

Year 2 HDR -

Dogwood notes

Null: There is no difference in phenophase onset and end between *Cornus floradensis* var Appalachian Spring and other varieties of *Cornus floridensis* in the same environmental envelope.

Factors that may cause differences:

- 1) Environment
- 2) Observer bias
- 3) Genetics

Environmental Variables (ecozones)

- GDD
- Rainfall
- Light and latitude
- First frost
- Last frost
- Canopy species/community
- Soil type/micro-rhizomal microbial community
- Slope
- Aspect

NEON "Tracked phenophases include initial growth, young leaves/needles, open flowers/pollen cones, colored leaves/needles, and falling leaves/needles."

(<https://github.com/genophenoenvo/neon-datasets>)

Phenophase types for dogwood (all in NPN)

Visualization... print one icon for clones and another for non-clones. Set color of non-clones based on deviation before or after phenophase start and stop of nearest clone(s).

Process for finding enviro-twins for Appalachian spring specimens

- 1) Same location::
operational definition: eg. less than than 1Km apart.- seems too strict
- 2) Select filter where all variance in ecozone is below threshold or maybe K-means to cluster like... force clone i the middle?

Will need to use phylogenetics because too few full genomes in Union of US-NPN and whole Genomes.

Wilczek, A M et al. "Genetic and physiological bases for phenological responses to current and predicted climates." *Philosophical transactions of the Royal Society of London. Series B, Biological sciences* vol. 365,1555 (2010): 3129-47. doi:10.1098/rstb.2010.0128

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2981944/>

Genes/pathways involved in Phenology

From the proposal " Mutant and transgenic studies have identified individual genes and epigenetic mechanisms that respond directly to specific environmental factors^{25,30,31}, but natural polymorphisms within genes (e.g., *FRIGIDA (FRI)* and *FLOWERING LOCUS C (FLC)*) can result in dramatic phenotypic differences³²⁻³⁴. It remains undetermined how layers of molecular mechanisms coordinate intricate interactions and incorporate environmental cues to regulate phenotype observed at the whole organism-level (e.g., for plants³⁵). Considering that organisms take clues from environmental conditions to express traits, evaluation across multiple contexts is critical to understanding molecular mechanisms that underlie phenotype and genome plasticity (e.g.,³⁶). Further, integrating these phenotypes and plasticity into ecosystem functions such as carbon, water, and nitrogen cycling remains a complex issue of measurement scale and model scale³⁷⁻³⁹.
"

A search of the original proposal will give a set of papers on bloom time genetics.

Leaf Senescence - Distinguish between stress induced senescence and fall

Jeongsik Kim, Jin Hee Kim, Jae Il Lyu, Hye Ryun Woo, Pyung Ok Lim, New insights into the regulation of leaf senescence in Arabidopsis, *Journal of Experimental Botany*, Volume 69, Issue 4, 6 February 2018, Pages 787–799, <https://doi.org/10.1093/jxb/erx287>

PPO inference can find structures with PO annotation.

Plant Ontologies linked to phenology - See: Phenology ontology

<http://purl.obolibrary.org/obo/ppo.owl>

Stucky, Brian J., Rob Guralnick, John Deck, Ellen G. Denny, Kjell Bolmgren, and Ramona Walls. "The Plant Phenology Ontology: A New Informatics Resource for Large-Scale Integration of Plant Phenology Data." *Frontiers in Plant Science* 9 (2018): 517. <https://doi.org/10.3389/fpls.2018.00517>.

Processing tools can use the ELK reasoner against the source to make a knowledge graph.

