secure	G4	N4	S4
Secure	G5	N5	S5



Vetting Names

- N = 150 taxa extinct or globally historic
- *Franklinia* – Universally accepted as distinct
- *Rubus fryei* – Extinct single site endemic of West Virginia, or.....not a meritorious taxon, subsumed within *R. allegheniensis*.



Index of Taxonomic Uncertainty (ITU)

- Scientific consensus of a name
- Calculated using novel taxonomic treatments
 - (i.e. different authorships)
- Not calculated using databases
 - (i.e. USDA Plants, BONAP, NatureServe, etc.)



Index of Taxonomic Uncertainty (ITU)

A. Unanimous recognition (no source doubts recognition):

Franklinia alatamaha - Franklinia

B. Majority taxonomic acceptance (accepted by $\geq 50\%$ of sources):

Juncus pervetus Fernald – Bluntflowered Rush

C. Minority taxonomic acceptance (accepted by $< 50\%$ of sources):

Narthecium montanum (Small) C.H. Grey- Mountain Bog Asphodel

D. Significantly dubious taxonomy (accepted by a single, or very few sources):

Rubus fryei H.A. Davis & T. Davis – Fry's Blackberry

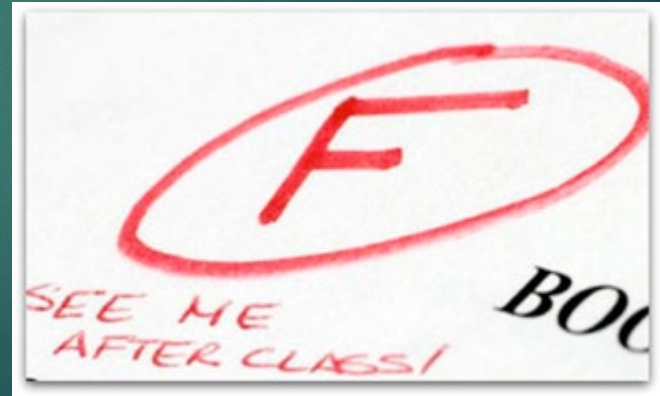
F. Described then never recognized by any subsequent treatment:

Penstemon leptanthus Pennell



Index of Taxonomic Uncertainty (ITU) Results

- ▶ A = 41
 - ▶ B = 14
 - ▶ C = 9
 - ▶ NA = 1
 - ▶ D = 29
 - ▶ F = 16
- ▶ $A + B + C + NA = 65$ taxa presumed extinct



