Building Local Geospatial Inquiries for Your Students Using ArcGIS Online

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National Council for Geographic Education
6 December 2020

Awards 1949400,
1949393, & 1949388

Socio-Environmental Science Investigations (SESI)

- **Inquiry-based investigations**
- **Map-based mobile data collection**
- **Analysis with Web-based mapping software**
- **Pedagogical frameworks of place-based education and socio-scientific investigations**
- **Local issues**
- **Field work in the local setting**

Our Project

First ITEST project: *Socio-Environmental Science Investigations* (SESI)…

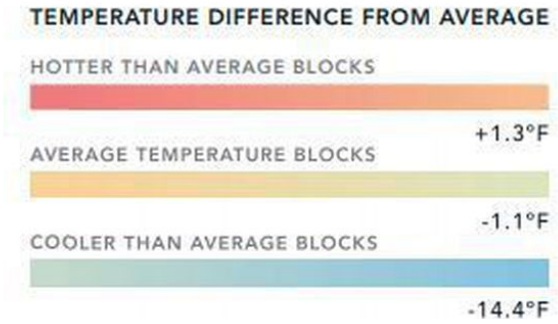
- One university (Lehigh) working with one local high school
- Integrating geospatial tools into science & social studies classes
- Intended outcomes:
  - Teacher knowledge, integration of geospatial tools into curriculum-aligned instruction
  - Student use of geospatial tools →
    - Interest / engagement in STEM-related college and career paths
    - Advances in spatial thinking
    - Preparation for geospatial workforce

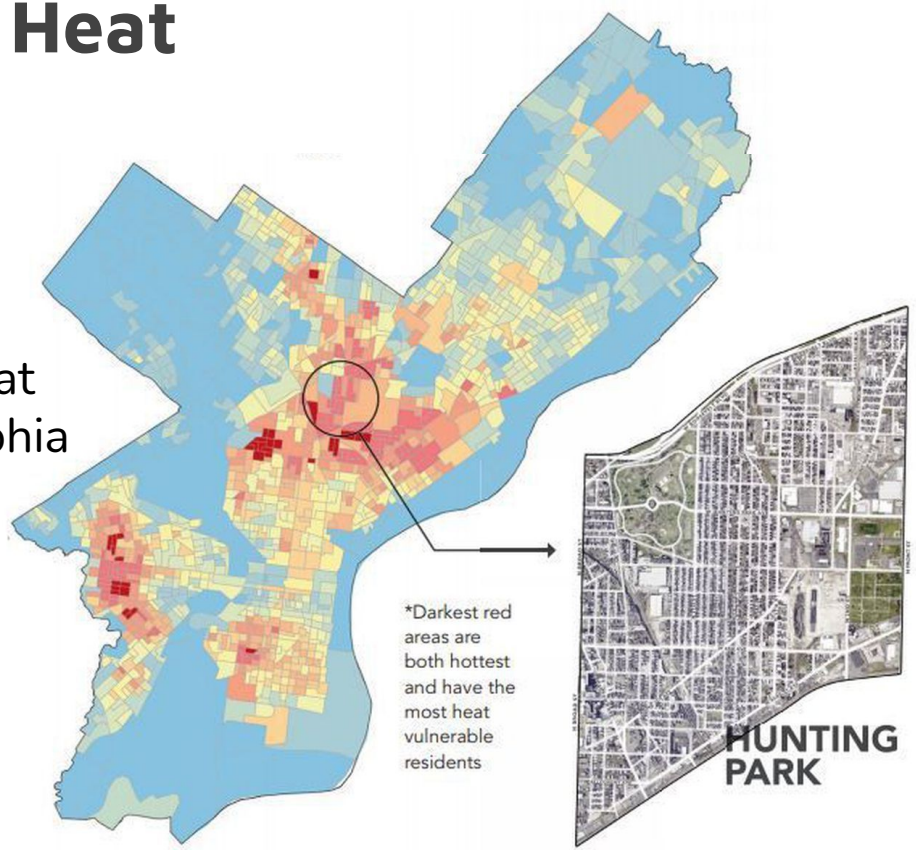
Since then: Funded for *SESI-ExpAND*

- Three universities…
- …working across four states…
- …with six high schools…
  - Traditional
  - Magnet
  - Alternative
- …and a wide range of content areas
  - Biology
  - Environmental & Earth Science
  - Social Studies
  - STEM
  - Computer Science
  -
  - (etc.)

Example: Urban Heat Islands

A map of heat exposure and most heat vulnerable census blocks in Philadelphia





SOURCE: David Hondula, Arizona State University, 2013-2015

1. Start with a driving question...

How do surface properties affect heat?

(Note: Lots of thermodynamics lurk within this simple question...)

2. Collect data on school property

Equipment used:
- iPad w/ GPS chip (no phone plan needed), [can also use a cell phone]
- Esri Collector app (freely available)
- IR thermometer (~$12/each)

Step 2: Start making observations in your area

Your job is to gather data on different surface types within a few blocks of the school and observe the temperature differences of these surfaces. **Always stay with your partner when you are outside the school**.

Where to go:

a. Go to your assigned area.

What to do:

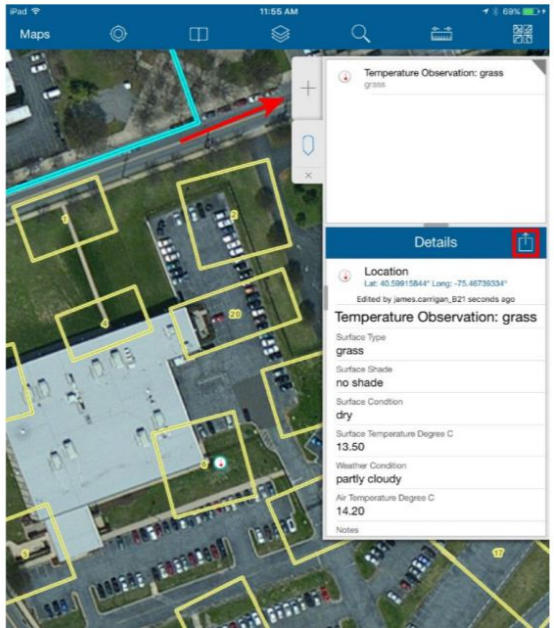
b. Start making temperature observations with the **Collector app**.

c. You will make observations for all the different ground surfaces. Make at least 10 observations in your class period.

d. To enter a new observation, select the **plus sign** on the **upper right of the screen (red arrow)**.

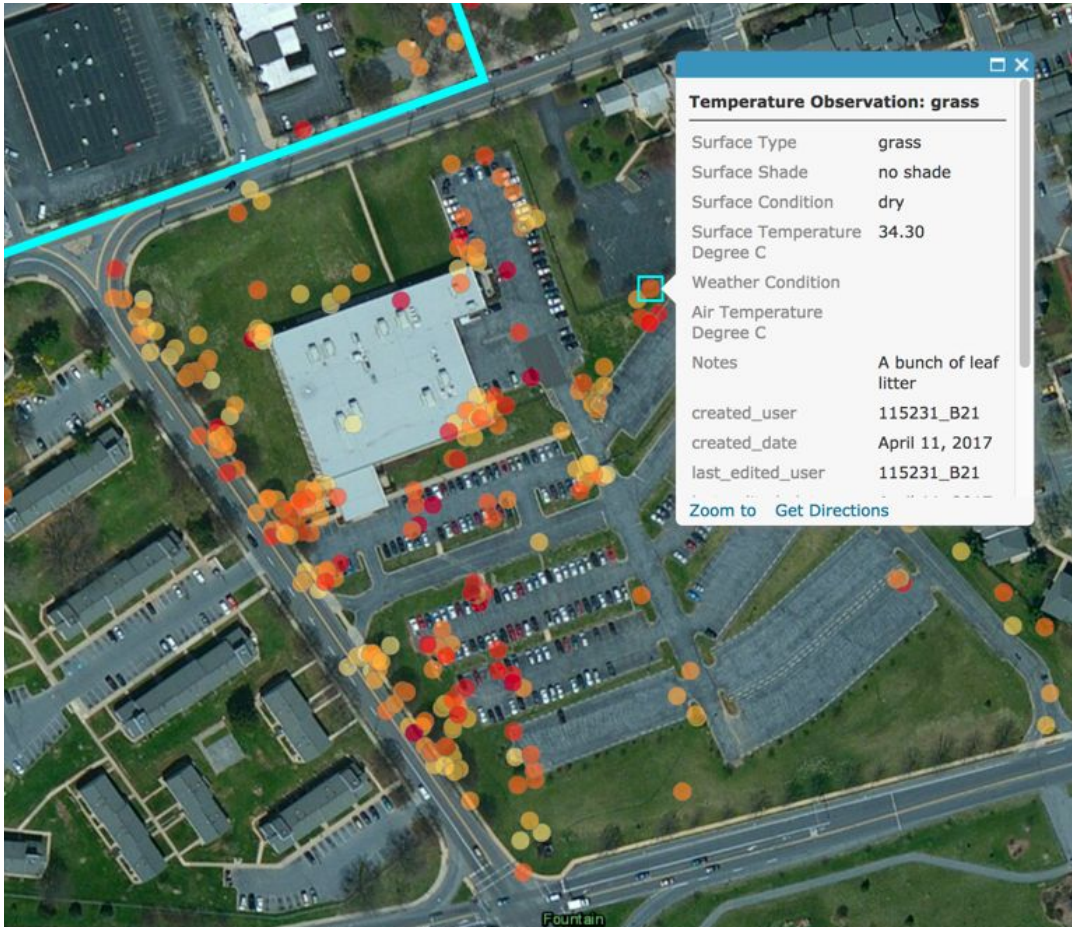
e. You can add other observations by selecting the **Notes** menu and typing your observation. You can also **add photos** by selecting the **camera icon** at the top of the screen.

f. Once you have completed all the data fields, select **Submit**.



3. Examine data, look for patterns

a. Visual inspection



3. Examine data, look for patterns b. Structured analysis

Note: The students we work with need plenty of scaffolding

b. What surface gave your group the lowest temperature reading?