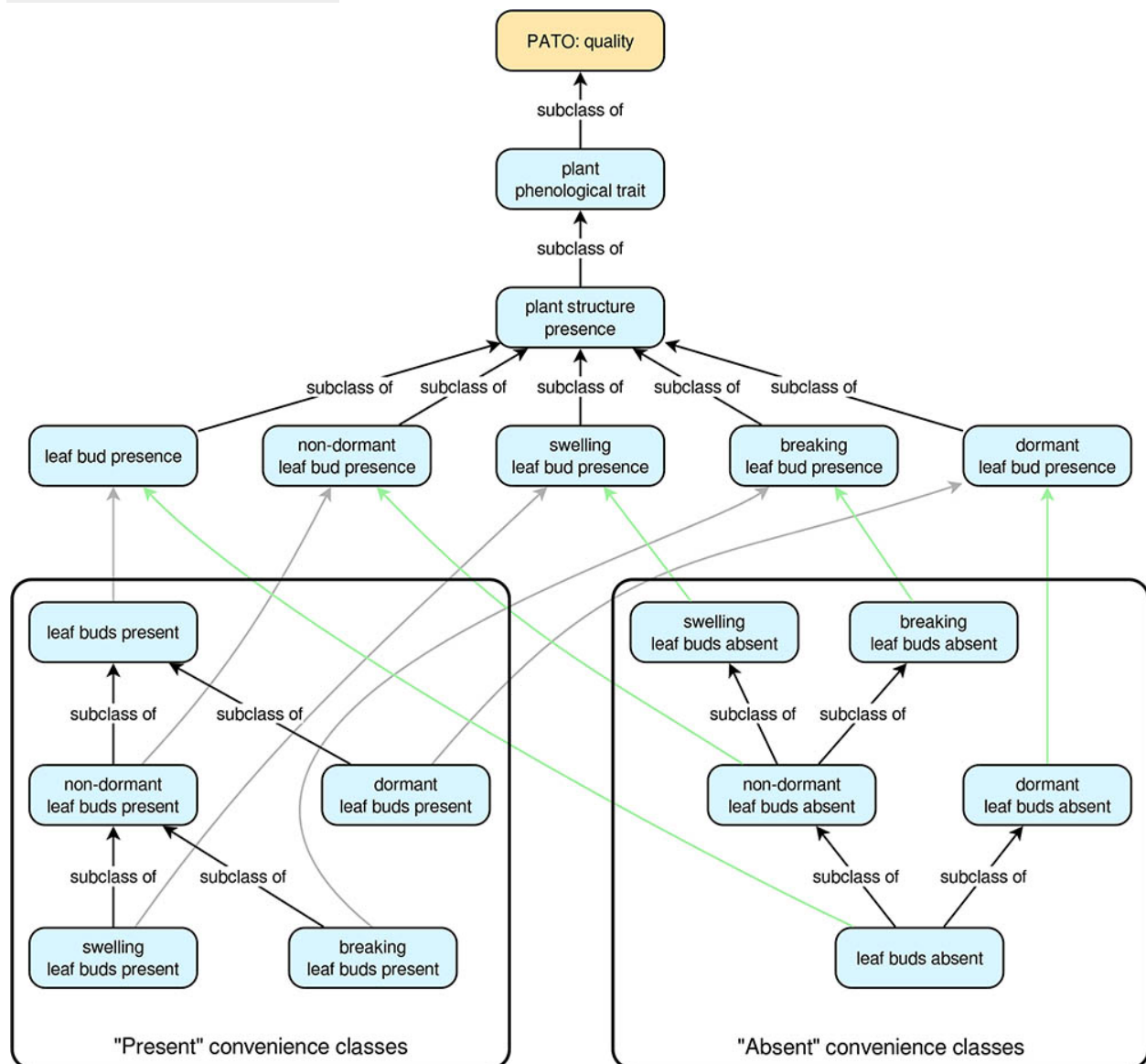
253 new classes, four new data properties, and seven new object properties.

PPO is a set of subclasses of PO entries where possible.

Graph of PPO

https://www.frontiersin.org/files/Articles/346008/fpls-09-00517-HTML/image_m/fpls-09-00517-g001.jpg

FIGURE 1. The trait class hierarchies for all Plant Phenology Ontology (PPO) trait classes pertaining to leaf buds. All arrows indicate subclass relationships, with gray arrows indicating subclass relationships between “present” classes and higher-level “presence” classes, and green arrows indicating subclass relationships between “absent” classes and higher-level “presence” classes. The “subclass of” labels for the gray and green arrows have been omitted to simplify the diagram. Note that subclass relationships for the “present” convenience classes are inverted for the “absent” convenience classes.



