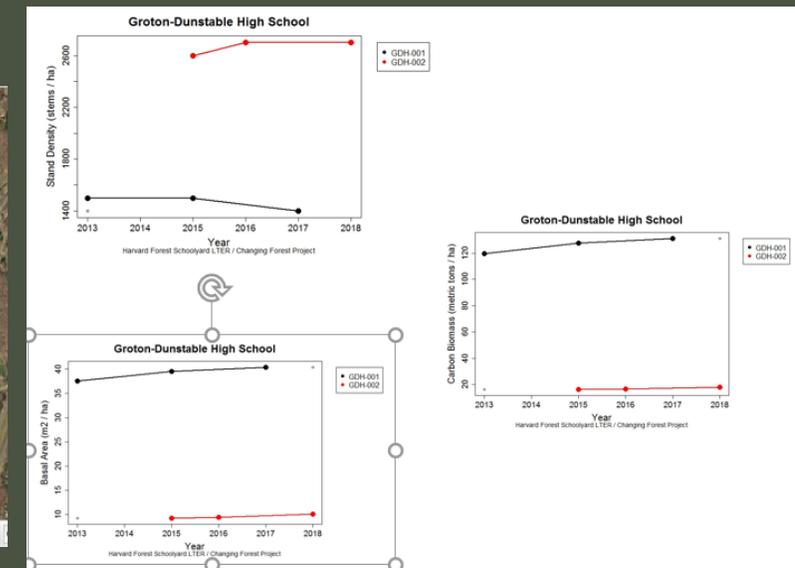
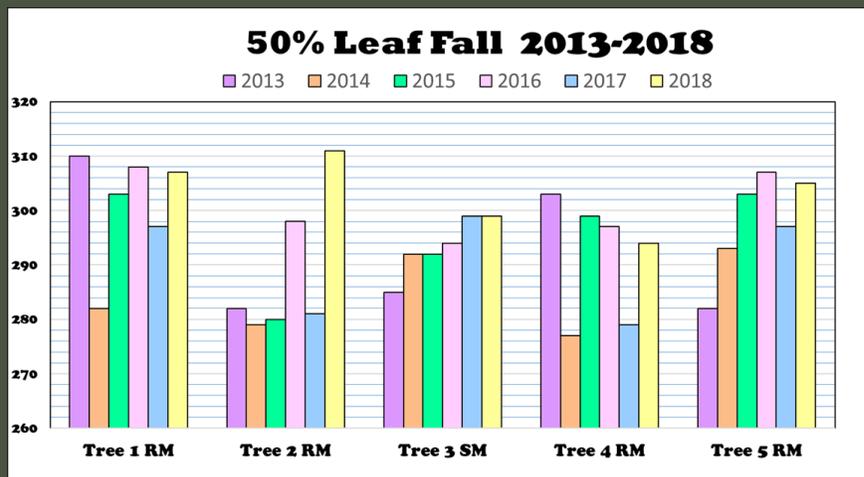




Works in Progress: Teacher Created Graphs and Data Documents

Harvard Forest Schoolyard Ecology Looking at Data Workshop 2019

Compiled by Pamela Snow



Schoolyard Ecology Teachers: Colleen Casey, Emily Chamas, Jane Lucia, Elisa Margarita, Melanie McCracken, Lori Primavera, Joe Scanio, Martha Slone

Harvard Forest Staff and Mentors: Betsy Colburn, John O'Keefe, Lucy Lee, Ann Lewis, Clarisse Hart, Emery Boose

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Section One: Representing Our Changing Forests Project Data

Schoolyard Ecology Teachers: Emily Chamas, Melanie McCracken, Joe Scanio

Harvard Forest Staff and Mentors: Betsy Colburn, John O'Keefe, Lucy Lee, Ann Lewis, Clarisse Hart, Emery Boose

Figure 1: Our Changing Forests, Groton-Dunstable Looking at Data Learning Progression



► Description of Document:

Introduction to learning activities engaging students in interpreting project data. This learning progression begins in the classroom examining a series of teacher-created graphs of student data. Students then go out to the woods to see the story the data is telling by looking at the trees with an eye towards density, size, species, composition, etc.