4. How did temperatures of the same surface vary between shaded areas and unshaded areas? (Hint: look at **Surface Shade** column in the table)

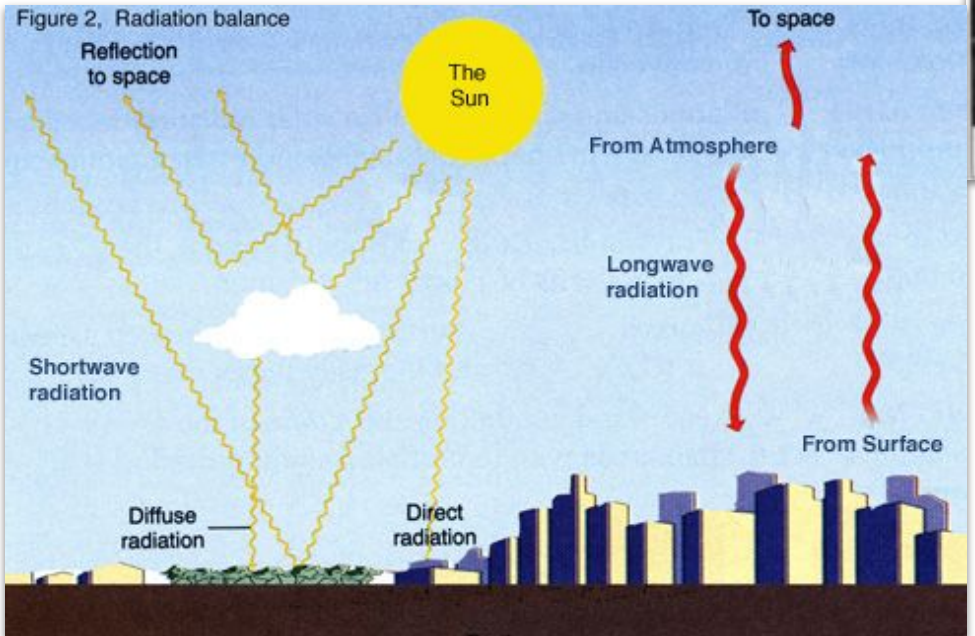
5. Select two observations for each type of unshaded surface from **your group**. Average these temperatures. Rank the averaged surface in order from hottest to coldest. **1 = the hottest**, **6 = the coldest**

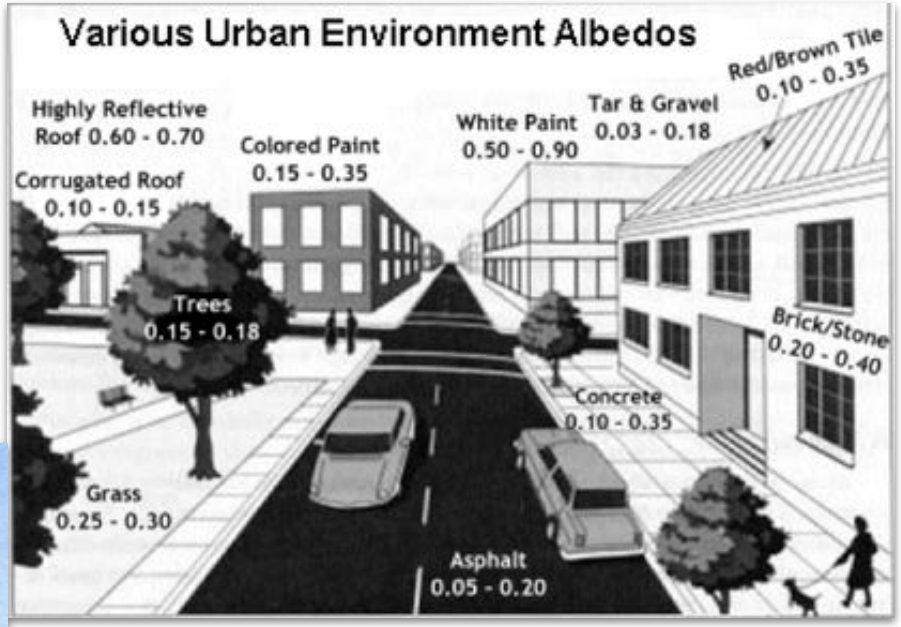
Unshaded Surface	Observation 1 Temperature	Observation 2 Temperature	Average temperature	Rank
Grass				
Dark Asphalt				
Light Asphalt				
Concrete				
Dirt				
Other				

6. What is the temperature difference between the hottest and coldest surfaces?

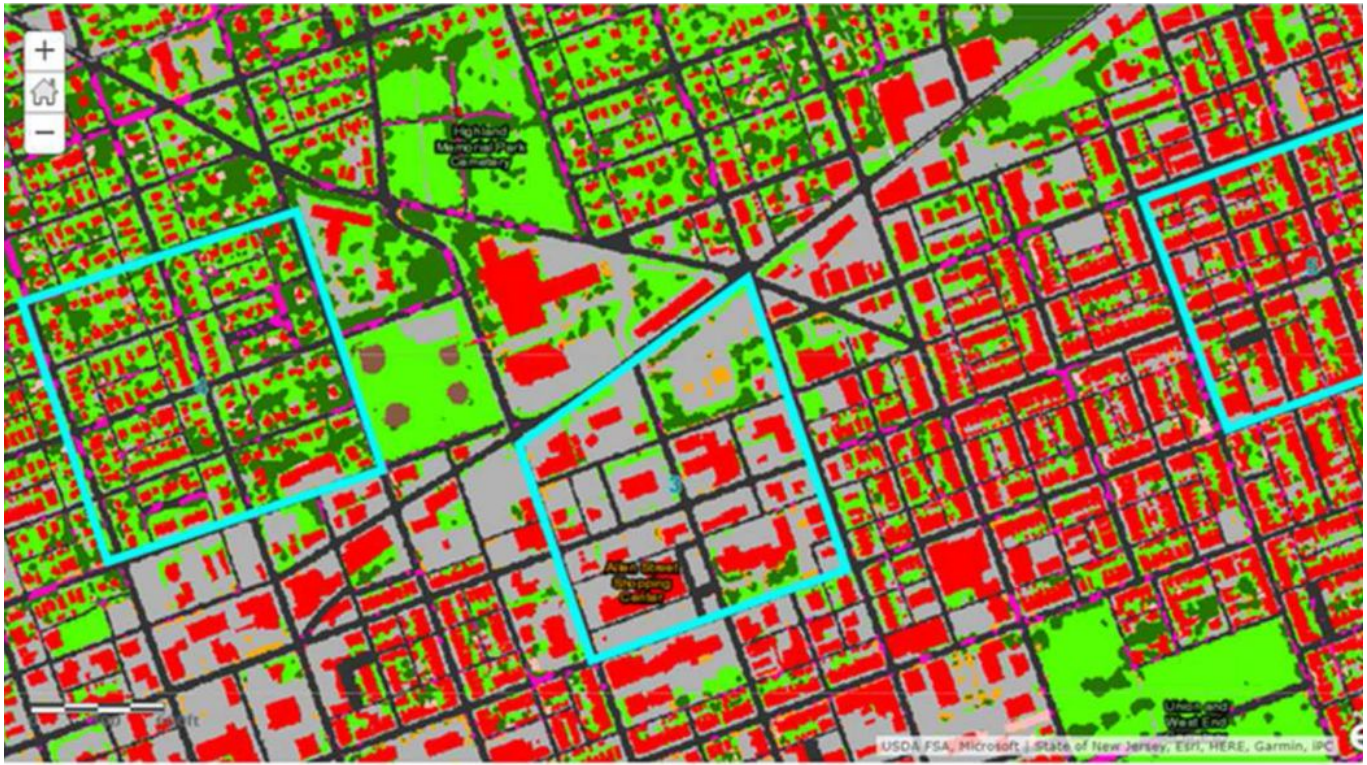
7. What was the average air temperature during data collection? How does the air temperature compare to your hottest and coldest surface?

4. Unpack necessary background info (thermodynamics)





5. Integrate additional data layers for analysis (land cover/surface types)



Let’s review the steps as we come to the most impactful one...

1. Start with a driving question
2. Collect data
3. Examine data, look for patterns
4. Unpack necessary background information (thermodynamics)
5. Integrate additional data layers
6. **Propose changes to the community**

6. Propose changes to the community

Student Questions

1. What changes would you make within your selected area to reduce the urban heat island effect without altering land use?
2. If you were allowed to alter land use, what changes would you make within your selected area to reduce the urban heat island effect?
3. How would you change the school's property to reduce its urban heat island effect?

Student response

Draw polygons to show areas you would change...

Overlay on a satellite image

Changing assumptions conditions

SESI instruction as conceived during precursor grant

1. Start with a driving question
2. Collect [local] data [using school-supplied devices]
3. Examine data, look for patterns
4. Unpack necessary background information (thermodynamics)
5. Integrate additional data layers
6. Propose changes to the community

Changing assumptions for pandemic learning

SESI instruction as conceived during precursor

1. Start with a driving question
2. Collect [local] data [using school-supplied devices]
3. Examine data, look for patterns
4. Unpack necessary background information (thermodynamics)
5. Integrate additional data layers
6. Propose changes to the community

...re-built for pandemic conditions

1. Start with a driving question
2. Collect [at home] data [using personal device]
3. Examine data, look for patterns
4. Unpack necessary background information (thermodynamics)
5. Integrate additional data layers
6. Propose changes to the community

Changing assumptions for pandemic learning

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Modified for pandemic conditions

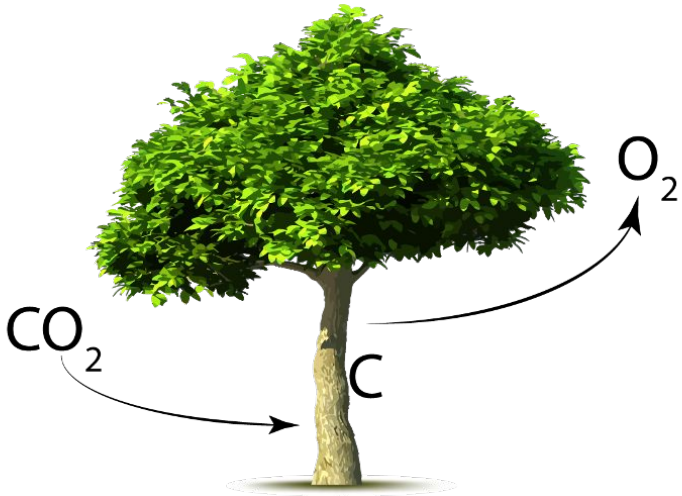
1. Start with a driving question
2. Collect [at home] data [using personal device]
3. Examine data, look for patterns
4. Unpack necessary background information (thermodynamics)
5. Integrate additional data layers
6. Propose changes to the community

Start slow!

Scaffold student (and teacher!) work with GIS, data collection, analysis, etc.

