A Guide to Exploring Caterpillars Count! Data

Whether or not you conducted your own *Caterpillars Count!* surveys, all of the data submitted by citizen scientists from all over are available for exploring and visualizing. This type of data exploration can make for productive inquiry-based learning activities with students of almost any age, and can provide a nice classroom-based complement to the outdoor activities of the surveys themselves.

Below are instructions for the different types of data visualization available from the **Maps & Graphs** page (https://caterpillarscount.unc.edu/mapsAndGraphs), the types of questions that may be asked and answered, as well as some background information for teachers that might be helpful for discussing student findings.
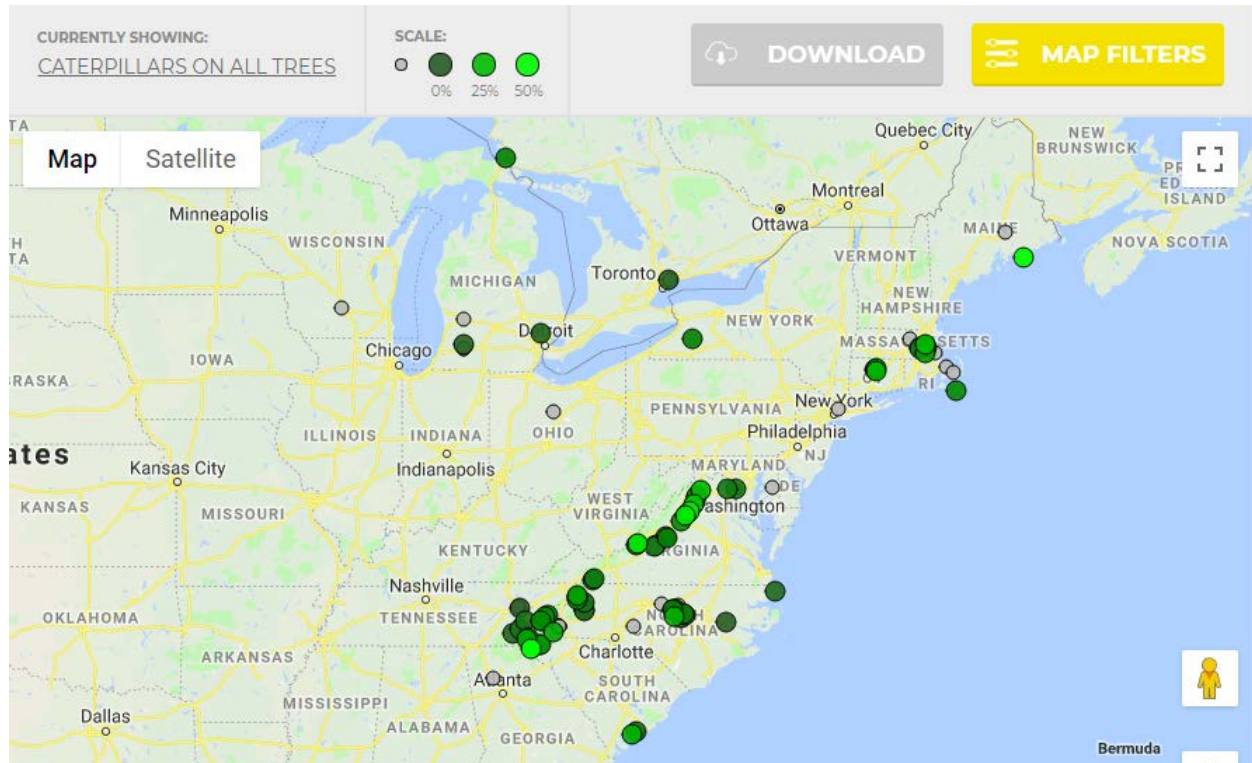
Leaderboard

Keep track of your progress relative to other survey sites throughout the year by checking out the Leaderboard.

