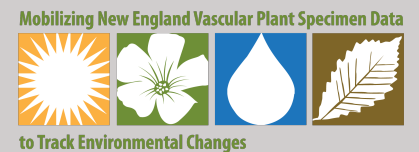


Documenting reproductive phenology using herbarium specimens: experiences from the New England Vascular Plants project

Patrick W. Sweeney
Yale University Herbarium
Peabody Museum of Natural History



Yale PEABODY MUSEUM
OF NATURAL HISTORY



PARTNERS



Consortium of Northeastern Herbaria



PARTNERS

- Brown University (BRU)
- Harvard University (HUH)
- U. of New Hampshire (NHA)
- U. of Massachusetts Amherst (MASS)
- U. of Vermont (VT)
- Yale University (YU)

- Bartlett Arboretum (BART)
- Berkshire Museum (BERK)
- Boston University (BSN)
- Central Connecticut State U. (CCSU)
- Connecticut College (CCNL)

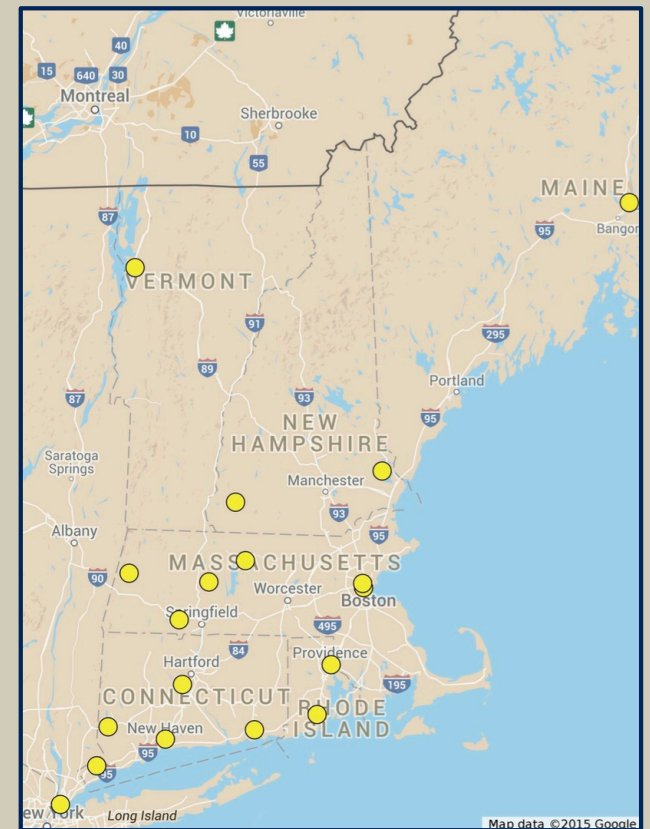
- Harvard Forest (HF)
- Keene State (KESC)
- U. of Rhode Island (KIRI)
- Western Connecticut State U. (WCSU)
- Westfield State U. (WSCH)

PENs:

- U. of Maine (MAINE)
- New York Botanical Garden (NYBG)

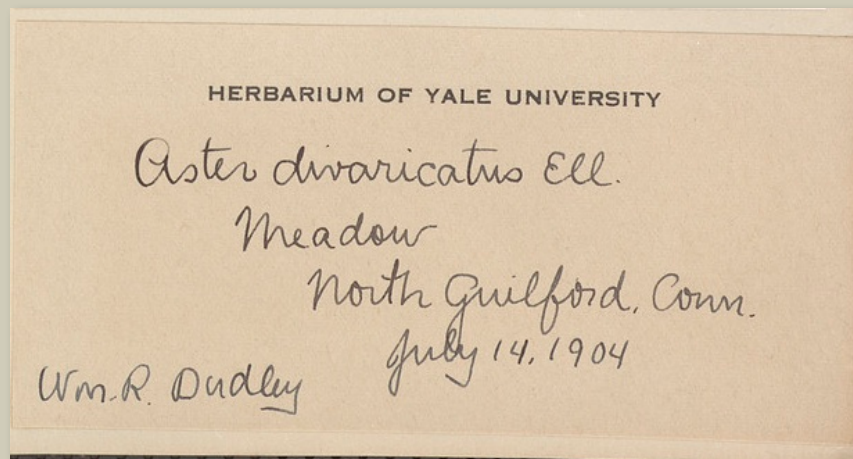
OVERALL OBJECTIVES

- Digitize over one million New England vascular plant specimens from 18 regional herbaria
- Georeference
- Score phenology