Species	Family	Species	Family
<i>Agalinis caddoensis</i> Pennell	Scrophulariaceae	<i>Elodea schweinitzii</i> Caspary	Hydrocharitaceae
<i>Arctostaphylos franciscana</i> Eastw. (= <i>A.hookeri</i> ssp. <i>franciscana</i>)	Ericaceae	<i>Erigeron mariposanus</i> Congdon	Asteraceae
<i>Arctostaphylos nummularia</i> A. Gray ssp. <i>mendocinensis</i> (P. V. Wells) V. T. Parker, M. C. Vasey & J. E. Keeley (1997)	Ericaceae	<i>Juncus pervetus</i> Fernald	Juncaceae
<i>Astragalus endopterus</i> (Barneby) Barneby (1964)	Fabaceae	<i>Micranthemum micranthemoides</i> (Nuttall) Wettstein	Linderniaceae
<i>Astragalus robbinsii</i> (Oakes) Gray var. <i>robbinsii</i>	Fabaceae	<i>Polygonatum biflorum</i> (Walter) Elliott var. <i>melleum</i> (Farwell) R.P. Ownbey	Polygonaceae
<i>Atriplex tularensis</i> Coville	Chenopodiaceae	<i>Proboscidea spicata</i> Correll	Pedaliaceae
<i>Blephilia hirsuta</i> (Pursh) var. <i>glabrata</i> Fern.	Lamiaceae	<i>Prunus murrayana</i> E.J. Palmer	Rosaceae
<i>Boechea fructuosa</i> (A. Nelson) Al-Shehbaz	Brassicaceae	<i>Quercus tardifolia</i> C.H. Muller	Fagaceae
<i>Brickellia hinkleyi</i> Standley var. <i>terlinguensis</i> (Flyr) B.L. Turner	Asteraceae	<i>Cryptantha insolita</i> J.F. Macbr.	Boraginaceae
<i>Calochortus indecorus</i> Ownbey & M. Peck, (1954)	Liliaceae	<i>Erigeron perglaber</i> S.F. Blake	Asteraceae
<i>Calochortus monanthus</i> Ownbey	Liliaceae	<i>Euonymus atropurpureus</i> Jacq. var. <i>cheatumii</i> Lundell	Celastraceae
<i>Corispermum pallidum</i> Mosyakin (1995)	Chenopodiaceae	<i>Helianthus praetermissus</i> E. Watson	Asteraceae
<i>Cryptantha aperta</i> (Eastwood) Payson	Boraginaceae	<i>Iliamna grandifolia</i> (Rydberg) Wiggins	Malvaceae
<i>Cryptantha hooveri</i> I.M. Johnston	Boraginaceae	<i>Iris pariensis</i> S.L. Welsh	Iridaceae
<i>Eremogone franklinii</i> (Douglas ex Hooker) R. L. Hartman & Rabeler var. <i>thompsonii</i> (M. Peck) R. L. Hartman & Rabelerri	Caryophyllaceae	<i>Margaranthus lemmonii</i> Gray	Solanaceae
<i>Eriochloa michauxii</i> (Poir.) A.S. Hitchcock var. <i>simpsonii</i> A.S. Hitchcock	Poaceae	<i>Mentzelia nitens</i> (Greene) var. <i>leptocaulis</i> J. Darl.	Loasaceae
<i>Franklinia alatamaha</i> Marshall	Theaceae	<i>Narthecium montanum</i> (Small) C.H. Grey	Nartheciaceae
<i>Govenia floridana</i> F.M. Brown	Orchidaceae	<i>Robus concameratus</i> H.A. Davis & T. Davis	Rosaceae
<i>Helianthus nuttallii</i> Tor & A. Gray ssp. <i>parishii</i> (A. Gray) Heiser	Asteraceae	<i>Streptanthus glandulosus</i> Hook var. <i>hoffmanii</i> (Krukeb.) M.S. Mayer & D.W. Taylor	Brassicaceae
<i>Isocoma humilis</i> G.L. Nesom	Asteraceae	<i>Calamagrostis nubila</i> Louis-Marie	Poaceae
<i>Lasthenia nacrantha</i> (A. Gray) Greene ssp. <i>bakeri</i> (J.T. Howell) Omduff	Asteraceae	<i>Castilleja leschkeana</i> J.T. Howell	Scrophulariaceae
<i>Lechea lakelae</i> Wilbur	Cistaceae	<i>Castilleja uliginosa</i> Eastw.	Scrophulariaceae
<i>Lycium verrucosum</i> Eastw.	Solanaceae	<i>Cirsium praetereans</i> J.F. Macbr.	Asteraceae
<i>Matelea radiata</i> Correll	Asclepiadaceae	<i>Crataegus kenneyi</i> Sargent	Rosaceae
<i>Mimulus traskiae</i> A.L. Grant	Scrophulariaceae	<i>Crataegus menandiana</i> Sargent	Rosaceae
<i>Monardella leucocephala</i> A. Gray	Lamiaceae	<i>Crataegus pearsonii</i> Ashe	Rosaceae
<i>Orbexilum macrophyllum</i> (Rowlee in Small) Rydberg	Fabaceae	<i>Echinacea angustifolia</i> de Candolle var. <i>strigosa</i> McGregor	Asteraceae
<i>Orbexilum stipulatum</i> (Torrey & Gray) Rydberg	Fabaceae	<i>Elodea nevadensis</i> (Planch.) H. St. John	Hydrocharitaceae
<i>Phacelia amabilis</i> Constance	Hydrophyllaceae	<i>Malacothamnus mendocinensis</i> (Eastw.) Kearn	Malvaceae
<i>Phacelia insularis</i> Munz var. <i>insularis</i>	Hydrophyllaceae	<i>Malacothamnus parishii</i> (Eastw.) Kearn	Malvaceae
<i>Plagiobothrys glaber</i> (A. Gray) I.M. Johnston	Boraginaceae	<i>Mimulus brandegeei</i> Pennell	Scrophulariaceae