► Teacher/Author:

Melanie McCracken

► School:

Groton-Dunstable High School

► Grade Level:

High School

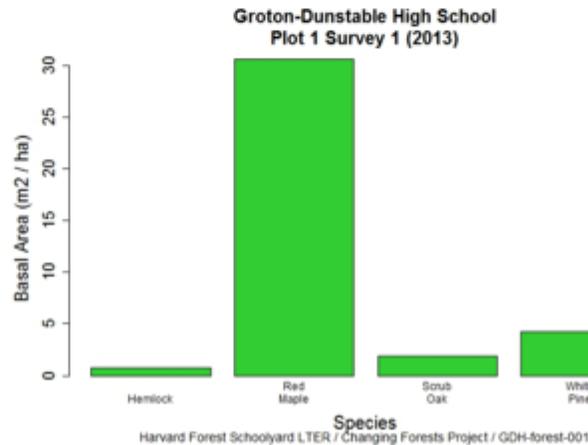
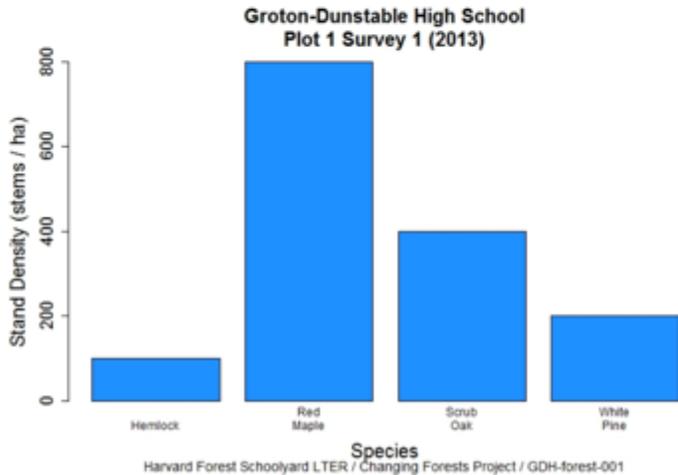
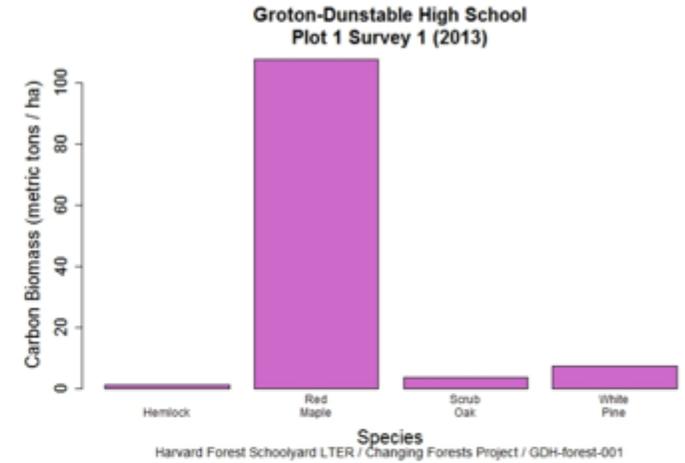
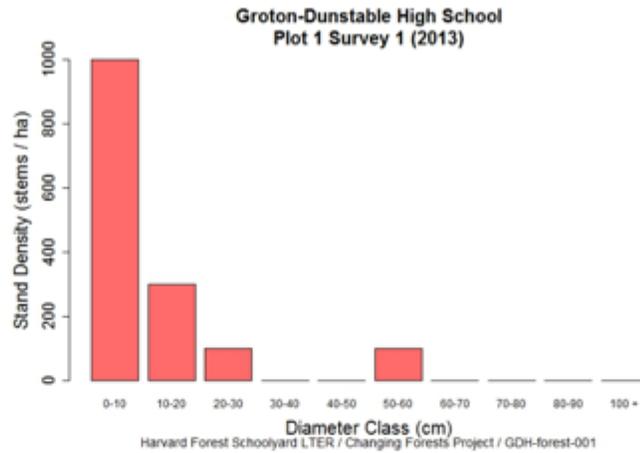
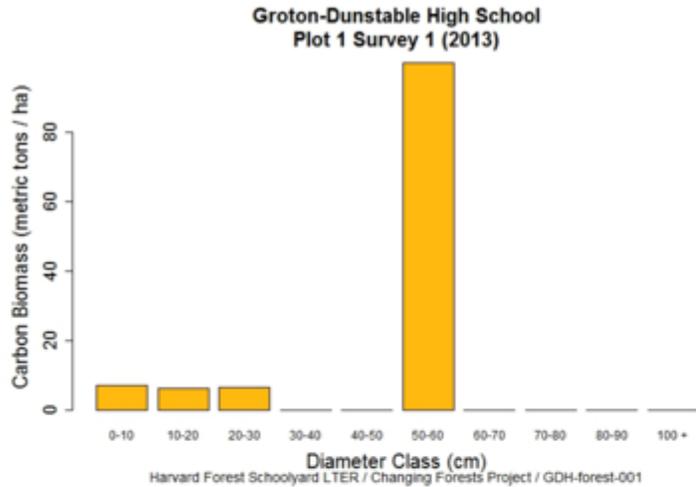
► Harvard Forest Mentors:

Betsy Colburn

► Notes : See notes below

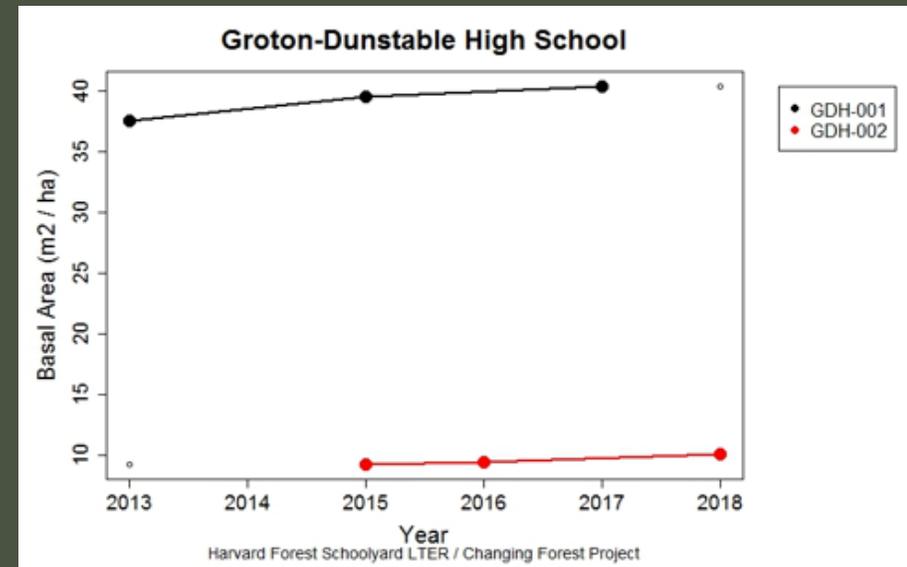
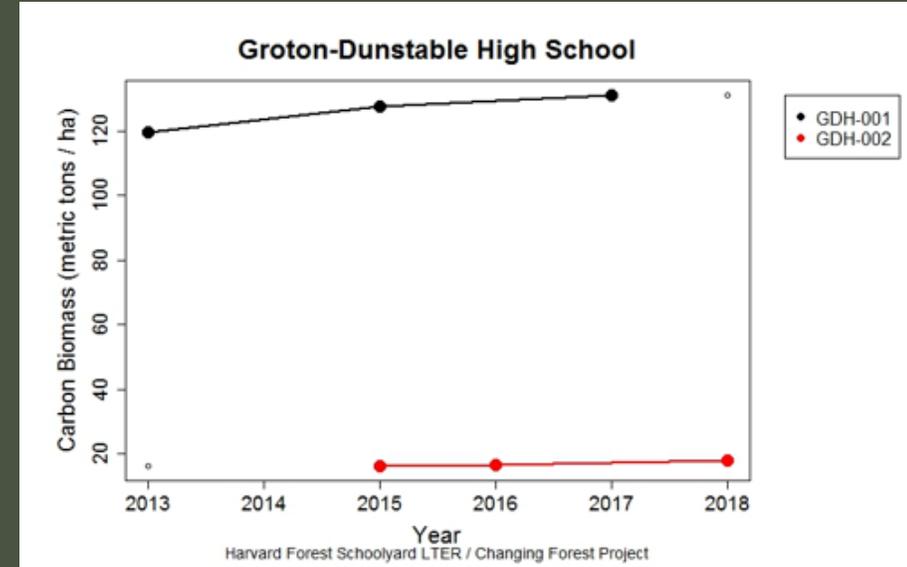
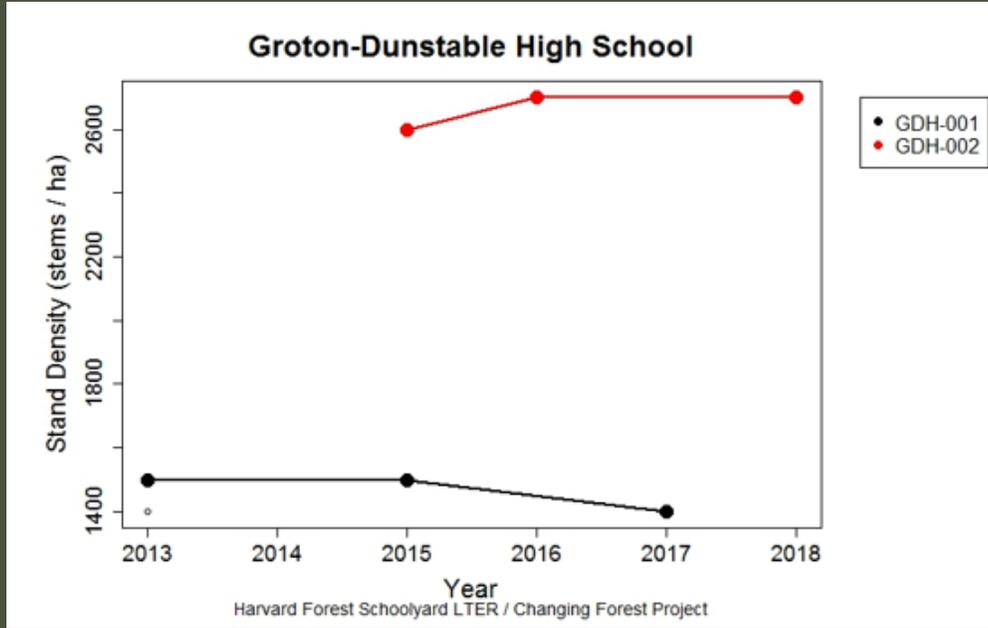
- Interpreting Our Changing Forests Project Graphs
- Look at the following graphs and use the information to differentiate two forest plots
- Make a list of as many facts about each site as you can
- Make a list of any similarities and any differences between sites
- Draw a picture of the sites