	Site name	SURVEYS THIS...			Caterpillars
		Week	**Month**	**Millennium**	
1	CawCaw Interpretive Center (SC)	36 1 survey date(s)	214 5 survey date(s)	397 15 survey date(s)	5.29%
2	Museum of American Bird Art (MA)	30 1 survey date(s)	150 5 survey date(s)	399 14 survey date(s)	19.8%
3	Hemlock Bluffs (NC)	25 2 survey date(s)	76 4 survey date(s)	645 21 survey date(s)	0.31%
4	Sault College (ON)	0 0 survey date(s)	60 2 survey date(s)	400 10 survey date(s)	10.75%
5	Kalamazoo Nature Center (MI)	0 0 survey date(s)	60 2 survey date(s)	363 14 survey date(s)	2.2%
6	Georgetown (DC)	0 0 survey date(s)	39 2 survey date(s)	370 14 survey date(s)	8.38%
7	The Children's Museum (CT)	0 0 survey date(s)	30 2 survey date(s)	127 9 survey date(s)	0.79%
8	Currituck Banks Reserve (NC)	0 0 survey date(s)	30 3 survey date(s)	110 11 survey date(s)	3.64%

You can sort the Leaderboard by site or by individual user. Click on the column headers to sort by the number of surveys conducted in the most recent week, month, or all time (millenium), or by the proportion of surveys on which caterpillars were observed.

Explore the Map

Scroll down from the leaderboard to access a **map** of existing *Caterpillars Count!* sites. By default, the point colors reflect the relative occurrence of caterpillars, but a user may customize this visualization by using the Map Filters button.

Filter Map Data

1) Choose which **Comparison Metric** you would like to display. ***Occurrence*** is the % of survey branches on which the specified arthropod group was found, while ***Density*** is the average number of individuals found per survey.
2) You can limit the display to data collected by a particular **Observation Method** if desired. By default, both ***Visual*** and ***Beat Sheet*** survey data are included.
3) Select the **Arthropod Group** you'd like to include in your visualization.
4) Select the M**inimum Length** in millimeters that you are interested in summarizing. For example, you might decide you only want to know about arthropods larger than 10 mm. By default, data on all sizes will be included.
5) You have the option of restricting your analysis of arthropod density or occurrence to a particular **Plant Species**. Start typing either the scientific or common name and then select the plant species of interest. By default, results will be displayed based on data from all plant species. NOTE: *If you restrict by plant species, you will quickly realize that not all tree species have been surveyed at every location!*
6) Unclick the check box if you do NOT want to include surveys conducted on **Wet Leaves**. Surveys conducted under these conditions may reflect lower insect activity than would otherwise be expected.
7) Adjust the sliders to restrict the **Month**(s) and **Year**(s) of data that you'd like to display.
8) Click **Apply Filters**!

This mapping interface provides the flexibility to investigate a wide range of scientific questions about arthropods found on woody plants. **Example questions** that could be asked:

- *Which locations have the most caterpillars?*
- *How do patterns of arthropod density vary with tree species?*
- *Which locations have surveys conducted on red oak?*
- *How do patterns of beetle density vary when including all beetles, versus including only large beetles?*
- *What is the impact of wet leaves on patterns of arthropod density and occurrence?*
- *Are geographic patterns of arthropod density consistent from year to year?*
- WHAT QUESTIONS DO YOU WANT TO ASK?

The data underlying the mapped values are provided by clicking on the **Download** button at the map's top right.

Exploring Site Specific Data

To dive into data from a particular site, **click a location on the map** or the site name on the leaderboard. That site will now show up as a yellow dot on the map. Keep scrolling below the map and you'll find a **site description**, a **summary of site data**, and a **leaderboard for users at that site**, with survey statistics that can be sorted by column headers.

Here's an example from the NC Botanical Garden site in Chapel Hill, North Carolina:

NC BOTANICAL GARDEN

Survey sites are along the Streamside Trail of the North Carolina Botanical Garden.

Last surveyed 47 days ago.