<i>Plagiobothrys glyptocarpus</i> (Piper) I.M. Johnston. var. <i>modestus</i> I.M. Johnston	Boraginaceae	<i>Mimulus whipplei</i> A.L. Grant	Scrophulariaceae
<i>Plagiobothrys lamprocarpus</i> (Piper) I.M. Johnston	Boraginaceae	<i>Penstemon parviflorus</i> Pennell	Scrophulariaceae
<i>Plagiobothrys lithocaryus</i> (A. Gray) I.M. Johnston	Boraginaceae	<i>Phacelia cinerea</i> Eastw. ex J.F. Macbr.	Hydrophyllaceae
<i>Plagiobothrys mollis</i> (A. Gray) I.M. Johnston. var. <i>vestitus</i> (Greene) I.M. Johnston	Boraginaceae	<i>Rhodiola roanense</i> Britton (Sedum <i>roseum</i> (L.) Schopol. var. <i>roanense</i> (Britton) Bergar)	Crassulaceae
<i>Potentilla multijuga</i> Lehm.	Rosaceae	<i>Rorippa coloradensis</i> R. Stucky	Brassicaceae
<i>Potentilla uliginosa</i> B.C. Johnston & Ertter	Rosaceae	<i>Robus aliciae</i> L.	Rosaceae
<i>Prunus maritima</i> Marshall var. <i>gravesii</i>	Rosaceae	<i>Robus fryei</i> H.A. Davis & T. Davis	Rosaceae
<i>Ribes divaricatum</i> Douglas var. <i>parishii</i> (A. Heller) Jepson	Grossulariaceae	<i>Robus huttonii</i> Bailey	Rosaceae
<i>Rumex tomentellus</i> Reehinger	Polygonaceae	<i>Robus vitifolius</i> Cham. & Schldt. var. <i>eastwoodianus</i> (Rydb.) Munz.	Rosaceae
<i>Sphaeralcea procera</i> Ced. Porter	Malvaceae	<i>Scutellaria ovata</i> Hill ssp. <i>pseudoarguta</i> (Epling) Core	Lamiaceae
<i>Streptanthus lemmonii</i> Watson	Brassicaceae	<i>Sisyrinchium farwellii</i> E.P. Bicknell	Iridaceae
<i>Trepshsia angustissima</i> Shuttleworth ex Chapman var. <i>angustissima</i>	Fabaceae	<i>Smilax leptanthera</i> Pennell	Smilacaceae
<i>Thimia americana</i> Pfeiff.	Burmanniaceae	<i>Suaeda duripes</i> I.M. Johnston	Chenopodiaceae
<i>Monardella pringlei</i> A. Gray	Lamiaceae	<i>Symphoricarpos guadalupensis</i> Correll	Caprifoliaceae
<i>Dalea sabinalis</i> (S. Watson) Shimmers	Fabaceae	<i>Hedyotis nigricans</i> (Lamarck) Fosberg var. <i>pulvinata</i> (Small) Fosberg	Spermacoceaceae
<i>Eleocharis brachycarpa</i> Svens	Cyperaceae	<i>Agalinis nuttallii</i> Shimmers	Scrophulariaceae
<i>Fryxellia pygmaea</i> (Correll) D.M. Bates	Malvaceae	<i>Aquilegia micrantha</i> Eastw. var. <i>mancosana</i> Eastw.	Ranunculaceae
<i>Hedeoma pilosa</i> Irving	Lamiaceae	<i>Cirsium modestum</i> (Osterhout) Cockercell	Asteraceae
<i>Paronychia maccartii</i> Correll	Caryophyllaceae	<i>Draba peasei</i> Fernald	Brassicaceae
<i>Sesuvium trianthemoides</i> Correll	Aizoaceae	<i>Linanthus harknessii</i> (Curran) Greene ssp. <i>condensatus</i>	Polemoniaceae
<i>Astragalus kentrophyta</i> A. Gray var. <i>douglasii</i> Barneby	Fabaceae	<i>Lupinus cusickii</i> S. Watson ssp. <i>abortivus</i> (Greene) B.J. Cox	Fabaceae
<i>Astilbe crenatiloba</i> (Britton) Small	Saxifragaceae	<i>Najas caespitosus</i> (Maguire) Reveal	Najadaceae
<i>Brickellia chenopodina</i> (Greene) B.L. Robinson	Asteraceae	<i>Opuntia superbosпина</i> Griffiths	Cactaceae
<i>Calystegia sepium</i> L. ssp. <i>binghamiae</i> (Greene) Brummitt	Convolvulaceae	<i>Penstemon campanulatus</i> (Cav.) Wildl.	Scrophulariaceae
<i>Crataegus delawarensis</i> Sargent	Rosaceae	<i>Penstemon leptanthus</i> Pennell	Scrophulariaceae
<i>Crataegus fecunda</i> Sargent	Rosaceae	<i>Phacelia ciliata</i> Benth. var. <i>opaca</i> J.T. Howell	Hydrophyllaceae
<i>Crinum americanum</i> var. <i>traubii</i> (Moldenke) L. S. Hamibal	Liliaceae	<i>Polyetenium fremontii</i> (S. Watson) Greene var. <i>bisulcatum</i> (Greene) Rollins	Brassicaceae
<i>Cuscuta jepsonii</i> Yuncer	Cuscutaceae	<i>Solanum bahamense</i> L. var. <i>rugellii</i> D'Arcy	Solanaceae
<i>Cuscuta warneri</i> Yuncer (1960)	Cuscutaceae	<i>Synthyris missurica</i> (Raf.) Pennell ssp. <i>hirsuta</i> Pennell	Scrophulariaceae
<i>Digitaria filiformis</i> var. <i>laevigulmis</i> (Fernald) Wipff	Poaceae	<i>Trifolium siskiyouense</i> J.M. Gillett	Fabaceae