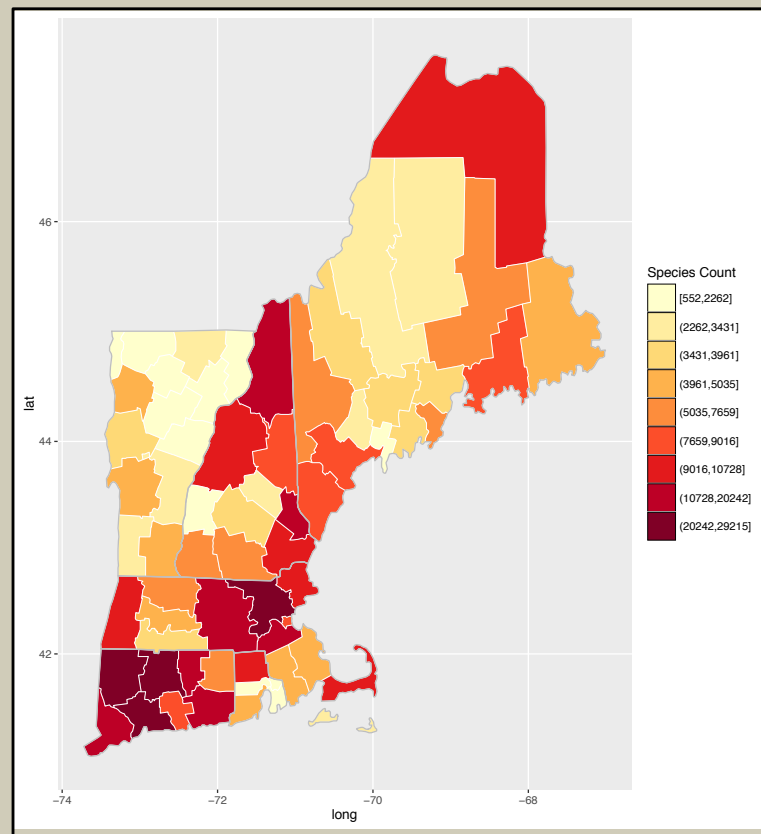


DIGITIZATION

- Capture an image and a subset of label data



DIGITIZATION: RESULTS



DISSEMINATION: PORTAL



symbiota.org

portal.neherbaria.org



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Portal Menu

- [Text-based Search](#)
- [Map-guided Search](#)
- [Collections](#)
- [Species Lists](#)
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- [Crowdsourcing](#)

- [Log In](#)
- [New Account](#)

Herbarium Specimen Data Sharing Portal for CNH

Number of records in database: 1,310,490

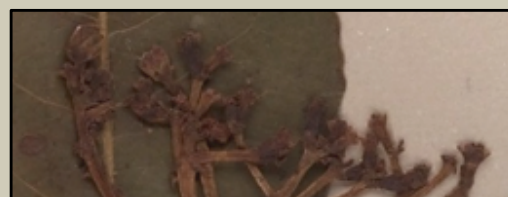
About:

The CNH portal provides access to herbarium specimen data housed in member institutions, with particular emphasis on specimens collected in the region. The database includes taxa traditionally found in herbaria, including plants, fungi, diatoms, algae, and lichens.

Use of any specimen data and related material (e.g., images, species checklists, etc.) accessed through this portal requires agreement to the terms and conditions in the [CNH data usage policy](#).

If your institution is interested in sharing data and is willing to abide by the terms of our [data sharing](#) and [data usage](#) policies, email [Patrick Sweeney](#) for further instructions about how to make this happen.