SITE SUMMARY

| Users	Surveys	Arthropod Groups	Arthropods	Caterpillars
31	6227	14	12960	453

USER LEADERBOARD

Visit your Settings page and click on "Privacy" to hide your name from leaderboards like these.

| | User name | SURVEYS THIS... | | | | Caterpillars |
		Week	Month	Year	Millennium	
1	Kinsey Fisher	0 0 survey date(s)	0 0 survey date(s)	429 22 survey date(s)	429 22 survey date(s)	5.83%
2	Allison Duprey	0 0 survey date(s)	0 0 survey date(s)	417 21 survey date(s)	417 21 survey date(s)	5.76%
3	Andrew Zachman	0 0 survey date(s)	0 0 survey date(s)	363 21 survey date(s)	363 21 survey date(s)	6.06%
4	Sara Snell	0 0 survey date(s)	0 0 survey date(s)	327 12 survey date(s)	438 17 survey date(s)	7.31%
5	Grace Di Cecco	0 0 survey date(s)	0 0 survey date(s)	245 12 survey date(s)	245 12 survey date(s)	4.9%
6	Allen Hurlbert	0 0 survey date(s)	0 0 survey date(s)	40 9 survey date(s)	796 54 survey date(s)	8.29%
7	Molly Jenkins	0 0 survey date(s)	0 0 survey date(s)	20 1 survey date(s)	20 1 survey date(s)	5%
8	William Larsen	0 0 survey date(s)	0 0 survey date(s)	0 0 survey date(s)	102 5 survey date(s)	1.96%

Graphing data - Phenology

Below the site summary is a graphing tool to help you visualize the **Phenology** (or seasonal variation) and **Composition** of the arthropods found at the site you selected. The default view plots a **line graph** showing the **Percent of Survey** branches examined on any given day at the site of interest with at least one caterpillar.

Click on the y-axis label to change the phenology metric and instead plot seasonal variation in arthropod density (**Arthropods per Survey**).
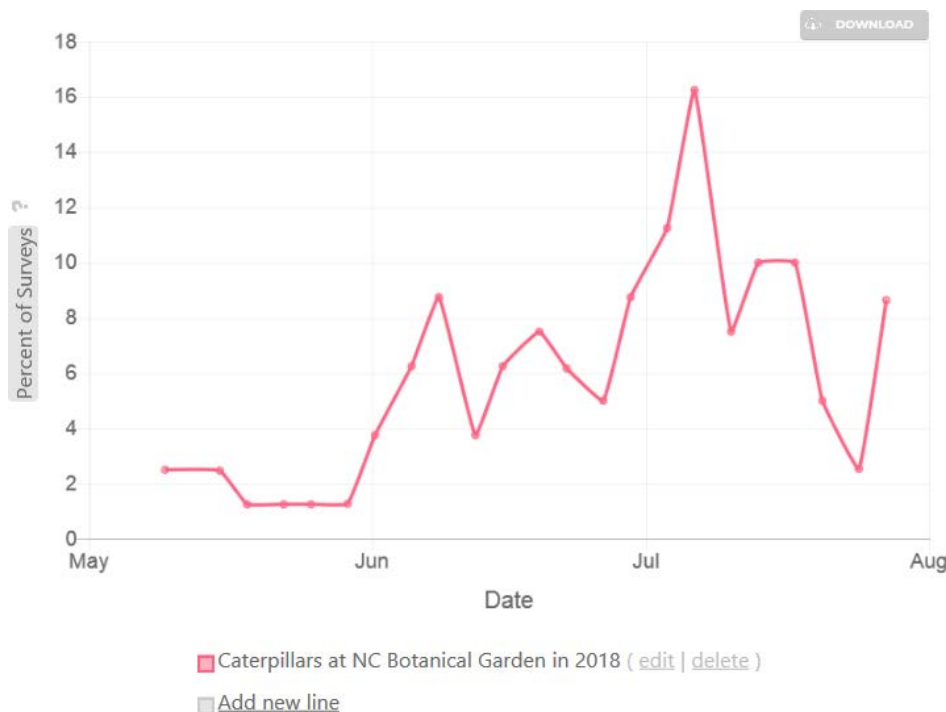
Use the **Add New Line** link at the bottom to add a new phenology curve to the graph. You will be able to select the arthropod group, the site, and the year you'd like to display by clicking on those terms. Then click **confirm**.