Figure 2: Groton Dunstable Our Changing Forests Graph Series (2013) For Learning Activity



Teacher: Melanie McCracken

Figure 3: Our Changing Forests Graph Series (2013-18) For Learning Activity



This series of graphs shows change in basal area, stand density and carbon biomass in study plots from 2013-17. These graphs were created using the HF online graphing tool. These data representations are embedded in a learning activity engaging students in interpreting project data.

Teacher: Melanie McCracken

Figure 4: Our Changing Forests Graph Series (2015) For Learning Activity



► Description of Document:

A series of graphs showing basal area, stand density and carbon biomass in study plots from 2015. These graphs were created using the HF online graphing tool. This series of graphs is embedded in a learning activity engaging students in interpreting project data.

► Teacher/Author:

Melanie McCracken

► School:

Groton-Dunstable High School

► Grade Level:

High School

► Harvard Forest Mentors:

Betsy Colburn

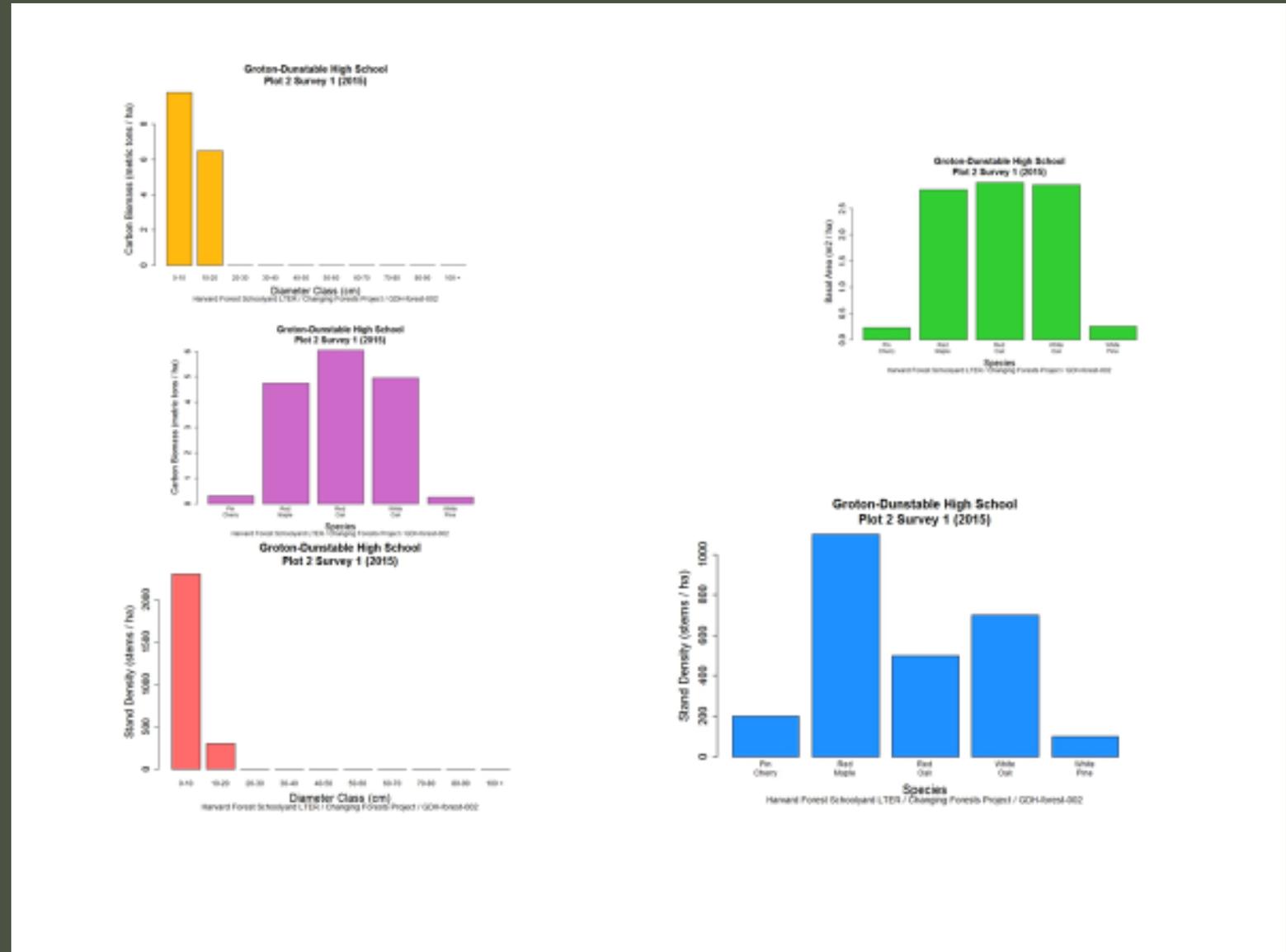




Figure 5: Our Changing Forests Field View Learning Activity

► Description of Document:

As the concluding piece of this learning activity, students will go outside to observe how density, size, and variety of trees appear

To the eye as compared with what the data looked like in the related graphs.

► Teacher/Author:

Melanie McCracken

► School:

Groton-Dunstable High School

► Grade Level:

High School

► Harvard Forest Mentors:

Betsy Colburn

► Notes : See notes below

Lets go outside and take a look!

- Bring your clipboards, paper and pencils
- Take notes on each site
 - How dense is the plot
 - How big are the trees
 - What types of trees are there
 - Draw a sketch of the site

Figure 6: Tree Diameters in the Our Changing Forests Plot at Applewild School 2016-2017



► Description of graph and related data table:

Graph 5 shows the diameters of each study tree in Plot 1 at Applewild School in Fitchburg, Ma. over 2 years.