PHENOLOGY



PHENOLOGY

- Involves humans scoring reproductive phenology (flowering & fruiting state) from images of specimens.



PHENOLOGY: TARGET TAXA

Prioritized list of target taxa

Acer pensylvanicum

Acer rubrum

Acer saccharum

Acer spicatum

Sagittaria latifolia

Ilex mucronata

Ilex verticillata

Asarum canadense

Betula lenta

Betula papyrifera

Betula populifolia

Cakile edentula

Cardamine concatenata

Cardamine diphylla

Lobelia cardinalis

Lobelia inflata

Diervilla lonicera

Lonicera canadensis

Viburnum lentago

Viburnum nudum var. cassinoides

Clethra alnifolia

...

PHENOLOGY: CONTROLLED VOCABULARY

- 1) Developed with input from users of data
- 2) Simplicity
- 3) Broad applicability
- 4) Subcategories within major stages put finer point on scorings, make it possible to spot subtler trends and measure flowering and fruiting periods.
- 5) A key point is that people using this system will need some level of training before they can start scoring specimens.

PHENOLOGY: CONTROLLED VOCABULARY



CAL POLY
SAN LUIS OBISPO

Jenn Yost

Coding Phenological Data from Herbarium Sheets

Add this event to your calendar:



This invited 2-day workshop will address standards and practices for research-driven phenological character extraction from imaged herbarium specimens.

The workshop will focus on data standards for finding consistent ways to code phenological data from herbarium sheets to make digitized data from museums more useful in large scale research endeavors.

Please visit the [workshop wiki page](#) for the latest updates.

Start Date:

Saturday, March 12, 2016 (All day) to Sunday, March 13, 2016 (All day)

Location:

The University of California, Berkeley and Jepson Herbaria

City:

Berkeley

State:

California

[printer-friendly version](#)

https://www.idigbio.org/wiki/index.php/Coding_Phenological_Data_from_Herbarium_Sheets

PHENOLOGY: CONTROLLED VOCABULARY

NEVP Phenology Term/Concept	URI
reproductive condition	http://purl.org/nevp/vocabulary/reproductive-phenology#01
sterile	http://purl.org/nevp/vocabulary/reproductive-phenology#02
reproductive	http://purl.org/nevp/vocabulary/reproductive-phenology#03
budding	http://purl.org/nevp/vocabulary/reproductive-phenology#04
number buds present	http://purl.org/nevp/vocabulary/reproductive-phenology#05
flowering	http://purl.org/nevp/vocabulary/reproductive-phenology#06
number flowers present	http://purl.org/nevp/vocabulary/reproductive-phenology-07
mostly buds	http://purl.org/nevp/vocabulary/reproductive-phenology#08
mostly open	http://purl.org/nevp/vocabulary/reproductive-phenology#09
mostly old	http://purl.org/nevp/vocabulary/reproductive-phenology#10
fruiting	http://purl.org/nevp/vocabulary/reproductive-phenology#11
number fruits present	http://purl.org/nevp/vocabulary/reproductive-phenology#12
mostly young	http://purl.org/nevp/vocabulary/reproductive-phenology#13
mostly mature	http://purl.org/nevp/vocabulary/reproductive-phenology#14
past maturity	http://purl.org/nevp/vocabulary/reproductive-phenology#15
not scorable	http://purl.org/nevp/vocabulary/reproductive-phenology#16

<http://purl.org/nevp/vocabulary/reproductive-phenology>
 SKOS (Simple Knowledge Organization System)

PHENOLOGY: WORKFLOW SYMBIOTA IMAGE SCORING TOOL



Home >> Collection Management >> Attribute Editor review

Med Res. High Res. YU.081785 SKIP >>

Filter

Taxon:

Phenology (ver 1.0)

Target Specimens: 54

Action Panel - Phenology (ver 1.0)


Reproductive


- Flowering
 - Mostly buds
 - Mostly open
 - Mostly old
- Fruiting
- Budding
- Sterile
- Not scorable

Notes:

Status:

PHENOLOGY: WORKFLOW SYMBIOTA IMAGE SCORING TOOL

 Med Res. High Res. YU.081851 SKIP >>



Filter

Taxon:

Target Specimens: 54

Action Panel - Phenology (ver 1.0)

Reproductive

Sterile

Not scorable

Notes:

Status:

PHENOLOGY: WORKFLOW SYMBIOTA IMAGE SCORING TOOL



Home >> Collection Management >> Attribute Reviewer edit

Med Res. High Res. YU.050138

A photograph of a herbarium specimen of a plant, showing a large, dark, lobed leaf and several smaller, lighter-colored flowers. A color calibration chart is visible in the top left corner of the image. The specimen is mounted on a light-colored background. There are two barcode labels at the bottom of the specimen, and some handwritten text and a printed label at the bottom right.

Reviewer

Phenology (ver 1.0) ▾

Sacco, Anthony (asacco99) ▾

All Dates ▾

Not reviewed ▾

13 of 176 records ([Next record >>](#))

Action Panel - Phenology (ver 1.0)

Reproductive

- Flowering
- Mostly buds
- Mostly open
- Mostly old
- Fruiting
- Budding
- Sterile
- Not scorable

Notes:

Status: Reviewed ▾

PHENOLOGY: WORKFLOW

- A key point is that people using this system will need some level of training before they can start scoring specimens.
 - Many people have only a limited idea of plant morphology.
 - Many plants have peculiarities, so that people may need to have some training for each species or each genus that they work on.

PHENOLOGY: WORKFLOW

■ Training

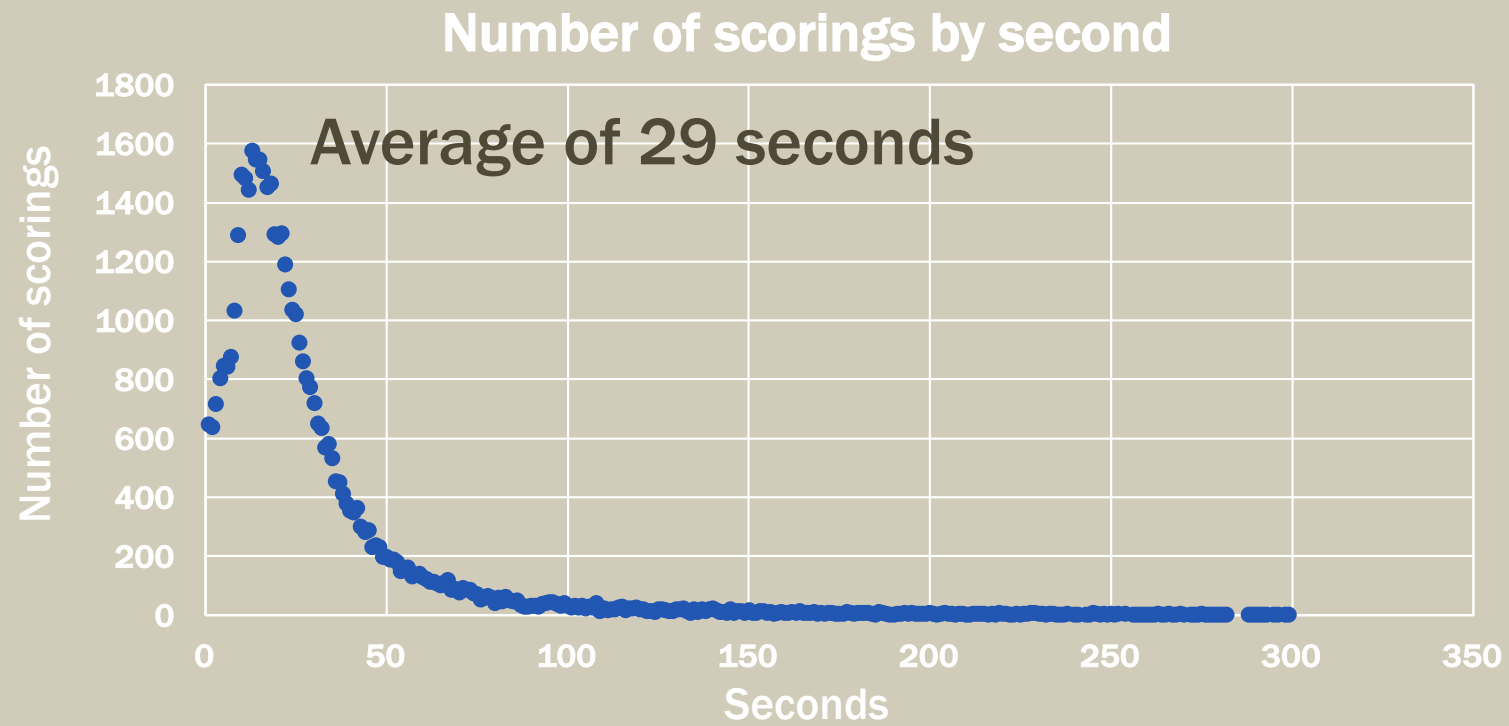
- Images of plants in nature
- Illustrations
- Physical Herbarium specimens
- Practice sessions with oversight
- Review and correction