Plants with full annotation :

https://en.wikipedia.org/wiki/List_of_sequenced_plant_genomes

NPN species with genomic sequences

NPN Species Spreadsheet file

https://drive.google.com/open?id=1PLBE-p_HTgQaOJaD4P1oqxDAHkGnYCEs

NPN-Number Genus-Species-Common Name

147 Aquilegia canadensis red columbine

https://en.wikipedia.org/wiki/Aquilegia_coerulea

"*Aquilegia caerulea*". *Phytozome* v9.1. Archived from the original on 2015-02-20.

Retrieved 2013-07-10.

199 Asclepias syriaca common milkweed

Weitemier K, Straub SC, Fishbein M, Bailey CD, Cronn RC, Liston A (2019-09-20). "A draft genome and transcriptome of common milkweed (*Asclepias syriaca*) as resources for evolutionary, ecological, and molecular studies in milkweeds and Apocynaceae".

PeerJ. **7**: e7649. doi:10.7717/peerj.7649. ISSN 2167-8359. PMC 6756140. PMID 31579586.

807 Barbarea vulgaris garden yellowrocket

Byrne SL, Erthmann PØ, Agerbirk N, Bak S, Hauser TP, Nagy I, Paina C, Asp T (January 2017). "The genome sequence of *Barbarea vulgaris* facilitates the study of ecological biochemistry". *Scientific Reports*. **7**: 40728. Bibcode:2017NatSR...740728B. doi:10.1038/srep40728. PMC 5240624. PMID 28094805.

430 Betula nana dwarf birch

Wang N, Thomson M, Bodles WJ, Crawford RM, Hunt HV, Featherstone AW, Pellicer J, Buggs RJ (June 2013). "Genome sequence of dwarf birch (*Betula nana*) and cross-species RAD markers". *Molecular Ecology*. **22**(11): 3098–111.

doi:10.1111/mec.12131. PMID 23167599.

152 Brassica rapa field mustard

Wang X, Wang H, Wang J, Sun R, Wu J, Liu S, et al. (August 2011). "The genome of the mesopolyploid crop species *Brassica rapa*". *Nature Genetics*. **43** (10): 1035–9. doi:10.1038/ng.919. PMID 21873998.

1725 *Capsicum annuum* cayenne pepper

Kim S, Park M, Yeom SI, Kim YM, Lee JM, Lee HA, et al. (March 2014). "Genome sequence of the hot pepper provides insights into the evolution of pungency in *Capsicum* species". *Nature Genetics*. **46** (3): 270–8. doi:10.1038/ng.2877. PMID 24441736.

Qin C, Yu C, Shen Y, Fang X, Chen L, Min J, et al. (April 2014). "Whole-genome sequencing of cultivated and wild peppers provides insights into *Capsicum* domestication and specialization". *Proceedings of the National Academy of Sciences of the United States of America*. **111** (14): 5135–40. Bibcode:2014PNAS..111.5135Q.

210 *Carnegiea gigantea* saguaro

Copetti D, Búrquez A, Bustamante E, Charboneau JLM, Childs KL, Eguiarte LE, et al. (November 2017). "Extensive gene tree discordance and hemiplasy shaped the genomes of North American columnar cacti". *Proc Natl Acad Sci U S A*. **114** (45): 12003–12008. doi:10.1073/pnas.1706367114. PMC 5692538. PMID 29078296.

824 *Carya illinoensis* pecan

Huang Y, Xiao L, Zhang Z, Zhang R, Wang Z, Huang C, et al. (May 2019). "The genomes of pecan and Chinese hickory provide insights into *Carya* evolution and nut nutrition". *GigaScience*. **8** (5). doi:10.1093/gigascience/giz036. PMC 6497033. PMID 31049561.

??218 *Citrus* spp. Citrus

Citrus clementina". Phytozome v9.1. Archived from the original on 2015-02-19. Retrieved 2013-07-10.

Xu Q, Chen LL, Ruan X, Chen D, Zhu A, Chen C, et al. (January 2013). "The draft genome of sweet orange (*Citrus sinensis*)". *Nature Genetics*. **45** (1): 59–66. doi:10.1038/ng.2472. PMID 23179022.