Sample of our current work: Trees & carbon

- **Driving question: About how much carbon is stored in a tree?**
- Data collection: Use Survey123 plug-in for ArcGIS & personal device to measure and photograph a tree
- Examine data...no pattern-seeking. This is an introductory activity and not a full inquiry
    - Illustrates curricular concept (trees & other plants are one of three major carbon sinks)
    - Allows for practice of process skills (data collection, measurement)
    - Introduces ArcGIS toolset (data collector, GIS, Story Maps)



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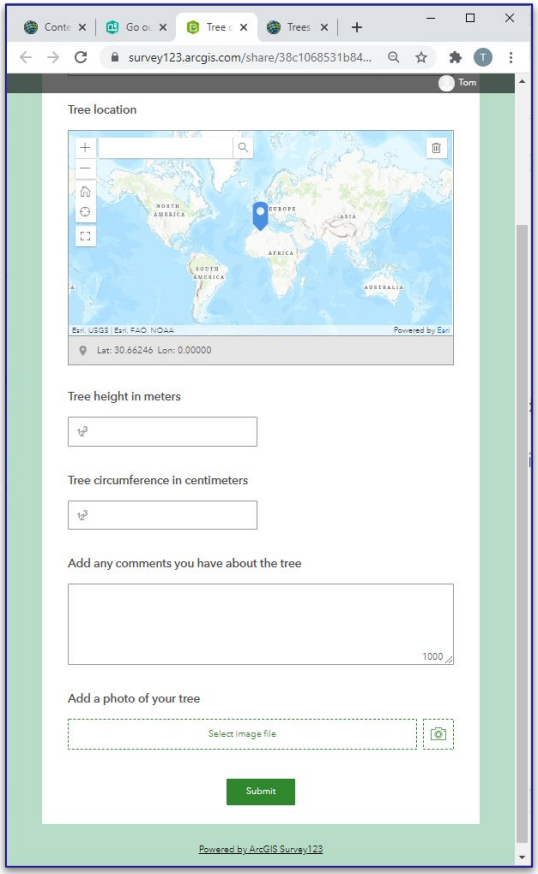

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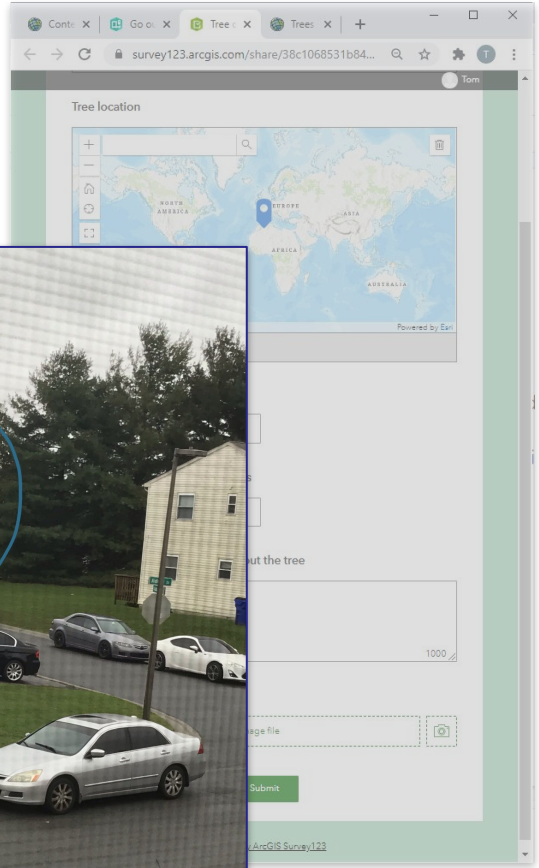

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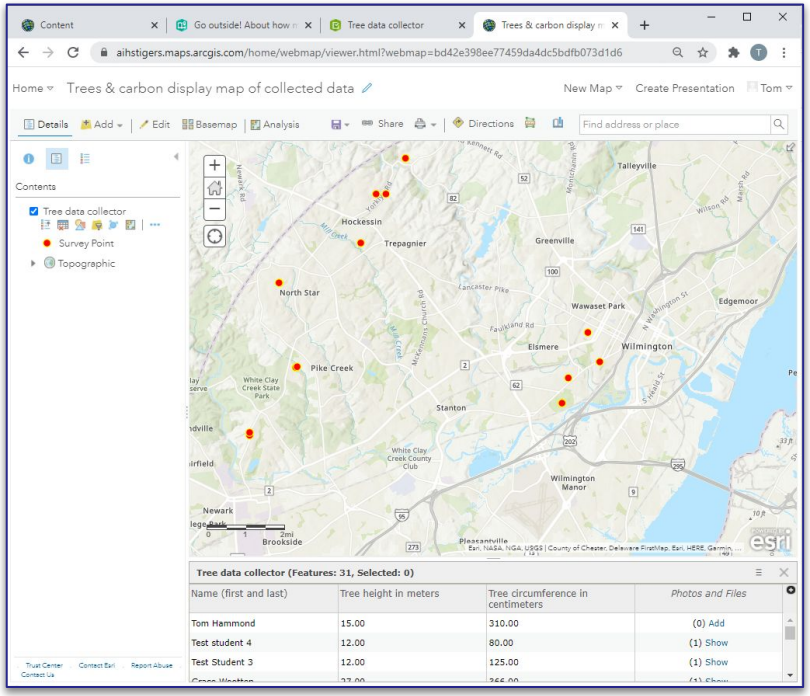

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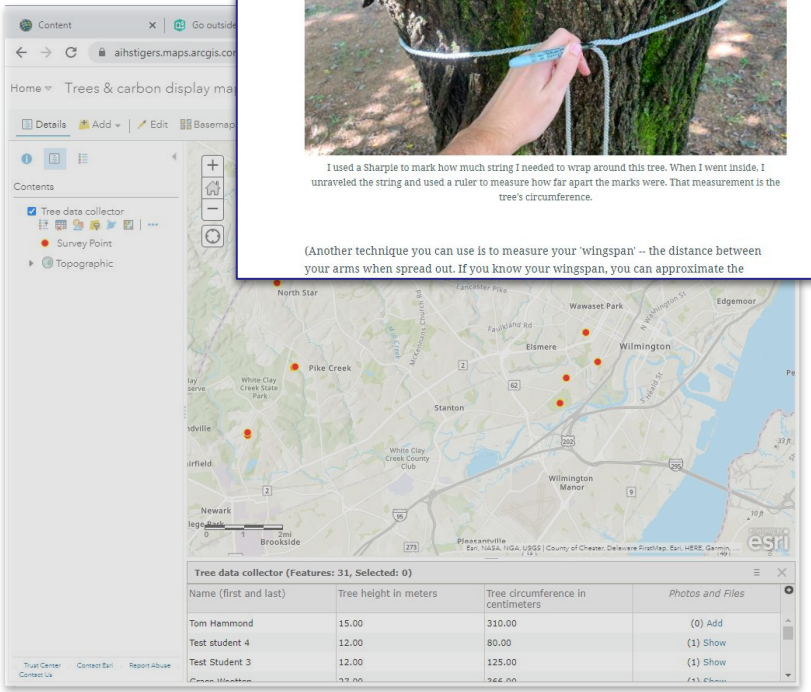

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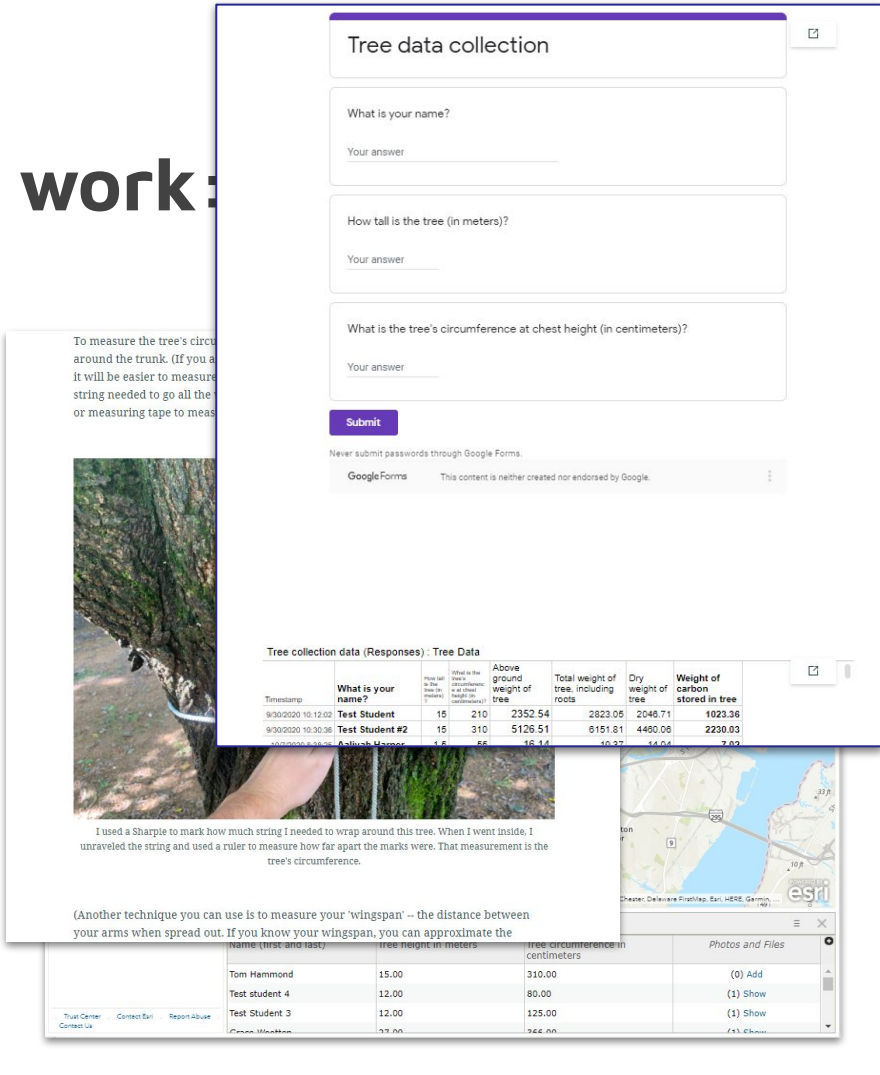


