

# Phenological trends and climate change in Minnesota

Pam Freeman -- The College of St Scholastica

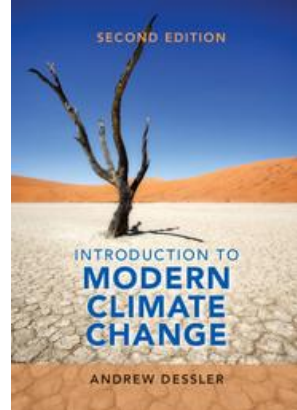


[https://commons.wikimedia.org/wiki/File:Monarch\\_Butterfly\\_Danaus\\_plexippus\\_Proboscis\\_2591px.jpg](https://commons.wikimedia.org/wiki/File:Monarch_Butterfly_Danaus_plexippus_Proboscis_2591px.jpg)

[https://commons.wikimedia.org/wiki/File:Painted\\_turtle\\_egglaying.jpg](https://commons.wikimedia.org/wiki/File:Painted_turtle_egglaying.jpg)

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# Background on course



- Global Challenges, Scientific Solutions: Climate Change
  - first semester biology majors course (+ allied students)
  - enrollment between 16-25 / section
  - approx. 30% first-generation students
  - take nothing for granted, then all can participate
- Build skills and core competencies related to Vision and Change (NSF)
  - apply the process of science
  - use quantitative analysis and mathematical reasoning
  - experience modeling and statistical approach
- What are the roadblocks that you or your students face re data?



Module was created at Project EDDIE workshop autumn 2019

## Roadblocks:

Students often intimidated by data

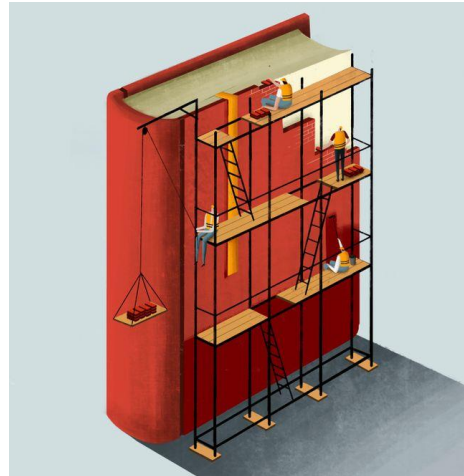
- how to ask a question
- how to work with the data
- how to utilize the technology/software



## Ticket through the difficulty:

Scaffold approach

- build confidence
- build skill and capacity!



## Additional positives:

Build on student interest in plants (or 16 other groups)

Learn if and how climate change has affected species locally

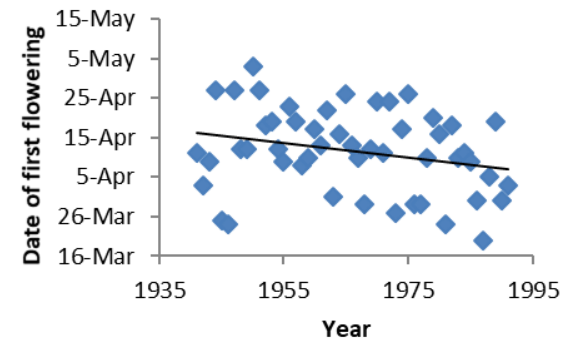
# What does the module look like?

- **Pre-homework** exercise (or in-class activity)
  - time to explore webpage and learn about phenology
  - time to download, practice moving within, and manipulating Excel (or Google Sheets)
  - less pressure if new to topic and data sheets





- **Activity A** – Identify an answerable question and answer with data
  - walk through American elm example together
    - widespread, familiar (surprise, flowers!), lots of data available
  - identify an answerable question given the data
  - manipulate Excel and data sets
  - build figures, and think about estimations and trends in data
  - confront assumptions (predictions) about climate change



- **Activity B** – Determine if change is significant

-short stats lesson of linear regression

Is there a significant *dependent* relationship between flowering date and temperature?

-What is your prediction of the data?

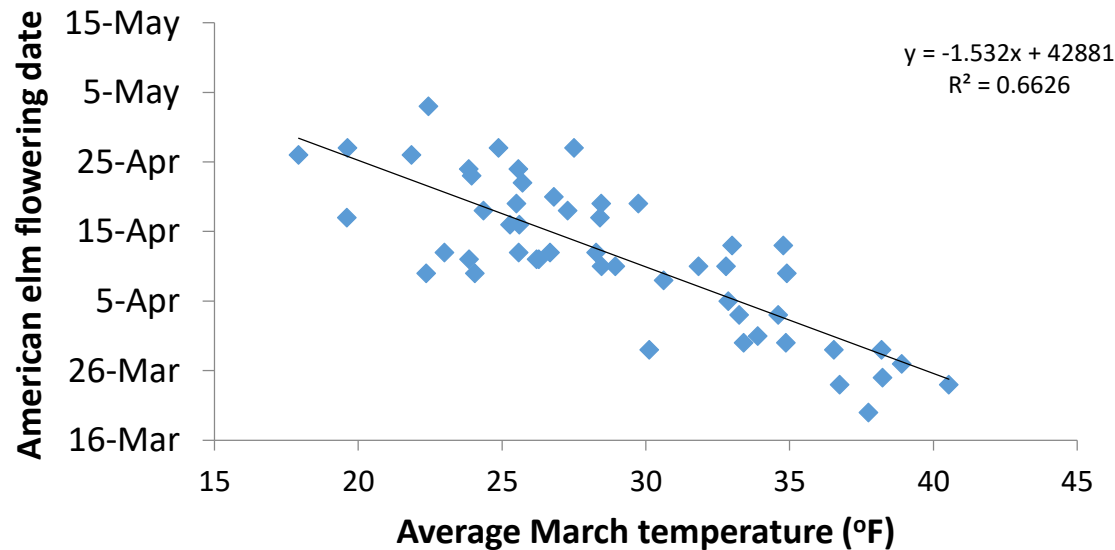


Figure 5. Elm flowering date and average March temperature from 1941-1991 in Ramsey Co, MN. As temperatures warm, first flowering date occurs earlier ( $r^2 = 0.66$ ,  $p < 0.001$ ).

(-If you are short on time, stop here and consider it a win!)

- **Activity C** – Students choose a favorite species and “practice”
  - discussion of climate change impact on multiple species
  - take a **look at** all the figures from your classmates.

Which phenophases (if any) are now occurring **earlier**?

How do the data help you reach this conclusion? Why might this be the case?

Which phenophases (if any) are now occurring **later**?

How do the data help you reach this conclusion? Why might this be the case?

Which phenophases (if any) do **not appear to have changed**?

How do the data help you reach this conclusion? Why might this be the case?

# Relevance

- Builds on what is familiar to students – find a familiar species
- Real data and real world example – data from MN, direct impact
- Expect all to be successful – assumes no prior experience
- Builds skills – practice with data, spreadsheets, statistics
- Builds relationships – lots of discussion and problem solving

Am. elm bud break



Lilac blooming date



Wild rice seed drop date





# Does the module “work?”

- Students self-reported
  - feeling more confident with data analysis and ability
  - surprised how they could manipulate data and do own analysis
  - surprised at how messy real data are
  - surprised how much some phenology had changed (and some did not!)
- Students remained engaged in activity
- Students engaged in discussed with peers and instructor

(More analysis of student confidence in class for presentation at AAC&U Transforming STEM Higher Ed meeting in Nov 2021)