1732 *Diospyros lotus* date plum

303 *Diospyros virginiana* common persimmon

Only same genus:

Zhu QG, Xu Y, Yang Y, Guan CF, Zhang QY, Huang JW, et al. (2019-12-18). "*Diospyros oleifera* Cheng) genome provides new insights into the inheritance of astringency and

ancestral evolution". *Horticulture Research*. 6 (1): 138. doi:10.1038/s41438-019-0227-2. PMC 6917749. PMID 31871686.

Suo Y, Sun P, Cheng H, Han W, Diao S, Li H, et al. (January 2020). "A high-quality chromosomal genome assembly of *Diospyros oleifera* Cheng". *GigaScience*. 9 (1). doi:10.1093/gigascience/giz164. PMC 6964648. PMID 31944244.

1738 *Fragaria vesca* woodland strawberry

Shulaev V, Sargent DJ, Crowhurst RN, Mockler TC, Folkerts O, Delcher AL, et al. (February 2011). "The genome of woodland strawberry (*Fragaria vesca*)". *Nature Genetics*. 43 (2): 109–16. doi:10.1038/ng.740. PMC 3326587. PMID 21186353.

884 *Ginkgo biloba* maidenhair tree

Guan R, Zhao Y, Zhang H, Fan G, Liu X, Zhou W, et al. (November 2016). "Draft genome of the living fossil *Ginkgo biloba*". *GigaScience*. 5 (1): 49. doi:10.1186/s13742-016-0154-1. PMC 5118899. PMID 27871309.

164 *Glycine max* soybean

Schmutz J, Cannon SB, Schlueter J, Ma J, Mitros T, Nelson W, et al. (January 2010). "Genome sequence of the palaeopolyploid soybean". *Nature*. 463 (7278): 178–83. Bibcode:2010Natur.463..178S. doi:10.1038/nature08670. PMID 20075913.

212 *Gossypium barbadense* creole cotton

213 *Gossypium hirsutum* upland cotton

Genus only, One of the putative progenitor species of tetraploid cotton

["*Gossypium raimondii* v2.1"](#). *Phytozome* v9.1. Archived from [the original](#) on 2015-02-18. Retrieved 2013-07-10.

203 *Helianthus annuus* common sunflower

Badouin H, Gouzy J, Grassa CJ, Murat F, Staton SE, Cottret L, et al. (2017). "The sunflower genome provides insights into oil metabolism, flowering and Asterid evolution". *Nature*. 546 (7656): 148–152. Bibcode:2017Natur.546..148B. doi:10.1038/nature22380. PMID 28538728.

80 *Juglans nigra* black walnut

Zhang J, Zhang W, Ji F, Qiu J, Song X, Bu D, et al. (January 2020). "A high-quality walnut genome assembly reveals extensive gene expression divergences after whole-genome duplication". *Plant Biotechnology Journal*. n/a (n/a). doi:10.1111/pbi.13350. PMID 32004401.

83 *Malus pumila* paradise apple

1472 *Malus sieboldii* toringo crab

1208 *Malus* spp. apple

Velasco R, Zharkikh A, Affourtit J, Dhingra A, Cestaro A, Kalyanaraman A, et al. (October 2010). "The genome of the domesticated apple (*Malus × domestica* Borkh.)". *Nature Genetics*. 42 (10): 833–9. doi:10.1038/ng.654. PMID 20802477.

174 *Medicago* sativa alfalfa

Genus only

Young ND, Debellé F, Oldroyd GE, Geurts R, Cannon SB, Udvardi MK, et al. (November 2011). "The *Medicago* genome provides insight into the evolution of rhizobial symbioses". *Nature*. 480 (7378): 520–4. Bibcode:2011Natur.480..520Y. doi:10.1038/nature10625. PMC 3272368. PMID 22089132.

439 *Mimulus* guttatus seep monkeyflower

"*Mimulus guttatus*". *Phytozome* v9.1. Archived from the original on 16 February 2015.

137 *Panicum* virgatum switchgrass

"*Panicum virgatum*". *Phytozome* v9.1. Archived from the original on 2015-02-19. Retrieved 2013-07-10.

47 *Picea glauca* white spruce

Nystedt B, Street NR, Wetterbom A, Zuccolo A, Lin YC, Scofield DG, et al. (May 2013). "The Norway spruce genome sequence and conifer genome evolution". *Nature*. 497 (7451): 579–84. Bibcode:2013Natur.497..579N. doi:10.1038/nature12211. PMID 23698360.

