Instructor Notes:

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Institution/Inst. type: Ashland University, Ashland, OH / 4-year, private university

Course/course format: general education science class for non-science majors of any class rank

TIEE module: Kellen M. Calinger. April 2014, posting date. Investigating the footprint of climate change on phenology and ecological interactions in North America. *Teaching Issues and Experiments in Ecology*, vol.10: practice #1 [online]. http://tiee.esa.org/vol/v10/issues/datasets/calinger/abstract.html

Quantitative skill focus (from list in original lab, 5 of 6 possible):

Synthesis, Analysis-- generating graphs, reading and analyzing graphs, including slope of a trendline (rates), independent vs. dependent variables, arithmetic calculations (rates)

Synthesis—develop method for calculating species-specific shift in flowering time with temperature increase

Application—use method(s) to calculate flowering shift in one or more plant species

Comprehension—describe the ecological consequences of shifting plant and animal phenology; also consequences to agriculture (business and food production)

Evaluation—evaluate data “cherry picking” as a climate change skeptic tactic vs. “weight of evidence”

Learning objectives content:

* Phenology (flowering time, arrival time)
* Climate change
* Pollinator-plant ecology
* mutualism
* Trophic mismatch

Pedagogical techniques:

* Scaffolding
* Guided inquiry
* Open-ended inquiry
* Critical thinking
* Lecture (basics and how-to)
* Video to introduce phenology
* Group and individual work = cooperative learning

Adaptations of TIEE materials and scaffolding:

* Prefaced official lab with a library research lab that included
	+ a guided search of science literature (I assigned search terms and introduced details of the database, in this case= Environment Complete)
* an assignment to select two journal articles from this search that looked interesting and write a statement that will “summarize the main finding of the project *in your own words* in one sentence”
	+ POST: copy of assignment file **[Saunders\_copy of library research assignment.docx]**
* Lab—Introduction + work time for questions 1-3 (*regional temperature changes*)
	+ Introduced phenology and climate change context with video (Phenology, Climate Wisconsin, 2010, ca. 2’) + brief lecture w/Q&A that followed Calinger lab introduction content
		- <http://www.youtube.com/watch?v=wWh6ulBsLHE>-- *“This* *video will introduce the concept of phenology and the value of long-term data collection for as many plant and animal species as possible. It also describes century long changes in Wisconsin.”*
	+ Students were allowed to work together and revise their answers after some discussion
	+ I cut questions 4-8 with “anomaly” version of district temperature trend plots and analysis
		- Time (this first part took most of our 2-hour lab period)
		- Same answer (this group of non-majors may not care much about the finer points of differences between the plot types in parts 1 and 2)
		- Repetition/reinforcement of the basic quantitative skills done in following parts of lab
		- Also worked on questions 8-12 (*state-wide temperature change*)
		- Followed up (at end of lab) with
			* posting of rates per district on board and (quick) transfer to copy of district map
			* class discussion of variation and overall picture.
* Class (4 weeks later)
	+ *REVIEW discussion from previous part of lab: “Why is it important to assess temperature change across large areas rather than simply at small, regional scales (such as climate divisions)? How might climate change skeptics use long-term temperature data collected in small regions to present misleading temperature trends? Provide specific divisions as examples of this tactic in your answer.”*
	+ Follow-up with questions 13-17 in class (*flowering times*), and…
	+ Questions 18-21 (*pollinator emergence and arrival times, cherry picking*)—take-home, individual work
* Lab Supplements:
	+ assignment of campus plant to each student to observe for phenophase dates >>I would recommend doing the phenophase lab, that emphasized flowering time data, with spring classes. Students really liked adopting a plant (those that shared an opinion); they made comments that indicate they found the assignment engaging without being stressful.
		- We did a couple of mini-field trips (campus walks) to introduce/review plants (before and after spring break and species selection)
		- data summarized in shared Google spreadsheet, forms submitted on last day of class
		- discussed patterns and variation among species at last class meeting
	+ I informed students that their data were to be entered into the Project Budburst database, as has been for different classes and somewhat different species in previous semesters.
		- *Side note:* With repetition (and data), I am getting more familiar with campus plants in spring and fall; I am maintaining lists of spring/fall species on campus for use in similar exercises in other classes.
* Last day of class—not enough time to do a lot, so more room to develop an entire lab or mini-labs for non-majors as well as revise the original lab for botany students (science majors)—We used Project Budburst species pages and the National Phenology Network database and visualization tool to show multi-year, regional or national context for each student’s recent, local observations.
	+ Started with finishing entry of phenophase observations into shared class Google spreadsheet, sorted by plant types according to Project Budburst (e.g. wildflowers and herbs)
	+ Project Budburst: <http://budburst.org/display_all_plants_list>: Each student was asked to i) look up species monitored, ii) review distribution (regional range) and variation in flowering time (if data available, if not, try a different species on the class list), then general class discussion of examples.
	+ National Phenology Network database and visualization tool: <https://www.usanpn.org/files/npn-viz-tool/>: After a general introduction to the purpose and how-to for the visualization tool, students were asked to select a couple of years (warm vs cool springs were an obvious choice) and, using the “calendar” tool, compare flowering time data for their species or another of their choice. Due to limited time we discussed example outcomes in small groups and then as a class. This exercise could be developed into a more formal assignment. Students seemed comfortable using the visualization tool, even after only a short introduction from me (several were comfortably using options that I did not introduce!).
	+ If their species was not in database or did not get active by first week of May, they could choose another species on the list (Note: both details could be “fixed” with revised plant lists for spring semester, though we also used the variation as the start of a discussion about real and important variation)
* Final exam question— *“For either the seawater inundation experiment OR the phenology project, write out a summary that explains (ca. 1 sentence each) the*
* *Context, i.e. why we were even interested in the project*
* *Method (in general terms about what we did, not step-by-step)*
* *General (class-wide) result and finding(s)*
* *Overall conclusion/recommendation from the project (linking back to context)”*
	+ One-third of this class opted for the “phenology project.”
	+ All students discussed species differences in flowering. Some students (43%) correctly connected this project to questions about climate change and inter-year differences in flowering time in their answers, though neither was mentioned in original question. The “conclusion” part of the question needs work (either revision of the question or better preparation of the students re what a project conclusion should be about), as several did not refer to findings or context in their answer.

