

# Incorporating digitized natural history collections data into virtual ecology and evolution course-based research experiences

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## Extended Abstract

Biological Collections in Ecology & Evolution Network (BCEENET) is a community of undergraduate educators, natural history collections professionals, education experts, and data experts that supports the development and implementation of Course-based Undergraduate Research Experiences (CUREs) in ecology and evolution, using freely available data from digitized natural history collections (dNHCs). In the summer of 2020, BCEENET members built four highly adaptable dNHC CUREs that can be implemented in introductory and advanced courses, over 4-16 week timespans. They can also be implemented entirely online, hybrid, or in person, broadening the range of institutional types able to offer CURE experiences. The CUREs can be implemented at low or no cost as they require only internet access and computers, and they make use of open source analysis tools and open access educational materials.

In these CUREs, students will:

1. Explore open access resources (e.g., iDigBio & GBIF) for digitized natural history collections data
2. Georeference (assign latitude and longitude) specimens from natural history museums
3. Map the spatial distribution of the specimens using QGIS
4. Collect morphological data from digitized specimen images using ImageJ (optional extension)
5. Analyze data to understand species variation across geographic ranges of the specimens

## CURE Summaries

- *Exploring the effects of invasion on plant morphology*: Students explore whether morphological traits of an invasive species differ in the species' invaded range compared to its native range. Using digital herbarium specimens, students collect morphological data on invasive plant species and apply spatial analyses to compare specimen characteristics between native and invasive ranges.
- *Sexual dimorphism in melanized wing patterns of Pieridae butterflies*: Students use digital images of *Pieris rapae*, the cabbage white butterfly, to investigate variation in sexually and non-

sexually dimorphic melanized wing patterns. Students measure melanization patterns in male and female butterflies, examining variation in relation to seasonality as well as changes in geographic distribution.

- *A CURE for invasions: Mobilizing digitized natural history collections to track invasive species:* Students select a pair of invasive species that play similar ecological roles and develop hypotheses about the mechanisms that affect the ability of their two species to disperse. They test their hypotheses using dNHC data by analyzing the distribution changes over time for both species.

- *Exploring species distribution changes and their drivers using digital natural history data:* Students examine species distributions and the human impacts that may influence them. Students compare present species distributions, using resources such as iNaturalist or their own field observations, with historical distributions using dNHC data.

## Implementer Support Available

Hundreds of CURE educational materials created by BCEENET members are currently available, and we provide training and ongoing support for faculty members who are implementing CUREs. Visit our website <https://bceenetwork.org> or contact us for more information at [bceenetwork@gmail.com](mailto:bceenetwork@gmail.com).

### *Training sessions*

- Natural history collections
- Data portals & cleaning
- Georeferencing
- Mapping & spatial analysis
- Morphological analysis

### *Resources*

- Syllabi
- Teaching materials & guides
- Student handouts
- Faculty and student tutorial videos

### *Community*

- CURE support meetings
- Regular newsletter
- Networking opportunities

**Keywords:** digitized natural history collections, digital data, big data, CURE, undergraduate research

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