54 *Pinus taeda* loblolly pine

Neale DB, Wegrzyn JL, Stevens KA, Zimin AV, Puiu D, Crepeau MW, et al. (March 2014). "Decoding the massive genome of loblolly pine using haploid DNA and novel assembly strategies". *Genome Biology*. 15 (3): R59. doi:10.1186/gb-2014-15-3-r59. PMC 4053751. PMID 24647006.

Zimin A, Stevens KA, Crepeau MW, Holtz-Morris A, Koriabine M, Marçais G, Puiu D, Roberts M, Wegrzyn JL, de Jong PJ, Neale DB, Salzberg SL, Yorke JA, Langley CH (March 2014). "Sequencing and assembly of the 22-gb loblolly pine genome". *Genetics*. 196 (3): 875–90. doi:10.1534/genetics.113.159715. PMC 3948813. PMID 24653210.

Wegrzyn JL, Liechty JD, Stevens KA, Wu LS, Loopstra CA, Vasquez-Gross HA, et al. (March 2014). "Unique features of the loblolly pine (*Pinus taeda* L.) megagenome

revealed through sequence annotation". *Genetics*. 196 (3): 891–909.
doi:10.1534/genetics.113.159996. PMC 3948814. PMID 24653211

1481 Populus trichocarpa black cottonwood

Tuskan GA, Difazio S, Jansson S, Bohlmann J, Grigoriev I, Hellsten U, et al. (September 2006). "The genome of black cottonwood, *Populus trichocarpa* (Torr. & Gray)". *Science*. 313 (5793): 1596–604. Bibcode:2006Sci...313.1596T.
doi:10.1126/science.1128691. PMID 16973872.

88 Prunus persica peach

Verde I, Abbott AG, Scalabrin S, Jung S, Shu S, Marroni F, et al. (May 2013). "The high-quality draft genome of peach (*Prunus persica*) identifies unique patterns of genetic diversity, domestication and genome evolution". *Nature Genetics*. 45 (5): 487–94. doi:10.1038/ng.2586. hdl:2434/218547. PMID 23525075.

1364 Pyrus communis common pear

arative Plant Genomics. 11 June 2013.

769 Simmondsia chinensis jojoba

Sturtevant D, Lu S, Zhou ZW, Shen Y, Wang S, Song JM, et al. (March 2020). "*Simmondsia chinensis*): A taxonomically isolated species that directs wax ester accumulation in its seeds". *Science Advances*. 6 (11): eaay3240.
doi:10.1126/sciadv.aay3240. PMC 7065883. PMID 32195345.

1767 Solanum lycopersicum garden tomato

"Details for species *Solanum lycopersicum*". Sol Genomics Network.
Tomato Genome Consortium (May 2012). "The tomato genome sequence provides insights into fleshy fruit evolution". *Nature*. 485 (7400): 635–41.
Bibcode:2012Natur.485..635T. doi:10.1038/nature11119. PMC 3378239. PMID 22660326.

1769 Solanum tuberosum Irish potato

Xu X, Pan S, Cheng S, Zhang B, Mu D, Ni P, et al. (July 2011). "Genome sequence and analysis of the tuber crop potato". *Nature*. 475 (7355): 189–95.
doi:10.1038/nature10158. PMID 21743474.

Hardigan MA, Crisovan E, Hamilton JP, Kim J, Laimbeer P, Leisner CP, et al. (February 2016). "Genome Reduction Uncovers a Large Dispensable Genome and Adaptive Role for Copy Number Variation in Asexually Propagated *Solanum tuberosum*". *The Plant Cell*. 28 (2): 388–405. doi:10.1105/tpc.15.00538. PMC 4790865. PMID 26772996.

1502 Triticum aestivum common wheat

142 Triticum spp. wheat

Appels R, et al. (International Wheat Genome Sequencing Consortium (IWGSC)) (August 2018). "Shifting the limits in wheat research and breeding using a fully annotated reference genome". Science. 361 (6403): 705.

Bibcode:2012Natur.491..705B. doi:10.1126/science.aar7191. hdl:10261/169166. PMID 30115783.