PHENOLOGY: WORKFLOW

- What cannot be scored easily from images...
 - grasses, sedges
 - small flowers

PHENOLOGY: WORKFLOW



PHENOLOGY: LEGACY DATA

- Legacy Data
 - Custom fields
 - Darwin Core
 - dwc:reproductiveCondition
 - dwc:occurrenceRemarks
 - dwc:dynamicProperties

PHENOLOGY: LEGACY DATA

- e.g., CNH
 - reproductiveCondition populated for 235,544 records from 39 institutions
 - 443 unique strings

fl	Flowering , Fruiting
fl, fr	flowering ?
fl, fr, v	flowering and fruiting
fl, v	Flowering(?)
fl. & fr.	Flowering, Flowering
flo	Flowering, Fruiting
flowering	Flowering, Fruiting, Post-fruiting
flowering	Flowering, some flowers already pollinated and shedding petals.
Flower	flowering-immature
flower and fruit	flowering-mature
flower & fruit	flowering-old persisting
flower and fruit	Flowering.
Flower and Fruit Fertile	Flowering. Flowers open and some anthers have started to shed p
Flower and Fruit See notes	flowering/ fruiting
flower bud present	flowering/fruit
flower bud visible, closed	flowering/fruiting
flower buds	flowering/going to seed
flower buds present	Flowering: contains flowers that have 5 petals and are bright pink
Flower clear yellow, red spots inside	flowering: mostly old flowers (<1/2 open)
Flower with seeds	flowering: mostly open flowers (>1/2 open)
Flower Fertile	flowering; fruiting
Flower Fertile Fruit	flowering; w last yrs fruiting stalk
Flower Flower	Flowering?
Flower Fruit	flowers
Flower Fruit Fertile	Flowers and fruit
Flower Fruit Fruit	flowers & fruit
flower,Fruit	Flowers and capsules are both present on the specimen.
FlowerAndFruit	Flowers and Fruit
flowering/fruiting	Flowers and Fruits
flowerinf	flowers in buds but not in bloom, vegetative
flowering	flowers present in an inflorescence but not in bloom
Flowering & fruiting	flrs
flowering & fruiting	Flw
flowering & fruiting (mature fruit 8/30)	Flwoering, Fruiting
Flowering & Fruiting.	foliage dark green
Flowering & fruitng	fr
flowering & in fruit	fr, fl

PHENOLOGY: WORKFLOW SYMBIOTA ATTRIBUTE MINING TOOL

Home >> Collection Management >> Adjust Collection Selection >> **Attribute Mining Tool**

George Safford Torrey Herbarium, University of Connecticut (UConn-CONN)

Harvesting Filter

Occurrence trait: Phenology (ver 1.0)

Verbatim text source: Select Source Field (required)

Filter by text (optional): _____

Filter by taxon (optional): _____

- Habitat
- Substrate
- Occurrence Remarks (notes)
- Dynamic Properties
- Verbatim Attributes (description)
- Behavior
- Reproductive Condition
- Life Stage
- Sex