Extinction Results

- 51 sp. (65 taxa) believed extinct/globally historic
- 42 taxa (64%) single-site endemics (SSE)
 - Were these really single site endemics?
- Only 2 listed as extinct by IUCN Red List
- ca. 15,882 species in USA & Canada (0.4%)
- Since 1804 (216 yrs) 0.3 taxa/year (3/decade)
Franklinia last seen 1803

The Extinct Plants: Results

34 families

8 Asteraceae (Daisy), 7 Fabaceae (Bean), 7 Rosaceae (Roses), 6 Boraginaceae (Brome)
...2 Poaceae (Grasses), 1 Cyperaceae (Sedges), 1 Orchidaceae (Orchids)

53 Genera

4 *Crataegus* (Hawthorns),

3 *Astragalus* (Milkvetch),

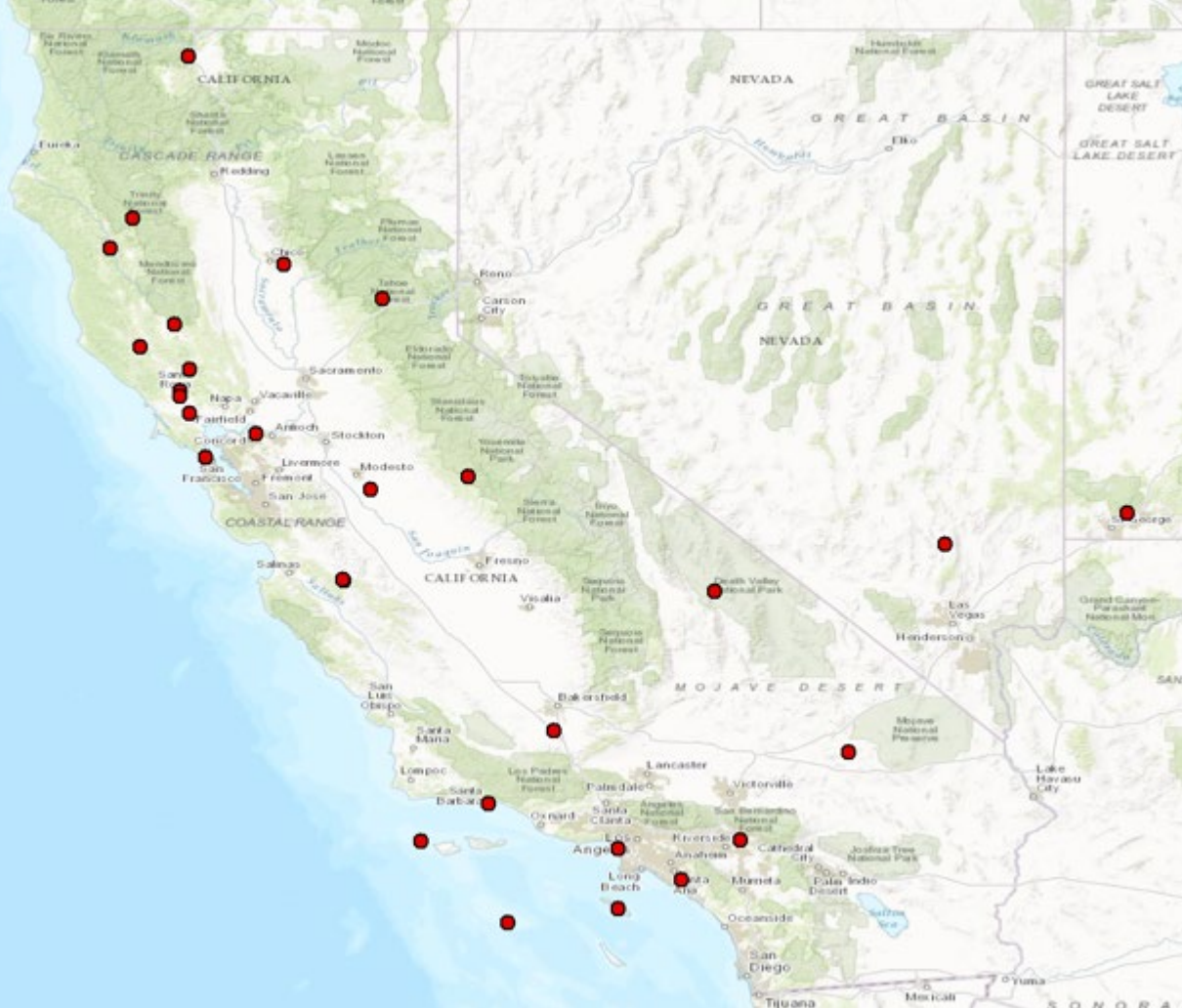
3 *Cryptantha* (Cat's Eyes), &

3 *Plagiobothrys* (Popcorn Flowers)