96 Vitis vinifera wine grape

Jaillon O, Aury JM, Noel B, Policriti A, Clepet C, Casagrande A, et al. (September 2007). "The grapevine genome sequence suggests ancestral hexaploidization in major angiosperm phyla". Nature. 449 (7161): 463–7. Bibcode:2007Natur.449..463J.

doi:10.1038/nature06148. PMID 17721507

1511 Zea mays corn

Schnable PS, Ware D, Fulton RS, Stein JC, Wei F, Pasternak S, et al. (November 2009). "The B73 maize genome: complexity, diversity, and dynamics". Science. 326 (5956): 1112–5. Bibcode:2009Sci...326.1112S. doi:10.1126/science.1178534. PMID 19965430.

NPN Guides.

https://en.wikipedia.org/wiki/Aquilegia_coerulea

NCBI NCBI Reference Sequence: NC_032053.1Agave americana chloroplast, complete genome

COMM ON NAME	GENU S	SPEC IES	DESCRIPTION	FILENAME
red maple	Acer	rubru m	Scarsdale Public Schools CHOICE Program: Acer	https://www.usanpn.org/files/nnp/hotoguides/Acer-rubrum_PhotoGuide-ScarsdalePS.pdf

			rubrum	
common lilac	Syringa	vulgaris	USA-NPN : Syringa vulgaris	https://www.usanpn.org/files/nn/photoguides/Syringa-vulgaris_PhotoGuide-NCO.pdf
Ashe's juniper	Juniperus	ashei	USA-NPN Pollen Trackers Campaign: Juniperus ashei	https://www.usanpn.org/files/nn/photoguides/Juniperus-ashei_PhotoGuide-NCO.pdf
creosote bush	Larrea	tridentata	USA-NPN Tucson Phenology Trail: Larrea tridentata	https://www.usanpn.org/files/nn/photoguides/Larrea-tridentata_PhotoGuide-NCO.pdf
Japanese knotweed	Fallopia	japonica	USA-NPN Pesky Plant Trackers Campaign: Fallopia japonica	https://www.usanpn.org/files/nn/photoguides/Fallopia-japonica_PhotoGuide-NCO.pdf
scarlet globemallow	Sphaeralcea	coccinea	USA-NPN Tucson Phenology Trail: Sphaeralcea coccinea	https://www.usanpn.org/files/nn/photoguides/Sphaeralcea-coccinea_PhotoGuide-NCO.pdf
saguaro	Carnegiea	gigantea	USA-NPN Flowers for Bats Campaign: Carnegiea gigantea	https://www.usanpn.org/files/nn/photoguides/Carnegiea-gigantea_Photo_Guide-NCO.pdf
saguaro	Carnegiea	gigantea	The Desert Lab at Tumamoc Hill: Carnegiea gigantea	https://www.usanpn.org/files/nn/photoguides/Carnegiea-gigantea_PhotoGuide-Tumamoc.pdf
easter tent caterpillar	Malacosoma	americanum	USA-NPN Pest Patrol Campaign: Malacosoma americanum	https://www.usanpn.org/files/nn/photoguides/Malacosoma-americanum_PhotoGuide-NCO.pdf
bald cypresses	Taxodium	distichum	Lewis Ginter Botanical Garden: Taxodium distichum	https://www.usanpn.org/files/nn/photoguides/Taxodium-distichum_PhotoGuide-LGBG.pdf