PHENOLOGY: LEGACY DATA SYMBIOTA ATTRIBUTE MINING TOOL

George Safford Torrey Herbarium, University of Connecticut (UConn-CONN)

Harvesting Filter

Occurrence trait: Phenology (ver 1.0)

Verbatim text source: Reproductive Condition

Filter by text (optional):

Filter by taxon (optional):

Reproductive Condition

Select Source Field Value(s) - hold down control or shift buttons to select more than one value

- flower buds - [712]
- flowering - [48594]
- flowering-immature - [292]
- flowering-mature - [220]
- flowering-old persisting - [121]
- flowering/fruitle - [20131]
- fruiting - [25708]
- fruiting-developing - [677]
- fruiting-old persisting - [337]
- fruiting-ripe - [172]
- juvenile - [104]
- sterile/vegetative - [11202]
- uncertain - [93]
- winter / dormant condition - [161]

Reproductive

- Flowering
- Mostly buds
- Mostly open
- Mostly old
- Fruiting
- Budding
- Sterile
- Not scorable

Notes:

Status:

At least one immature c

PHENOLOGY: WORKFLOW SYMBIOTA ATTRIBUTE MINING TOOL

George Safford Torrey Herbarium, University of Connecticut (UConn-CONN)

Harvesting Filter

Occurrence trait: Phenology (ver 1.0)

Verbatim text source: Reproductive Condition

Filter by text (optional):

Filter by taxon (optional):

Reproductive Condition

Select Source Field Value(s) - hold down control or shift buttons to select more than one value

- flower buds - [712]
- flowering - [48894]
- flowering-immature - [1922]
- flowering-mature - [2201]
- flowering-old persisting - [121]
- flowering/fruiting - [20131]
- fruiting - [25708]
- fruiting-developing - [677]
- fruiting-old persisting - [337]
- fruiting-ripe - [172]
- juvenile - [104]
- sterile/vegetative - [11202]
- uncertain - [93]
- winter / dormant condition - [161]

Reproductive

Flowering

- Mostly buds
- Mostly open
- Mostly old

Fruiting

Budding

Sterile

Not scorable

Notes:

Status:

At least one immature c

Marie-Victorin Herbarium (Université de Montréal Biodiversity Centre-MT)

Harvesting Filter

Occurrence trait: Phenology (ver 1.0)

Verbatim text source: Reproductive Condition

Filter by text (optional):

Filter by taxon (optional):

Reproductive Condition

Select Source Field Value(s) - hold down control or shift buttons to select more than one value

- envelope - [1]
- reproductive/budding - [2276]
- reproductive/flowering - [13343]
- reproductive/fruit forming - [14233]
- reproductive/fruiting - [20246]
- vegetative - [6781]

Reproductive

Flowering

- Mostly buds
- Mostly open
- Mostly old

Fruiting

Budding

Sterile


Not scorable

Notes:

Status:

PHENOLOGY: DISSEMINATION

DwC Archives with Extended Measurement Or Facts



[home](#) [eml](#) [extensions](#) [api](#) [about](#)

Darwin Core Archive Validator

Extended Measurement Or Facts

<http://rs.iobis.org/obis/terms/ExtendedMeasurementOrFact>

Support for generic measurements or facts, extended version linking to occurrences. This extension (eMoF) was developed to be used in combination with the Event Core, but is also compatible with other cores. When used with Event Core it allows to create an additional link between the eMoF and the occurrence extension. The eMoF can store measurements or facts related to a biological occurrence, environmental measurements or facts and sampling method attributes. This extension also provides the option to provide identifiers to reference a vocabulary for the measurementType, measurementValue and measurementUnit fields.

Link: <http://rs.tdwg.org/dwc/terms/index.htm#measureindex>

<https://tools.gbif.org/dwca-validator/extension.do?id=http://rs.iobis.org/obis/terms/ExtendedMeasurementOrFact>

ACKNOWLEDGEMENTS



National Science Foundation (EF1208829, EF1208835, EF1208972, EF1208973, EF1208975, EF1208989, EF1209149).



Symbiota



FilteredPush



CYVERSE™



Biota of North
America