Technology used: Suite of tools built around ArcGIS Online

ArcGIS Collector app

Survey123

Data collectors

ArcGIS Online

Maps, data, analysis tools

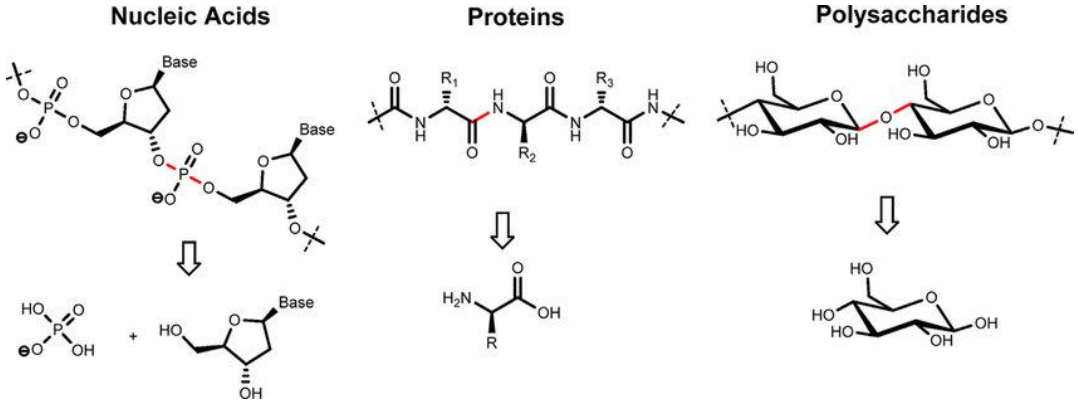
Data dashboards

Story maps

Instructional scaffolds

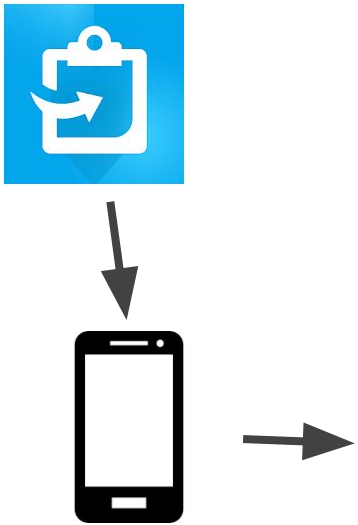
Sample #2: Macromolecules

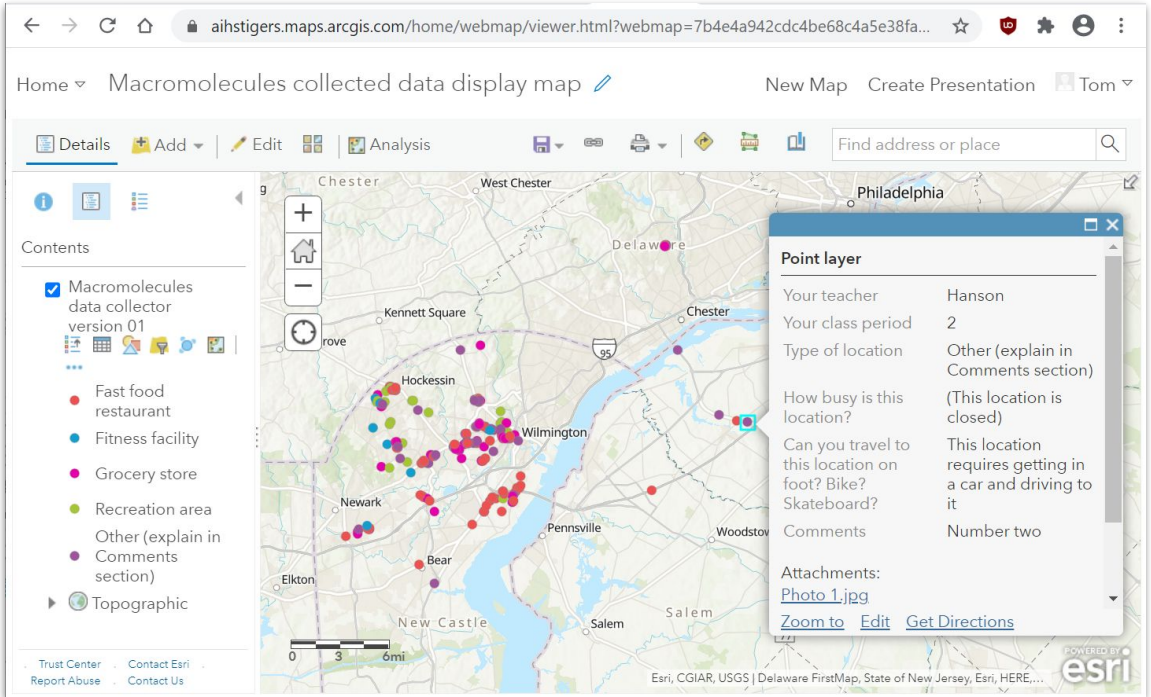
- Large molecules, necessary for life, built from smaller organic molecules
- Four classes:
  - Carbohydrates
  - Proteins
  - Lipids
  - Nucleic acids (RNA, DNA)
- Take in through food, and burn off with exercise



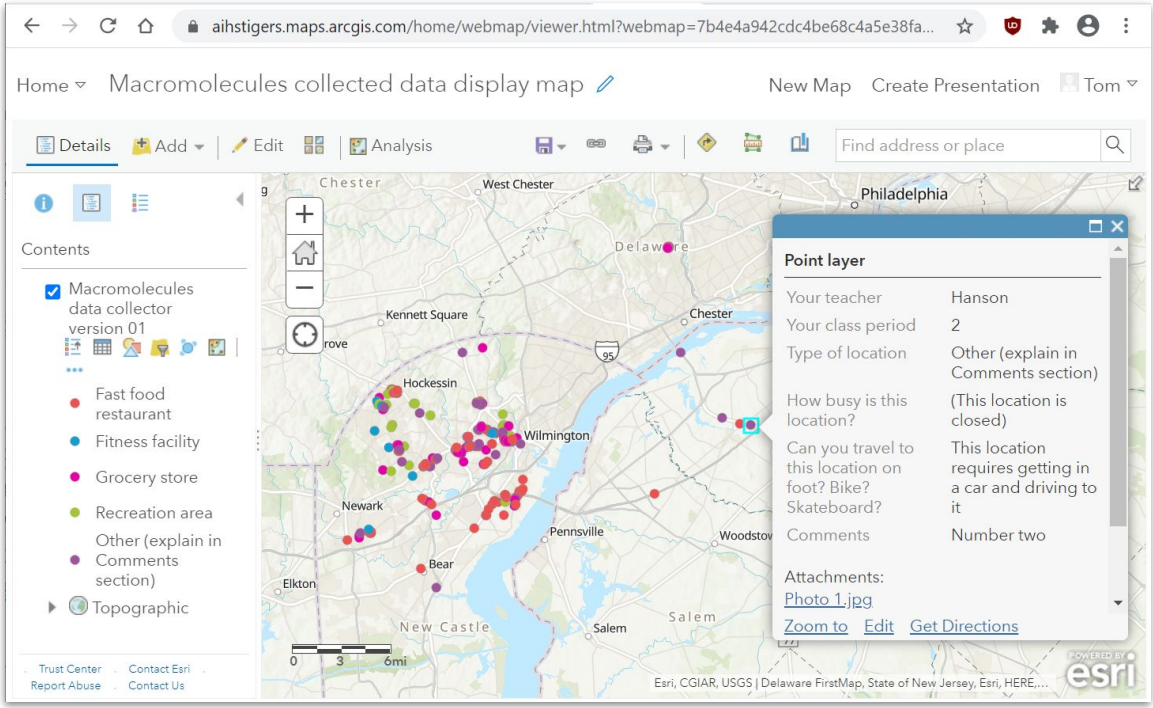
Macromolecules as a socio-environmental topic for Biology

Student data collection: Where in my community are macromolecules consumed? Where are they used up?

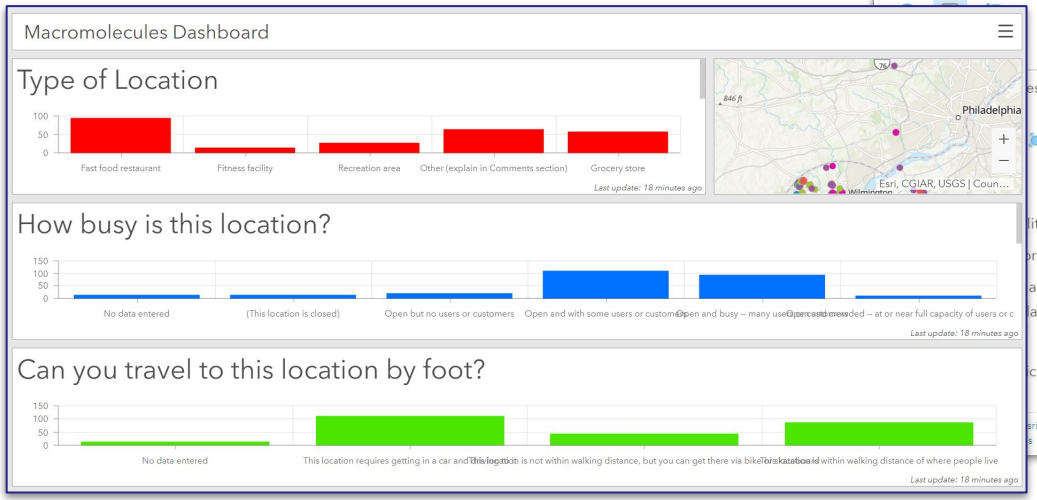


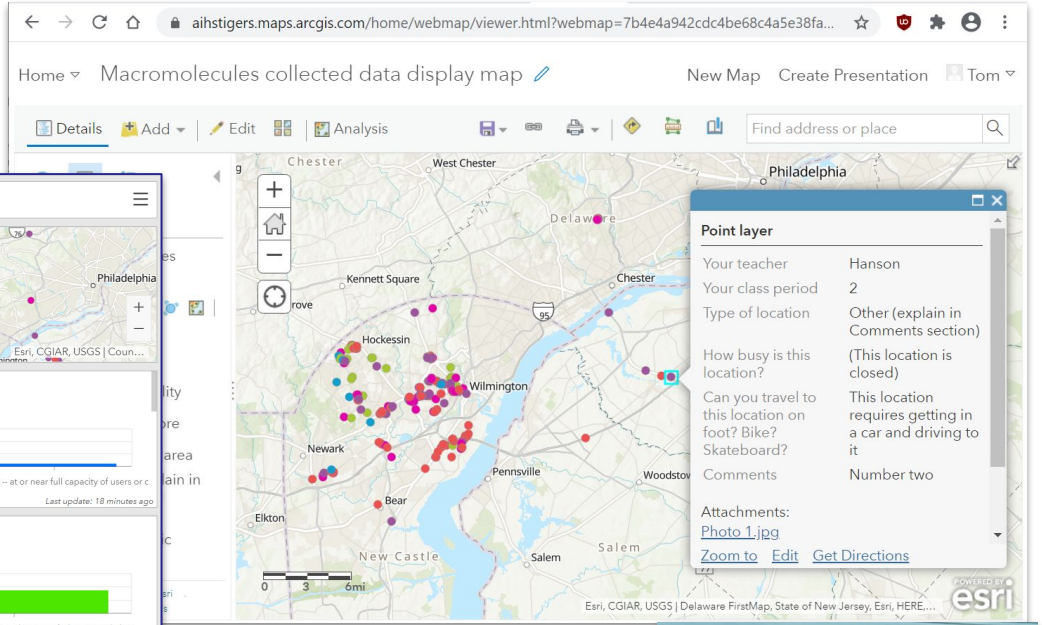


Student Data: high school gym…a place for exercise



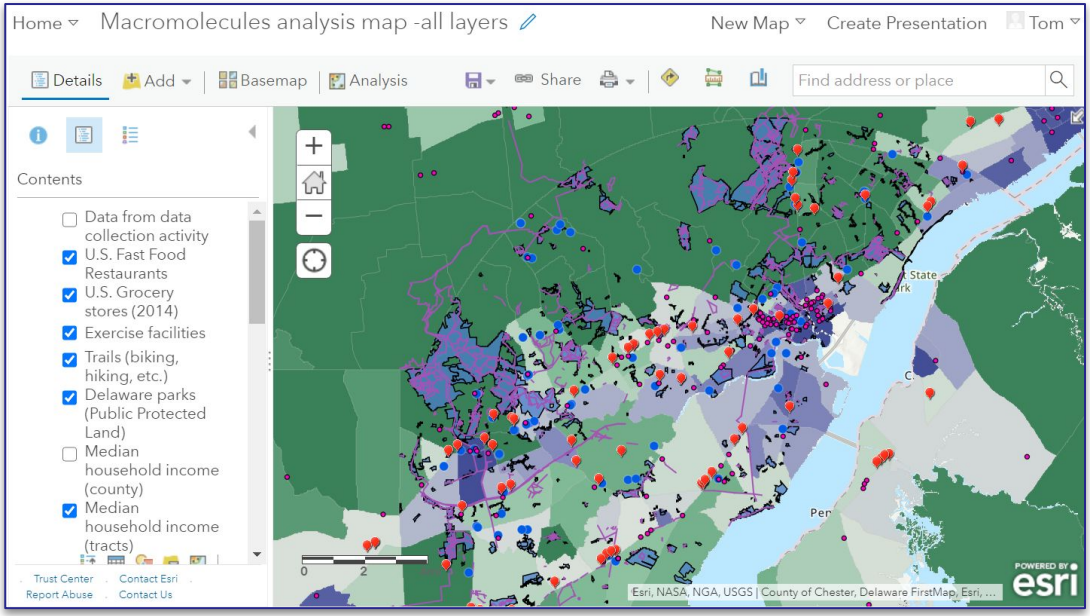
Learning more...