velvet mesquite	Prosopis	velutina	USA-NPN Tucson Phenology Trail: Prosopis velutina	https://www.usanpn.org/files/nn/photoguides/Prosopis-velutina_PhotoGuide-NCO.pdf
jojoba	Simmondsia	chinensis	USA-NPN Tucson Phenology Trail: Simmondsia chinensis	https://www.usanpn.org/files/nn/photoguides/Simmondsia-chinensis_PhotoGuide-NCO.pdf
Tatarian honeysuckle	Lonicera	tatarica	USA-NPN Shady Invaders Campaign: Lonicera tatarica	https://www.usanpn.org/files/nn/photoguides/Lonicera-tatarica_PhotoGuide-NCO.pdf
vine maple	Acer	circinatum	Oregon Season Tracker: Acer circinatum	https://www.usanpn.org/files/nn/photoguides/Acer-circinatum_PhotoGuide-OST.pdf
desert willow	Chilopsis	linearis	USA-NPN Tucson Phenology Trail: Chilopsis linearis	https://www.usanpn.org/files/nn/photoguides/Chilopsis-linearis_PhotoGuide-NCO.pdf
California brittlebush	Encelia	californica	University of Southern California: Encelia californica	https://www.usanpn.org/files/nn/photoguides/Encelia-californica_PhotoGuide-USCSeaGrant.pdf
Texas barometer bush	Leucophyllum	frutescens	USA-NPN Tucson Phenology Trail: Leucophyllum frutescens	https://www.usanpn.org/files/nn/photoguides/Leucophyllum-frutescens_PhotoGuide-NCO.pdf
northern spicebush	Lindera	benzoin	USA-NPN Shady Invaders Campaign: Lindera benzoin	https://www.usanpn.org/files/nn/photoguides/Lindera-benzoin_PhotoGuide-NCO.pdf
Santa Rita prickly pear	Opuntia	santa-rita	USA-NPN: Opuntia santa-rita	https://www.usanpn.org/files/nn/photoguides/Opuntia-santa-rita_PhotoGuide-NCO.pdf

apple	Malus	spp.	MSU Apple Bloom and Ripening Phenology Project: Malus spp.	https://www.usanpn.org/files/nn/p hotoguides/Malus-spp_PhotoGuide-MSU.pdf
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southern arrowwood	Viburnum	dentatum	USA-NPN Shady Invaders Campaign: Viburnum dentatum	https://www.usanpn.org/files/nn/p hotoguides/Viburnum-dentatum_PhotoGuide-NCO.pdf
pine needle scale	Chionaspis	pinifoliae	USA-NPN Pest Patrol Campaign: Chionaspis pinifoliae	https://www.usanpn.org/files/nn/p hotoguides/Chionaspis-pinifoliae_PhotoGuide-NCO.pdf
lilac borer	Podosesia	syringae	USA-NPN Pest Patrol Campaign: Podosesia syringae	https://www.usanpn.org/files/nn/p hotoguides/Podosesia-syringae_PhotoGuide-NCO.pdf
Amur honeysuckle	Lonicera	maackii	USA-NPN Shady Invaders Campaign: Lonicera maackii	https://www.usanpn.org/files/nn/p hotoguides/Lonicera-maackii_PhotoGuide-NCO.pdf
multiflora rose	Rosa	multiflora	USA-NPN Shady Invaders Campaign: Rosa multiflora	https://www.usanpn.org/files/nn/p hotoguides/Rosa-multiflora_PhotoGuide-NCO.pdf
Parry's agave	Agave	parryi	USA-NPN Flowers for Bats Campaign: Agave parryi	https://www.usanpn.org/files/nn/p hotoguides/Agave-parryi_PhotoGuide-NCO.pdf
Japanese barberry	Berberis	thunbergii	USA-NPN Shady Invaders Campaign: Berberis thunbergii	https://www.usanpn.org/files/nn/p hotoguides/Berberis-thunbergii_PhotoGuide-NCO.pdf
burning bush	Euonymus	alatus	USA-NPN Shady Invaders Campaign: Euonymus alatus	https://www.usanpn.org/files/nn/p hotoguides/Euonymus-alatus_PhotoGuide-NCO.pdf
privet	Ligustrum	spp.	USA-NPN Shady Invaders Campaign:	https://www.usanpn.org/files/nn/p hotoguides/Ligustrum-spp_Photo