subtribe Amsinckiinae



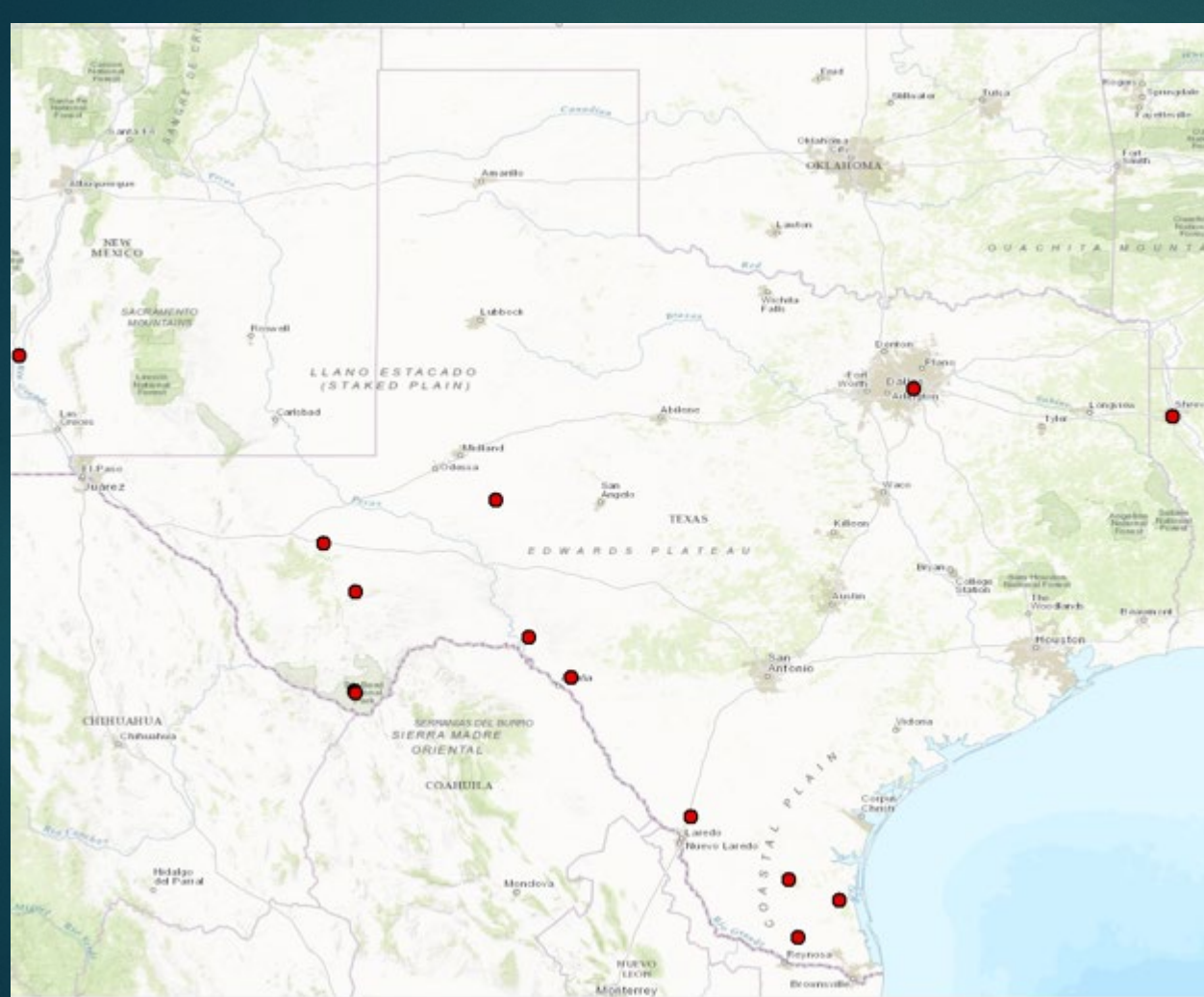




Biggest Loser!