Contextualizing Data

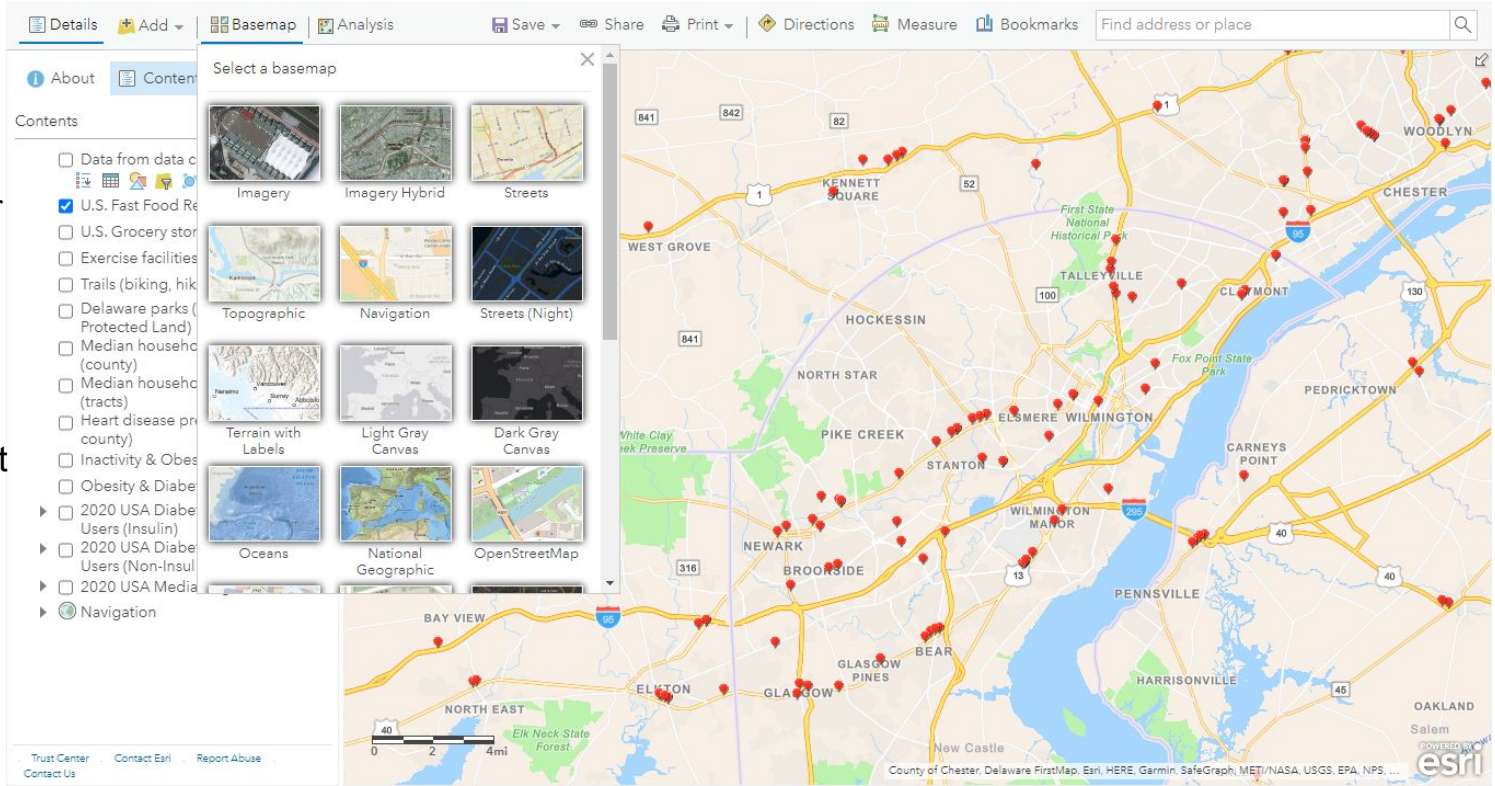
1. Macromolecules as a socio-environmental issue for Biology
2. Student data collection: Where in my community are macromolecules consumed? Where are they used up?
3. Putting this data in context: Student-collected data + external data layers to further explore variables & interactions



Spatial analysis and scaffolding

Look at one layer at a time!

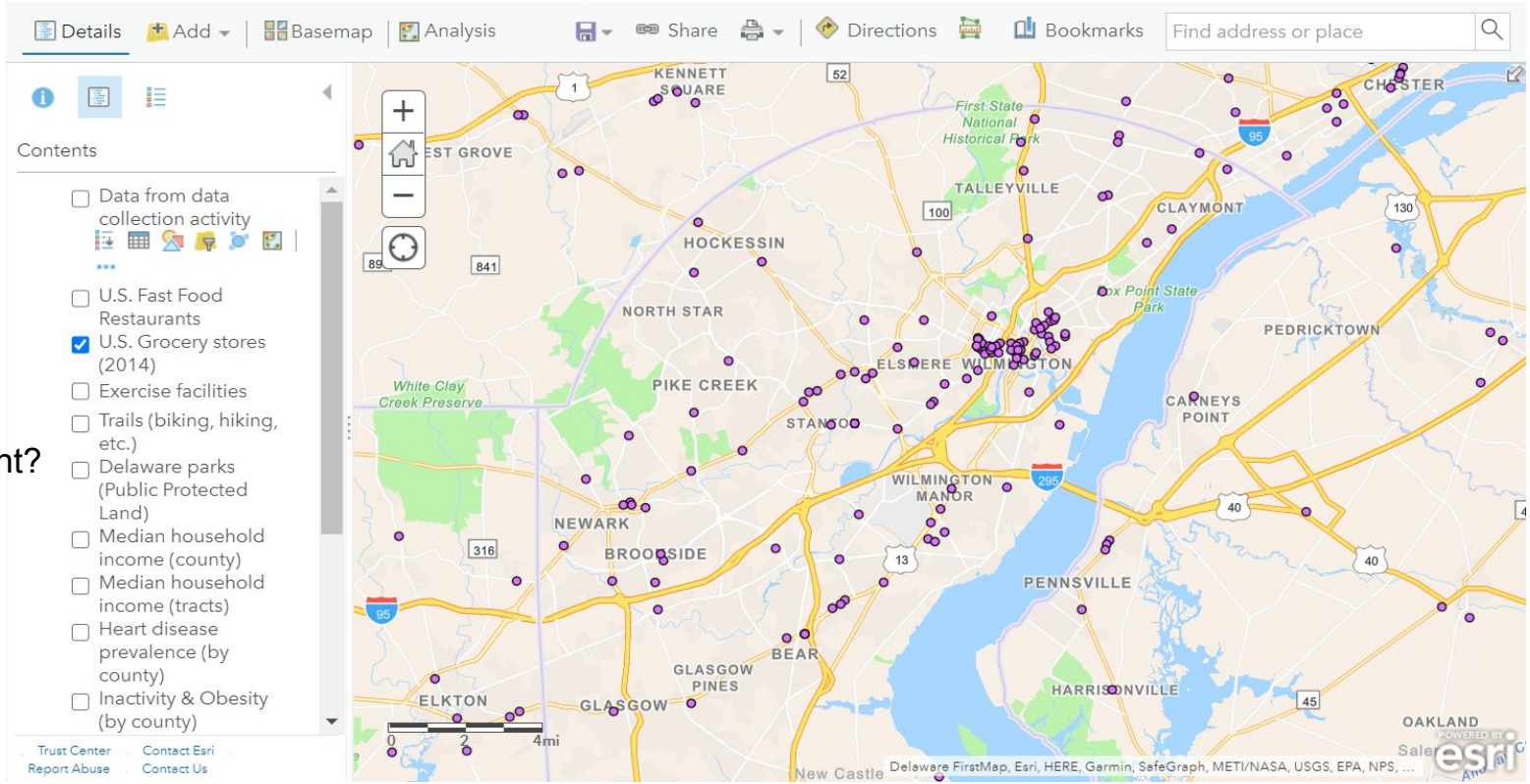
Consider which basemap is most appropriate (visibility, relevant features)



Where are grocery stores?

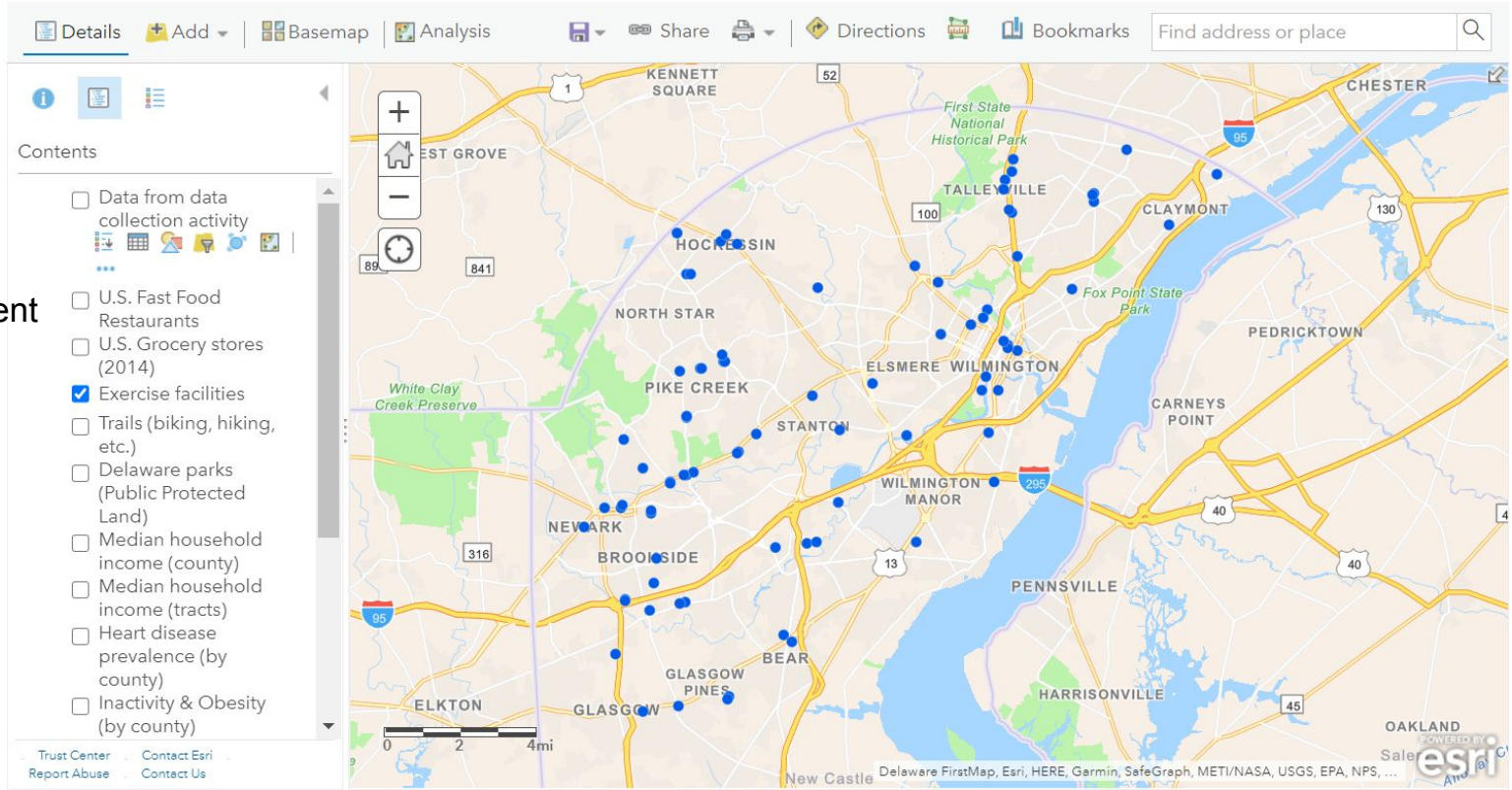
What is similar about this distribution?