			Ligustrum spp.	Guide-NCO.pdf
Morrow's honeysuckle	Lonicera	morrowii	USA-NPN Shady Invaders Campaign: Lonicera morrowii	https://www.usanpn.org/files/nn/p hotoguides/Lonicera-morrowii_PhotoGuide-NCO.pdf
mapleleaf viburnum	Viburnum	acerifolium	USA-NPN Shady Invaders Campaign: Viburnum acerifolium	https://www.usanpn.org/files/nn/p hotoguides/Viburnum-acerifolium_PhotoGuide-NCO.pdf
blackhaw	Viburnum	prunifolium	USA-NPN Shady Invaders Campaign: Viburnum prunifolium	https://www.usanpn.org/files/nn/p hotoguides/Viburnum-prunifolium_PhotoGuide-NCO.pdf
desert agave	Agave	deserti	USA-NPN Flowers for Bats Campaign: Agave deserti	https://www.usanpn.org/files/nn/p hotoguides/Agave-deserti_PhotoGuide-NCO.pdf
Palmer's century plant	Agave	palmeri	USA-NPN Flowers for Bats Campaign: Agave palmeri	https://www.usanpn.org/files/nn/p hotoguides/Agave-palmeri_PhotoGuide-NCO.pdf
hemlock woolly adelgid	Adelges	tsugae	New York State Hemlock Initiative: Adelges tsugae	https://www.usanpn.org/files/nn/p hotoguides/Adelges-tsugae_PhotoGuide-NYSHI.pdf
American century plant	Agave	americana	USA-NPN Flowers for Bats Campaign: Agave americana	https://www.usanpn.org/files/nn/p hotoguides/Agave-americana_PhotoGuide-NCO.pdf
Mexican giant cactus	Pachycereus	pringlei	USA-NPN Flowers for Bats Campaign: Pachycereus pringlei	https://www.usanpn.org/files/nn/p hotoguides/Pachycereus-pringlei_PhotoGuide-NCO.pdf
organpipe cactus	Stenocereus	thurberi	USA-NPN Flowers for Bats Campaign: Stenocereus thurberi	https://www.usanpn.org/files/nn/p hotoguides/Stenocereus-thurberi_PhotoGuide-NCO.pdf

bronze birch borer	Agrilus	anxius	USA-NPN Pest Patrol Campaign: Agrilus anxius	https://www.usanpn.org/files/nn/p-hotoguides/Agrilus-anxius_PhotoGuide-NCO.pdf
emerald ash borer	Agrilus	planipennis	USA-NPN Pest Patrol Campaign: Agrilus planipennis	https://www.usanpn.org/files/nn/p-hotoguides/Agrilus-planipennis_PhotoGuide-NCO.pdf

Asian longhorned beetle	Anoplophora	glabripennis	USA-NPN Pest Patrol Campaign: Anoplophora glabripennis	https://www.usanpn.org/files/nn/p-hotoguides/Anoplophora-glabripennis_PhotoGuide-NCO.pdf
gypsy moth	Lymantria	dispar	USA-NPN Pest Patrol Campaign: Lymantria dispar	https://www.usanpn.org/files/nn/p-hotoguides/Lymantria-dispar_PhotoGuide-NCO.pdf
winter moth	Operophtera	brumata	USA-NPN Pest Patrol Campaign: Operophtera brumata	https://www.usanpn.org/files/nn/p-hotoguides/Operophtera-brumata_PhotoGuide-NCO.pdf
evergreen bagworm moth	Thyridopteryx	ephemeraeformis	USA-NPN Pest Patrol Campaign: Thyridopteryx ephemeraeformis	https://www.usanpn.org/files/nn/p-hotoguides/Thyridopteryx-ephemeraeformis_PhotoGuide-NCO.pdf
apple maggot	Rhagoletis	pomonella	USA-NPN Pest Patrol Campaign: Rhagoletis pomonella	https://www.usanpn.org/files/nn/p-hotoguides/Rhagoletis-pomonella_PhotoGuide-NCO.pdf
spotted lanternfly	Lycorma	delicatula	USA-NPN Pest Patrol Campaign: Lycorma delicatula	https://www.usanpn.org/files/nn/p-hotoguides/Lycorma-delicatula_PhotoGuide-NCO.pdf
magnolia scale	Neolecanium	cornuparvum	USA-NPN Pest Patrol Campaign: Neolecanium cornuparvum	https://www.usanpn.org/files/nn/p-hotoguides/Neolecanium-cornuparvum_PhotoGuide-NCO.pdf

wild parsnip	Pastin aca	sativa	USA-NPN Pesky Plant Trackers Campaign: Pastinaca sativa	https://www.usanpn.org/files/nn/photoGuides/Pastinaca-sativa_PhotoGuide-NCO.pdf
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