Assessments to measure progress:

* Literature findings
* Part 1 of lab—responses to step-wise questions
* Part 2 of lab—responses to step-wise questions
* Exam question option (about one-third of students did phenology project option)—outline project

What would I do differently?

* Prepare/revise rubric to include Excel skills/tools
* Add handout/video with how to make an XY plot in Excel, etc.
	+ Reinforce the directions I stepped through in front of class at start of lab
* Provide and assign How-to videos for National Phenology Network visualization tool (on website) for student review before class/lab.
* Develop formal assignment to connect/compare phenophase observation data for larger region with general findings/conclusions from Calinger lab for Ohio

Describe overall experience

* Good. I plan to use a version of this module again.
	+ I was happy with the level of engagement of the students; a majority seemed interested in the climate change questions, the variation in flowering time among species or years, and/or the application of these ideas to agriculture.
	+ Many struggled initially with the quantitative skills and use of Excel for one or more steps needed to make the plots and analyze the data. Experience and comfort level varied widely.
		- The visual representation of rates in long-term data plots was not automatic for some students, and consulting with small groups in turn (multiple rounds of the classroom) was very important to the success of the first lab. [Note: Reassurance and review helped; the 2nd round of using those skills—for flowering and pollinator emergence time sections-- and having it all be more familiar and “work” more easily helped more.]
		- For the open-ended analysis of change (in local district temperature), some groups initially developed an approach that was not correct. For example, a group would subtract the first temperature in the time series from the final temperature in the series. I tried to use these examples as a starting point to helping the students (still in small groups) work through how this didn’t work. It was challenging to hold my tongue, but most of them could assess the problem for themselves with some nudging. After that, a discussion/reminder/review of slope was helpful.

Summary for post to the ESA QUBESHub Collections:

I slightly modified the phenology lab for a general education biology course for non-science majors, removing the anomaly plot section to make it a little shorter. The lab (in two parts) was prefaced early in the semester by a short library research assignment and, later, a video from Climate Wisconsin. These briefly introduced the topic of phenology and the value of long-term phenophase data, as well as a variety of questions related to climate change. The lab was also coupled with independent student collection of phenophase data (Project Budburst) for a spring-active species on our campus. Finally, students were shown how to access and compare other data for their species available via the National Phenology Network.