19 taxa

Broad Coverage



2nd Biggest Loser

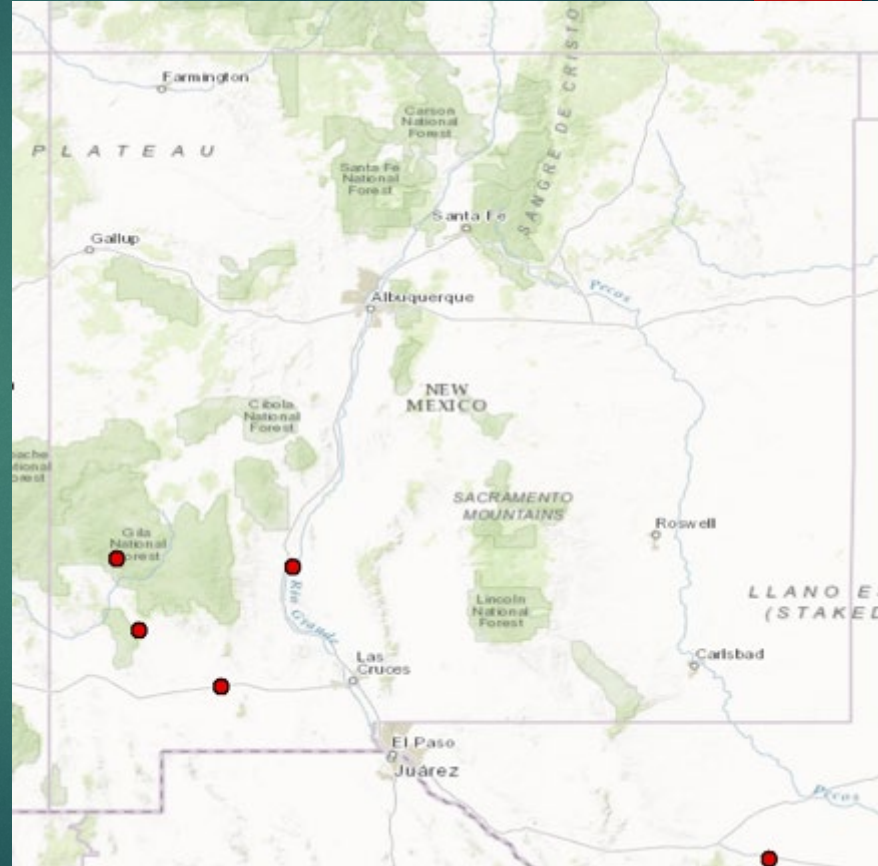
9 Extinct Taxa

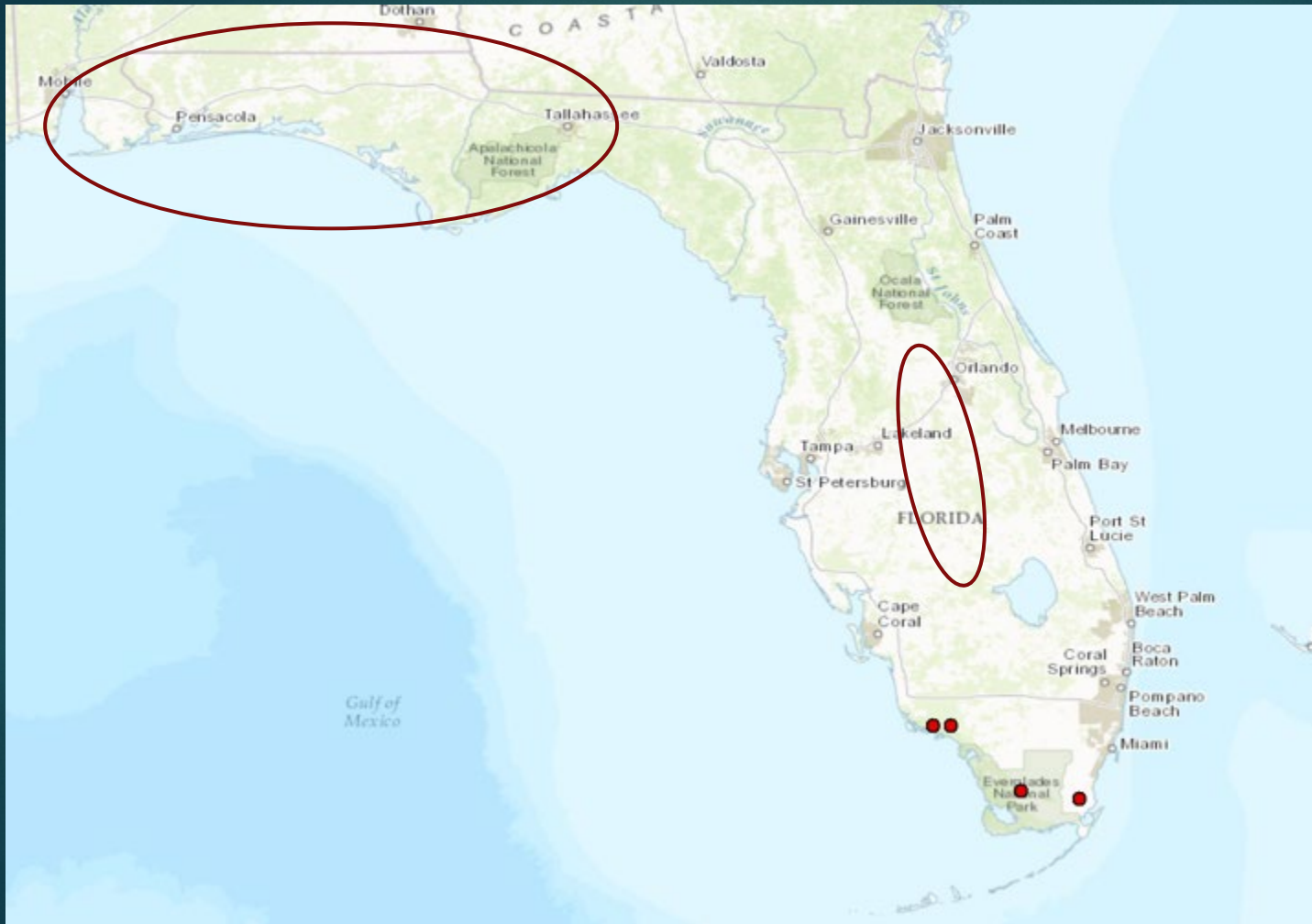
Largely southern
distribution

Some only extirpated?