What is different?



Where to work off calories

Clearly a different distribution -- why?



Spatial thinking constructs…

1. Macromolecules as a socio-environmental issue for Biology
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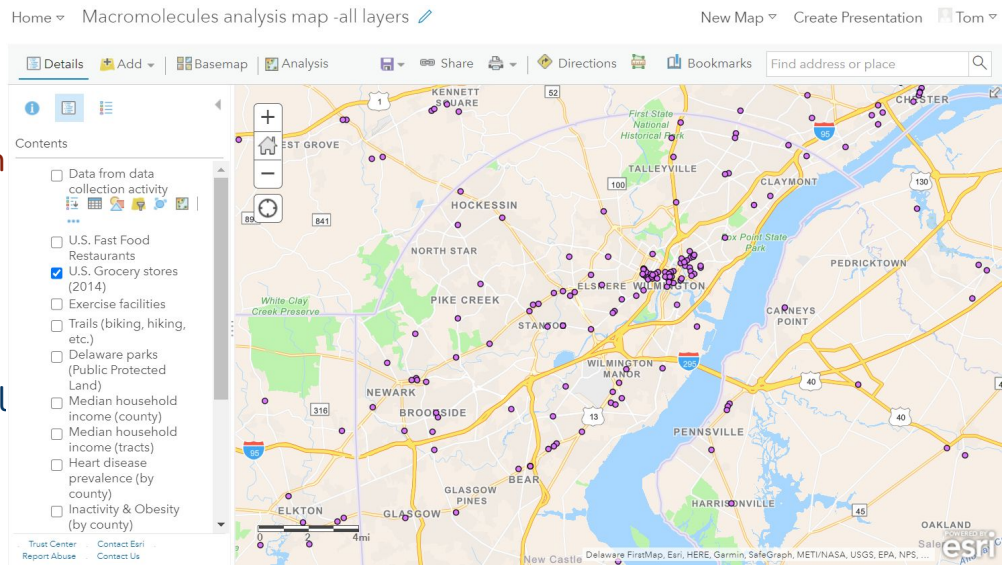
3. Putting this data in context: Student-collected data + external data layers to further explore variables & interactions
    a. **Spatial thinking: Points & pathways; correlation; density**



Spatial thinking constructs…and tools

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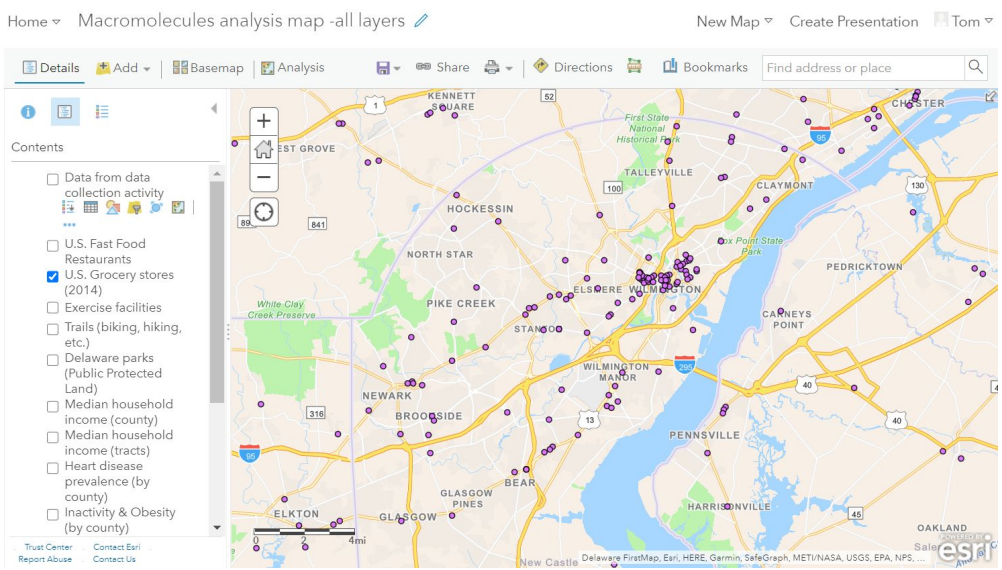
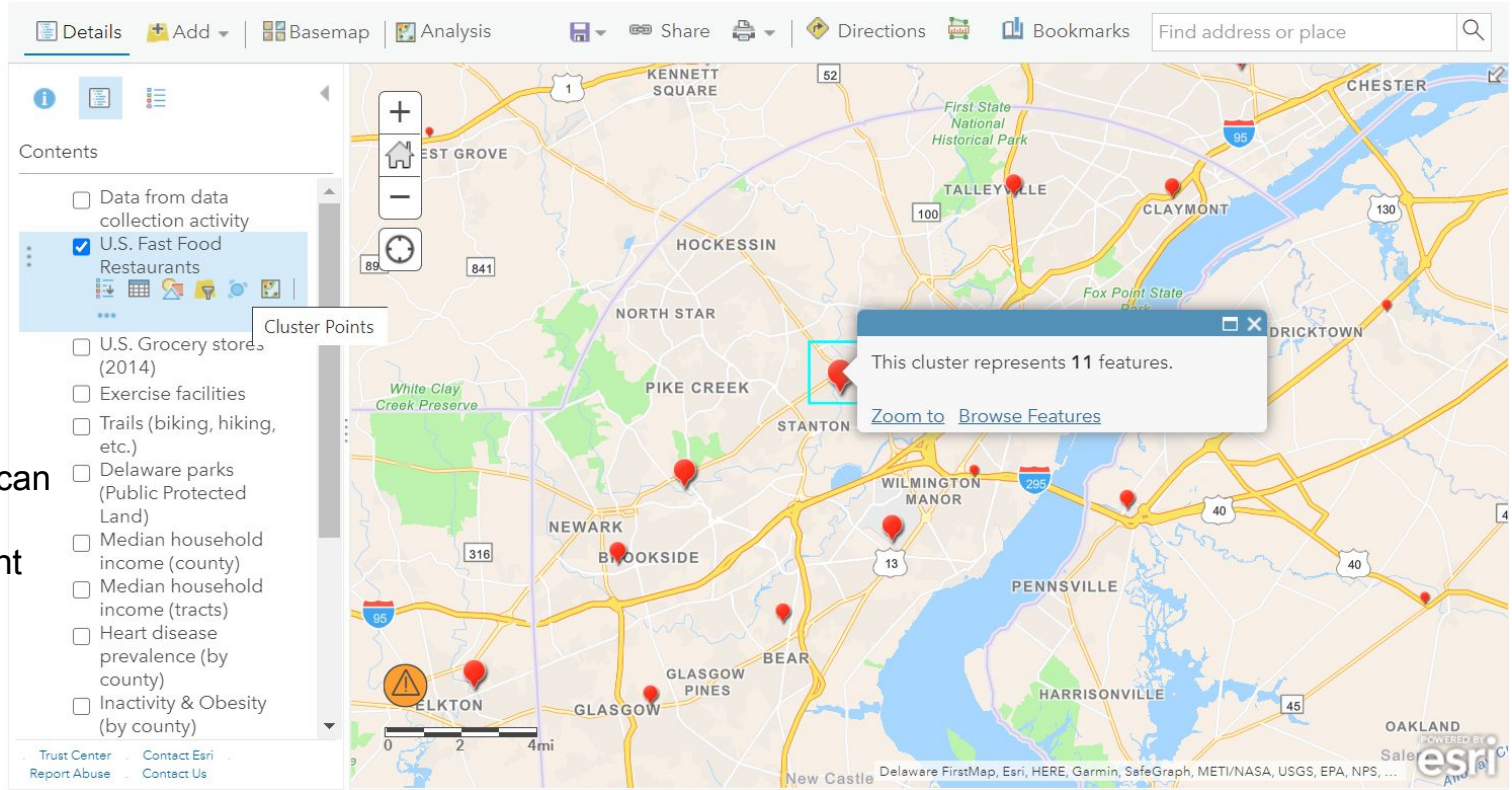
    a. Spatial thinking: Points & pathways; correlation; density
    b. Geospatial tools to support: Basemaps, clustering