You can add up to 14 phenology curves to the same graph.

Example questions that could be asked with this data visualization tool:
- *Which types of arthropods exhibit a seasonal peak in abundance?*
- *Is the timing of the peak consistent between years?*
- *Is the timing of the peak consistent between tree species in the same year?*
- *Is the timing of the peak consistent across different sites?*

Graphing data – Arthropod Composition
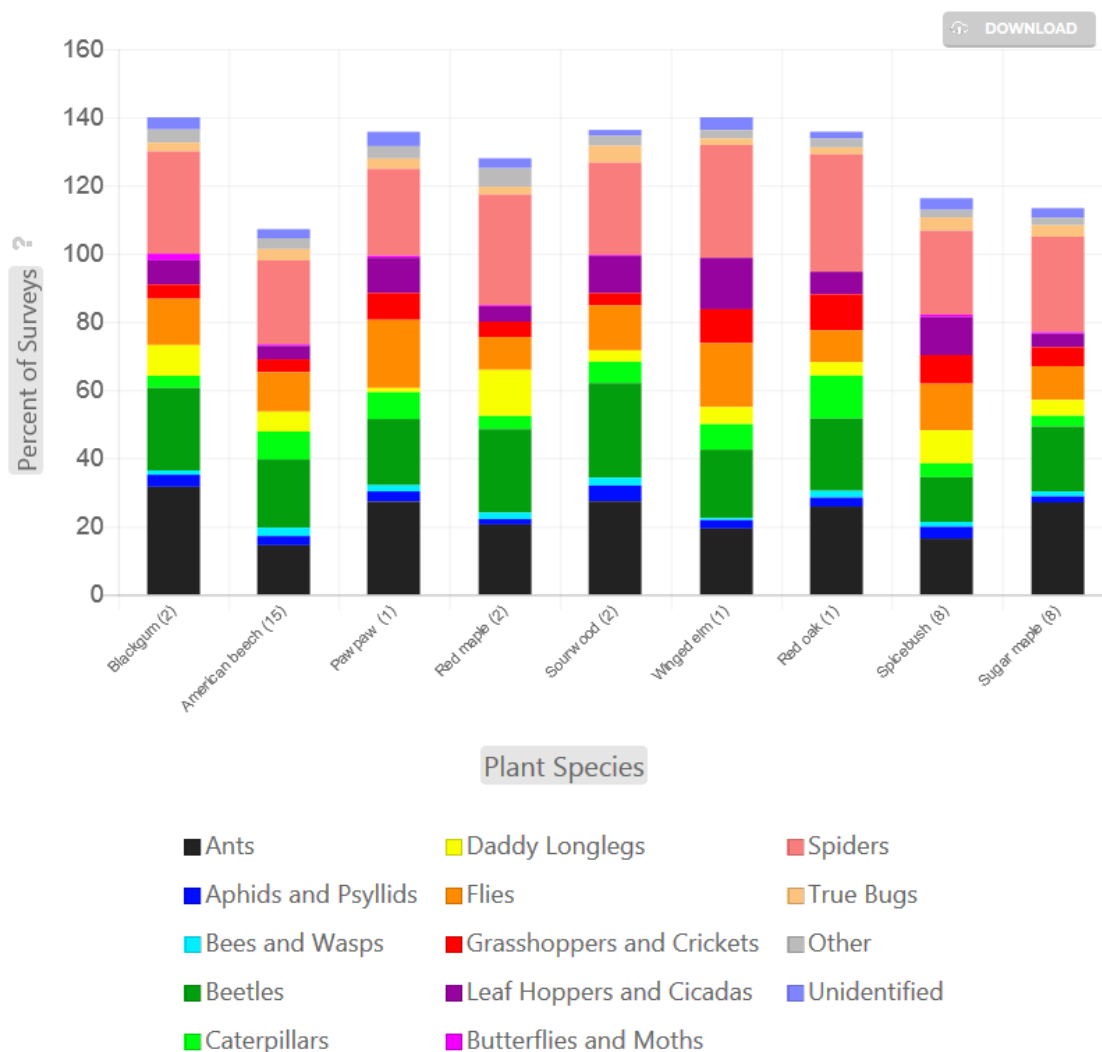
Clicking the **Composition** tab at the top of the **Graphs** panel will change the visualization to a bar graph depicting the prevalence of the different arthropod groups found at the site. You can get a **breakdown of arthropod composition for this site by Year or Plant Species** by clicking the "Site" label on the x-axis (which now reads "Plant Species" in the above figure).