New Mexico & Florida 3rd place

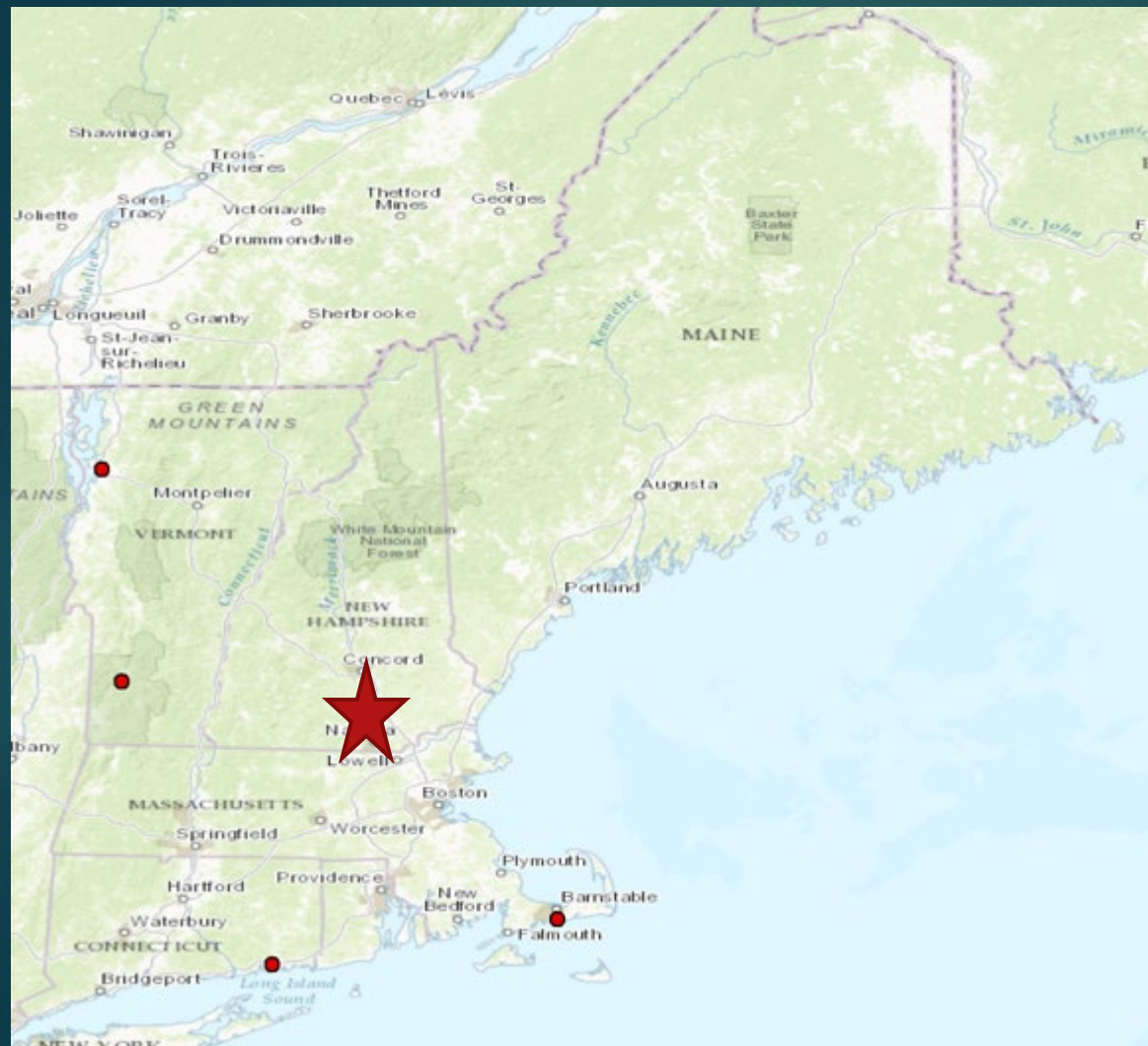
- ▶ 4 taxa per state
- ▶ 4 mapped in NM,
Lost Sunflower
(*Helianthus
praetermissus*), is
unmappable