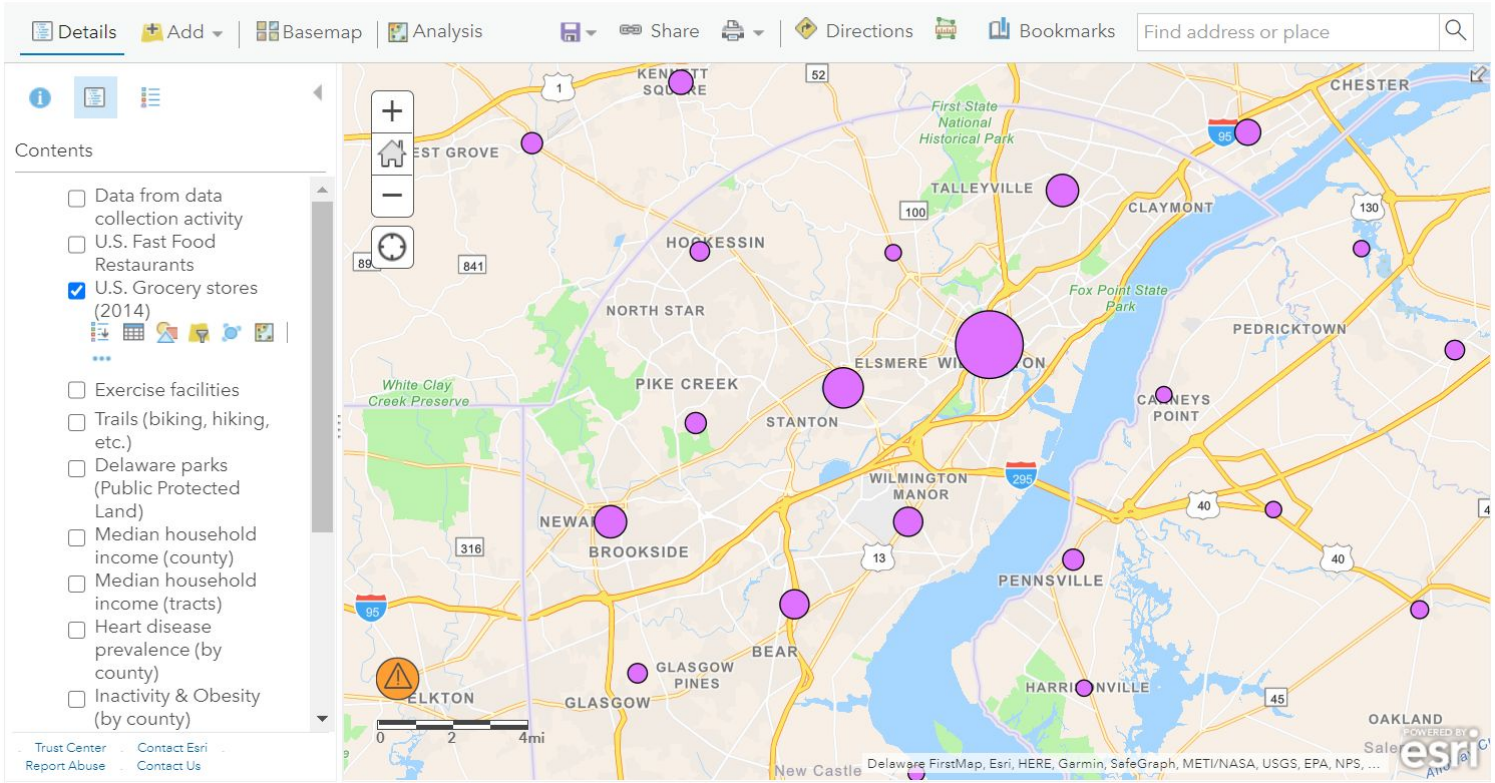


Fast Food: Cluster tool

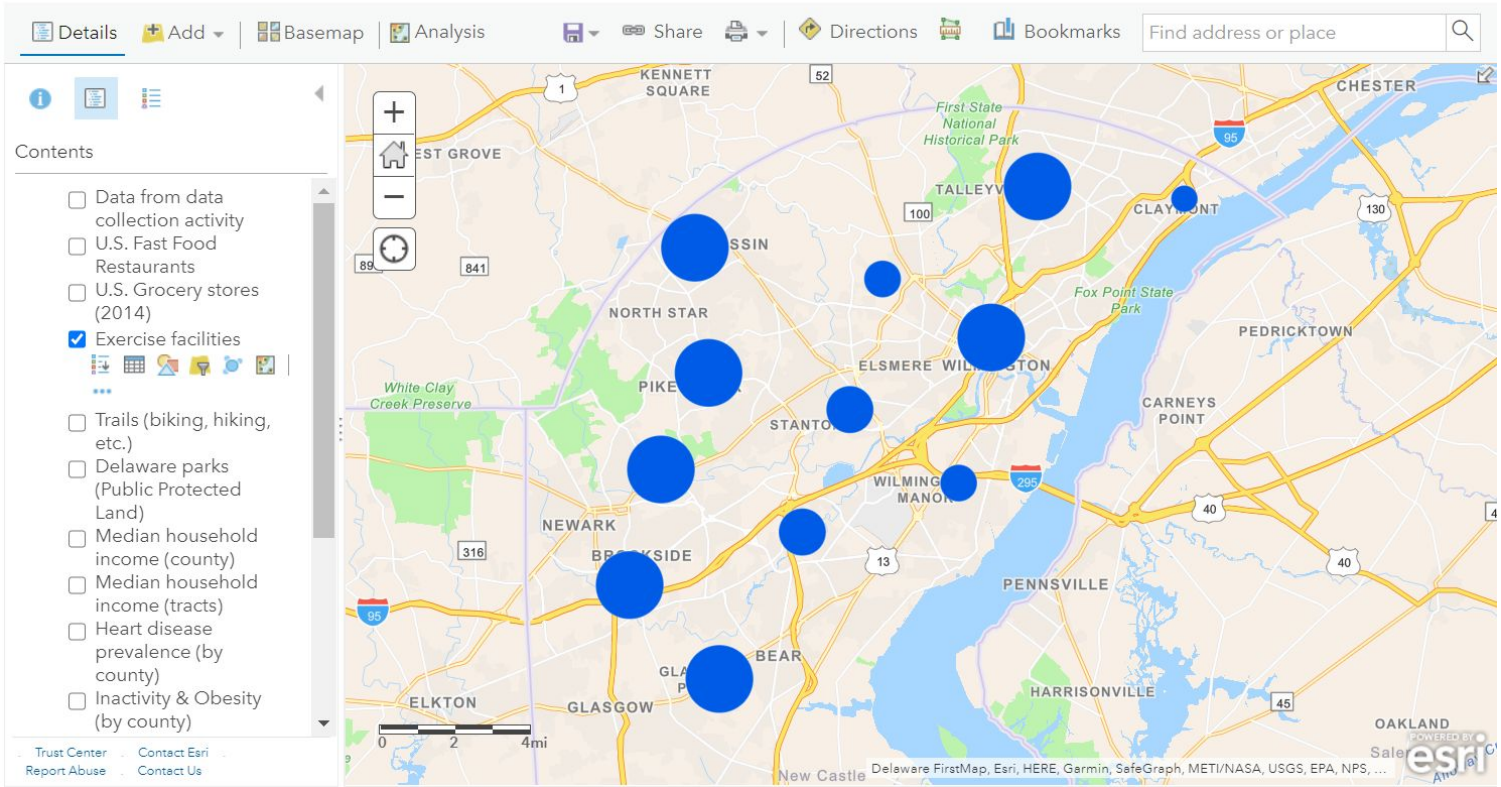
Cluster tool = greater abstraction...can make pattern more apparent



Grocery Store: Cluster Tool



Why are exercise facilities clustered differently?



Why might patterns exist, and how can we test that using layers?