To compare arthropod composition between sites, set the x-axis label to "Site" and then click "Add".

Change the composition metric being plotted by clicking the y-axis label. Options include:

- **Percent of Arthropods**: The percentage of all arthropods encountered by number of individuals. Must sum to 100 across arthropod groups.
- **Percent of Surveys**: The percent of survey branches with at least one arthropod of the type specified. Need not sum to 100 across arthropod groups.

- **Arthropods per Survey**: The total number of arthropods encountered divided by the total number of surveys calculated for each arthropod group.

Example questions that could be asked with this data visualization tool:
- *Which types of arthropods are most frequently encountered at my site?*
- *How do tree species differ in terms of the types of arthropods that are found on their leaves?*
- *Do spiders occur at some sites more frequently than at other sites?*
- *Has the relative abundance of different arthropod types changed over time at my site?*

Data availability

The data underlying any **Phenology** or **Composition** graphs created can be acquired using the **Download** buttons at the top right of each graph.

For advanced users, the raw Caterpillars Count! data can be downloaded from the Explore > Data Download page.

Data submitted by Caterpillars Count! participants are provided "as is", and no warranty, express or implied, is made regarding their accuracy, completeness, or reliability. These data are licensed under a Creative Commons CCZero 1.0 License.

Background Information for Class Instructors

Many of the patterns that will emerge from these data that you help collect have never been well described, so in many cases there is no "answer key"! The students or participants that you engage in this project are contributing important data that will help us better understand how foliage arthropods vary over time and across the map.

That said, here are some things we DO KNOW.

1. *Seasonality*

Just as leaves bud later and are on the trees for a shorter period of time farther north, we expect the same pattern for many insect groups. Temperature is expected to be a direct controller of both the timing of leaf out as well as insect development time. So expect to see peak densities of arthropods later at higher latitudes and elevations. The National Phenology Network (http://www.usanpn.org) has excellent resources and background information on phenology. See also our special Phenology Lesson Plan, linked on the project website.

2. *Trees as food*

For some arthropods, trees and leaves are merely habitat—a place where they live, hide, and catch other types of food. Spiders and daddy longlegs are great examples of these types of arthropods. But for others, the leaves are not just their habitat, but also their food.

Caterpillars, aphids, leafhoppers and many other arthropods eat leaf tissue or suck plant juices. But just as a twinkie, a hamburger, and a potato have different nutritional value to us, different tree species have different concentrations of proteins, carbohydrates, and potentially toxic secondary compounds that a given herbivore species may or may not have evolved to tolerate.

Caterpillar growth on different tree species. From Singer et al. 2012. Tritrophic interactions at a community level: effects of host plant species quality on bird predation of caterpillars. *The American Naturalist* 179: 363-374.

The graph at right shows an example of how different tree species differ in nutritional quality for caterpillars. The study is by Michael Singer of Wesleyan University, who showed that caterpillars raised on cherry tree leaves grow the most, ending at 45 mg before undergoing metamorphosis. In contrast, caterpillars fed only beech leaves grew to only 2/3 that size, a 33% reduction in growth! Tree species matters!

If you observe much higher densities of certain arthropods on some tree species than others, perhaps it is because of such differences in nutritional quality. Only a controlled experiment will let you know for sure. Science project anyone?