3rd place

4 extinct
taxa

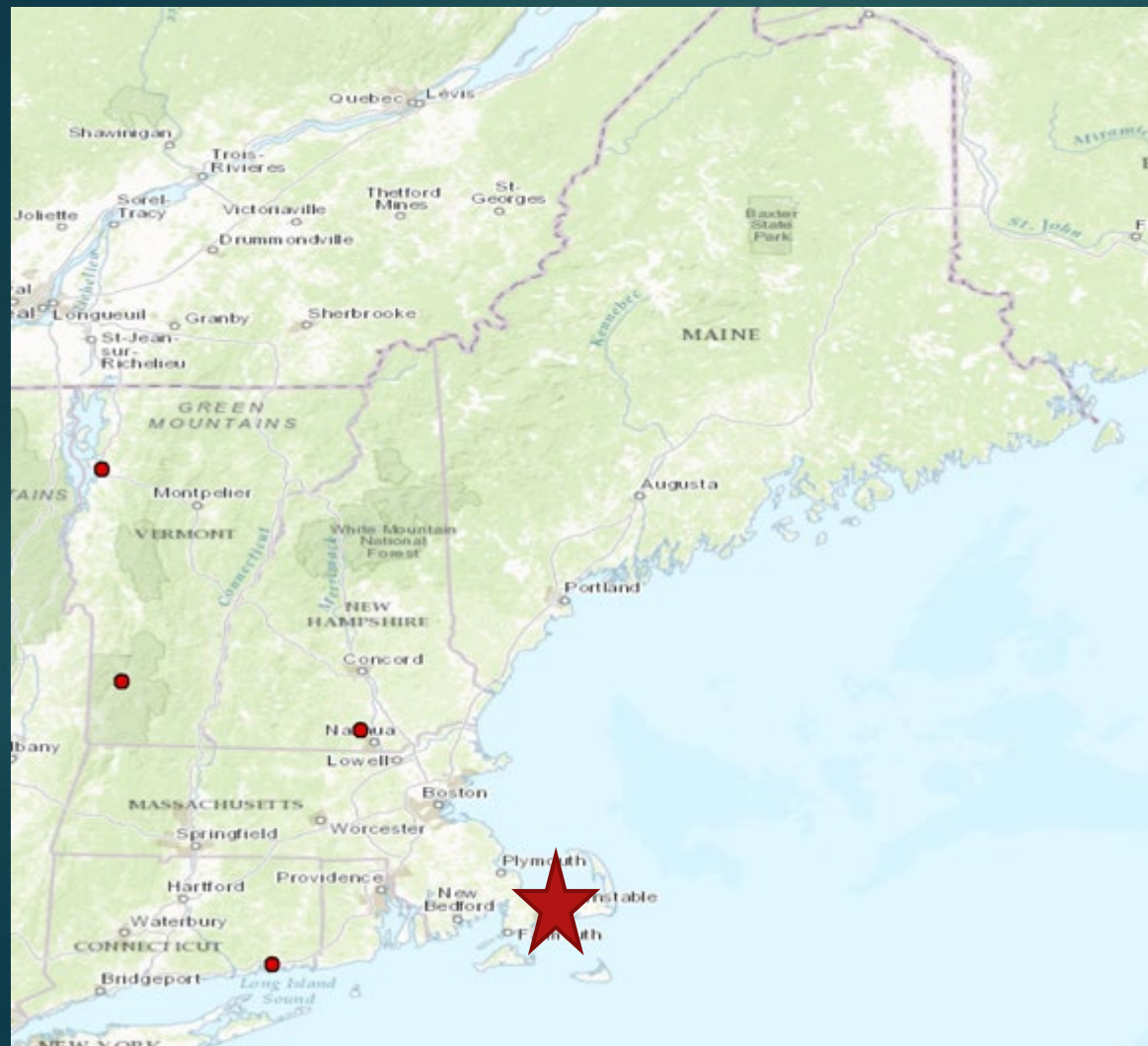


Smooth Slender Crabgrass

(*Digitaria filiformis* v. *laeviglumis*)

- ▶ Single-site endemic, Rock Rimmon, Manchester, NH. Dry peaty hollows in granite ledge.
- ▶ 30-meter temperate ridge-cliff-talus (Sperduto 2011).
- ▶ Described by Fernald 1920
- ▶ Last collected in 1931 “think humus in shallow depressions of granite ledge”
- ▶ ITU: B
- ▶ Fernald collected 31 herbarium sheets of material, all with roots (38 total collections known)





Bluntflowered Rush (*Juncus pervetetus*)

- ▶ Single-site endemic, brackish marsh, Hayannis, Massachusetts, Described by Fernald 1920
- ▶ Last collected in 1927
- ▶ ITU: B
- ▶ Occasionally included within *J. subnodulosus* (European sp.)