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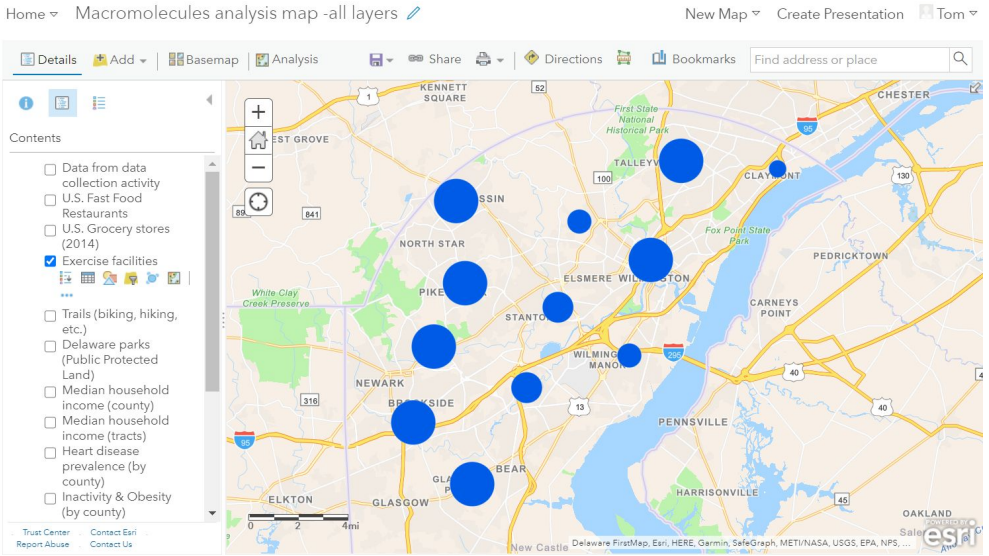
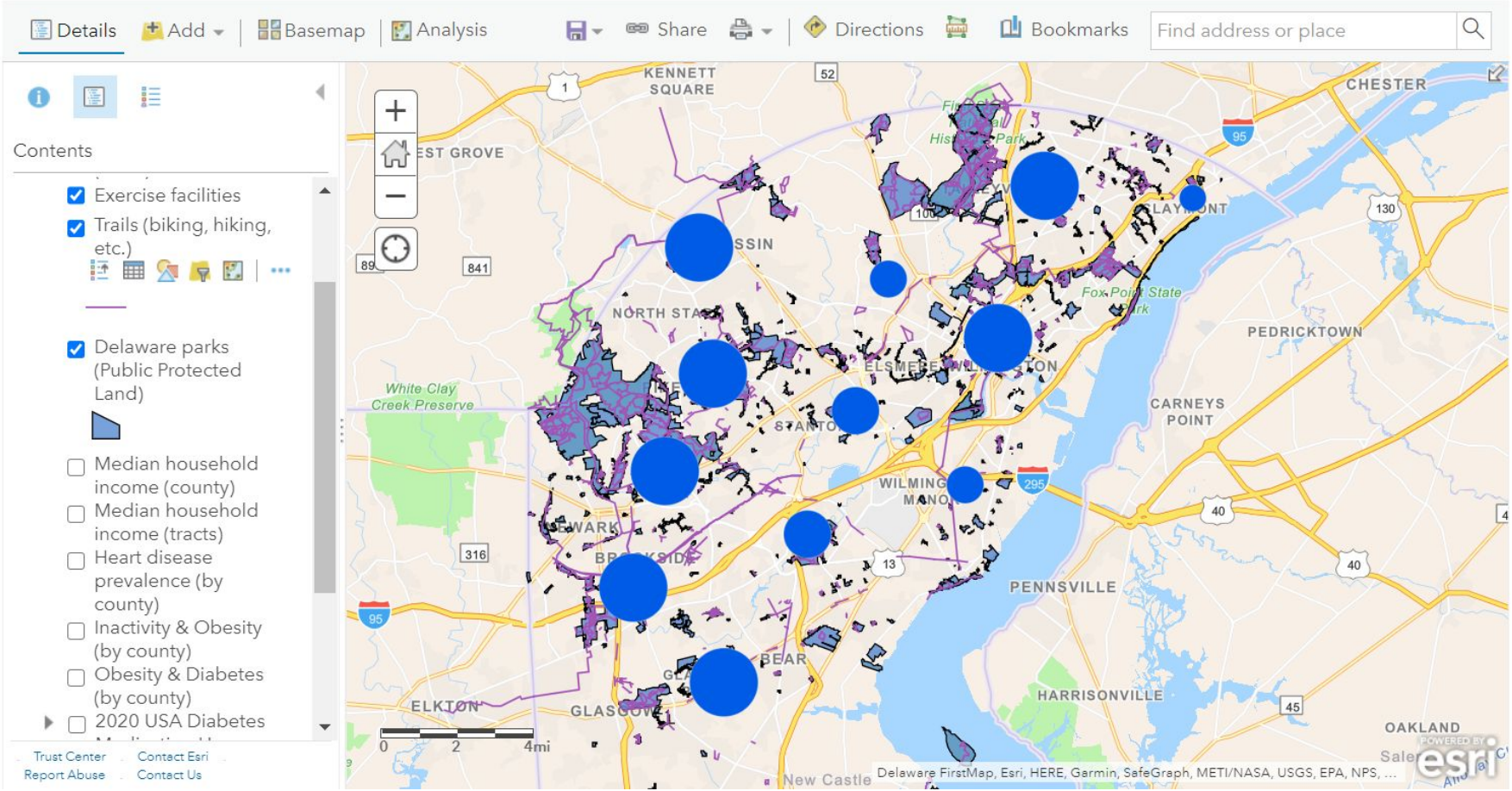
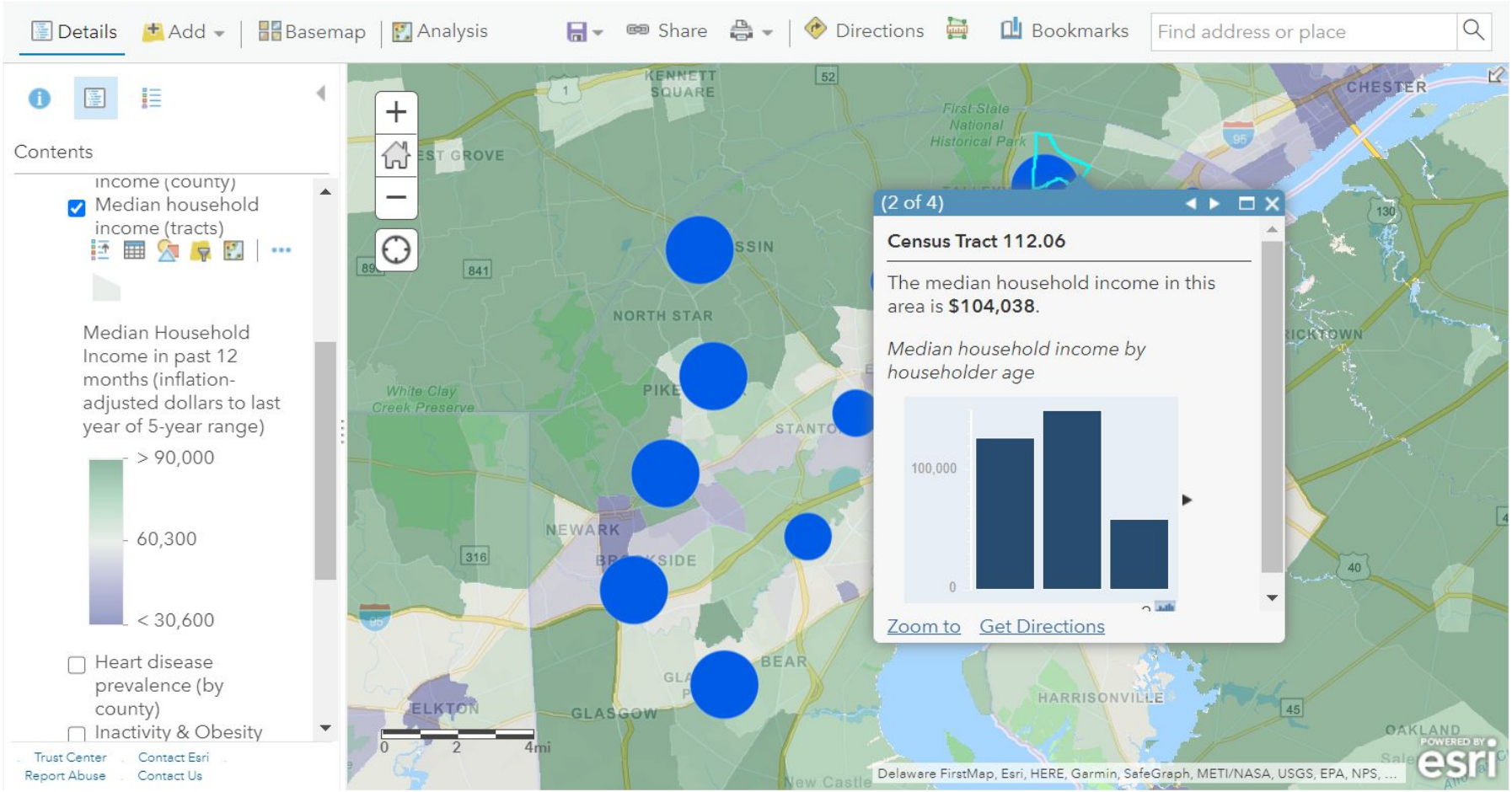
    a. Spatial thinking: Points & pathways; correlation; density
    b. Geospatial tools to support: Basemaps, clustering
    c. **Hypotheses & testing**



Parks & trails?



Income?


Details
Add
Basemap
Analysis
Share
Directions
Bookmarks
Find address or place
Contents
Median household income (tracts)
Median Household Income in past 12 months (inflation-adjusted dollars to last year of 5-year range)
> 90,000
60,300
< 30,600
Heart disease prevalence (by county)
Inactivity & Obesity
Trust Center
Report Abuse
Contact Esri
Contact Us
(2 of 4)
Census Tract 112.06
The median household income in this area is $104,038.
Median household income by householder age
100,000
0
Zoom to
Get Directions
KENNETT SQUARE
CHESTER
First State National Historical Park
NORTH STAR
PIKE
White Clay Creek Preserve
NEWARK
BEAR
GLASGOW
ELKTON
HARRISONVILLE
OAKLAND
0
2
4mi
Delaware FirstMap, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, ...
POWERED BY esri

How to use data to effect change

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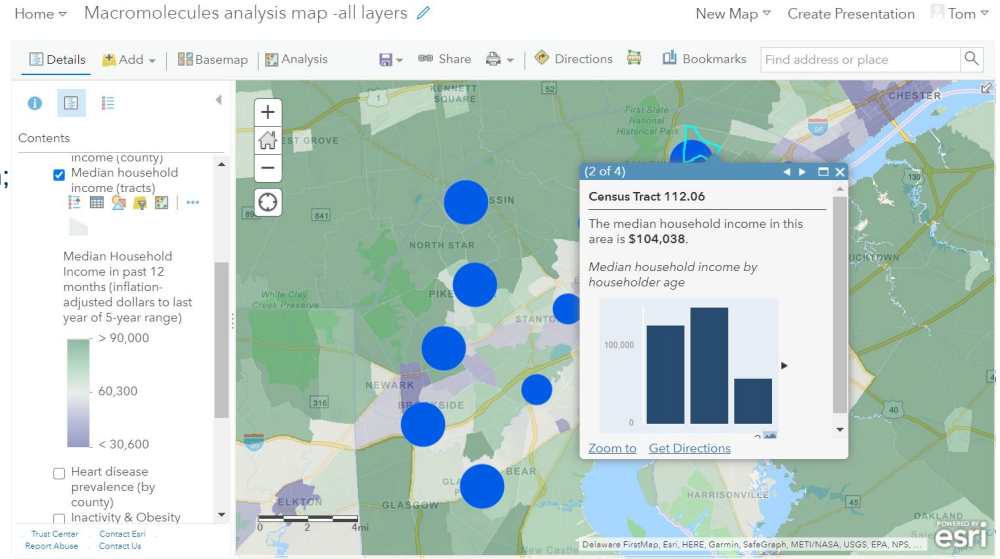
3. Putting this data in context: Student-collected data + external data layers to further explore variables & interactions
    a. Spatial thinking: Points & pathways; correlation; density
    b. Geospatial tools to support: Basemaps, clustering
    c. Hypotheses & testing
4. **Decision-making: How to balance using & consuming macromolecules in my county?**



Want to learn more about our work?

Precursor grant (including full materials)

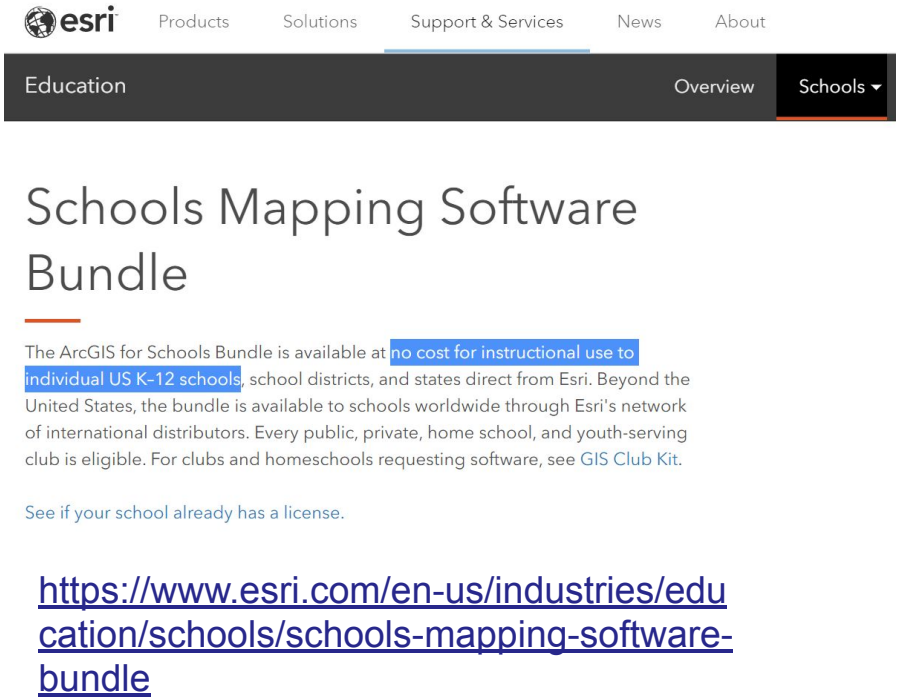
https://eli.lehigh.edu/sesi

Current grant (info on partners; will show working versions of materials)

https://sites.google.com/lehigh.edu/sesi-expand/welcome

Want to do this on your own?

Create a (free!) school account



https://www.esri.com/en-us/industries/education/schools/schools-mapping-software-bundle

Want to do this on your own?

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Learn how to use ArcGIS!

Esri GeoInquiries

Learn.ArcGIS.com

Esri K12 GIS Organization

Acknowledgements

We couldn't do this project without...

- Our partner teachers in Delaware:
  - Ian Hanson
  - Vic Leonard
  - Stashauna Carter

- Jeremy Mack, our GIS specialist at Lehigh University

Comments and Questions

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