► Teacher/Author:

Emily Chamas

► School:

Applewild School

► Grade Level:

8

► Harvard Forest Mentors:

Ann Lewis, Betsy Colburn

► Notes : See notes below

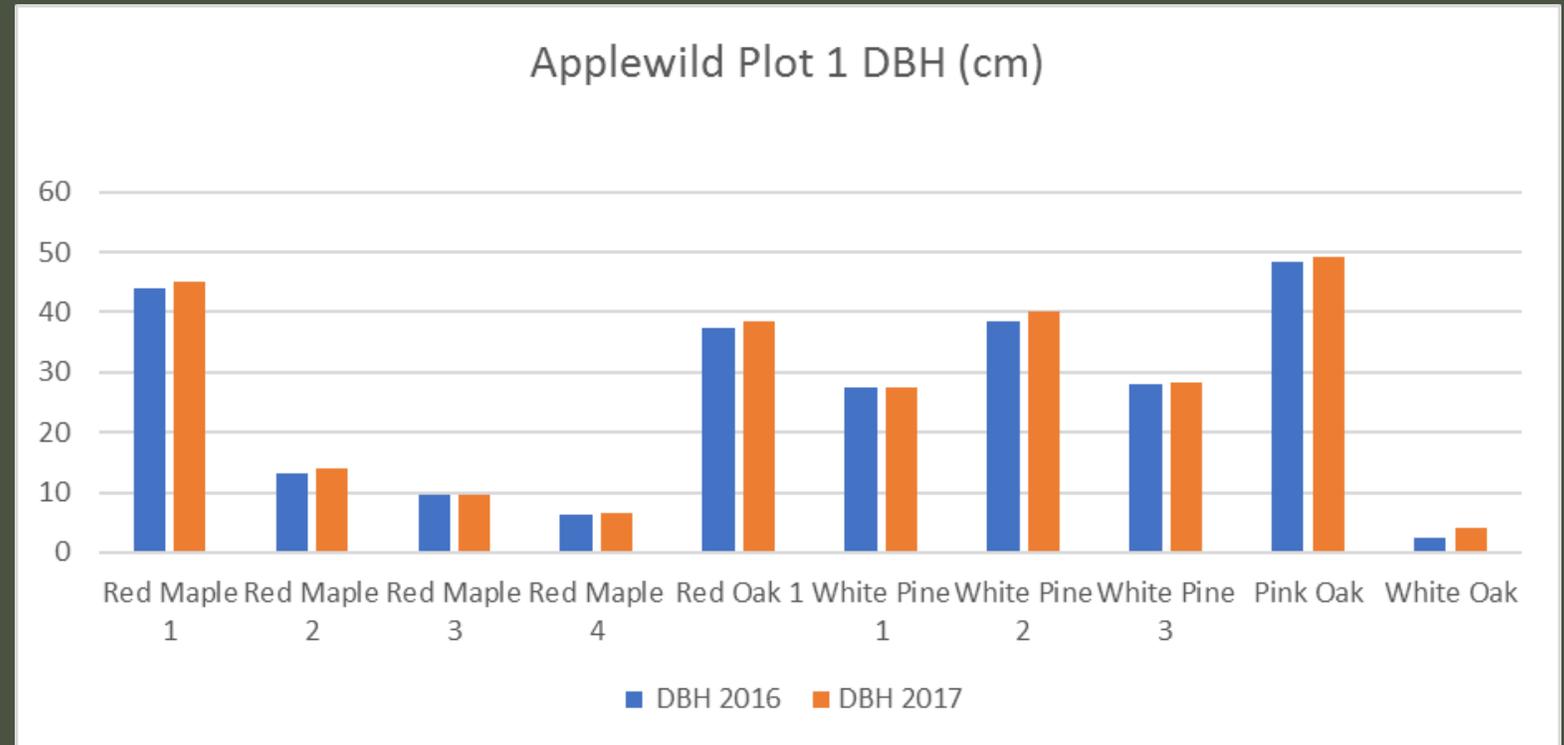


Figure 7: Our Changing Forests Study Tree Spatial Analysis by Ecological Community Type



► Description of graph and related data table:

This GIS map shows the location and size class of each tree in the Our Changing Forests study plot at Choate Rosemary Hall School in Ct.

► Created using QGIS which is a free version of GIS.

► Teacher/Author:

Joe Scanio

► School:

Choate Rosemary Hall

► Grade Level:

11,12

► Harvard Forest Mentor:

Lucy Lee

► Notes : See notes below

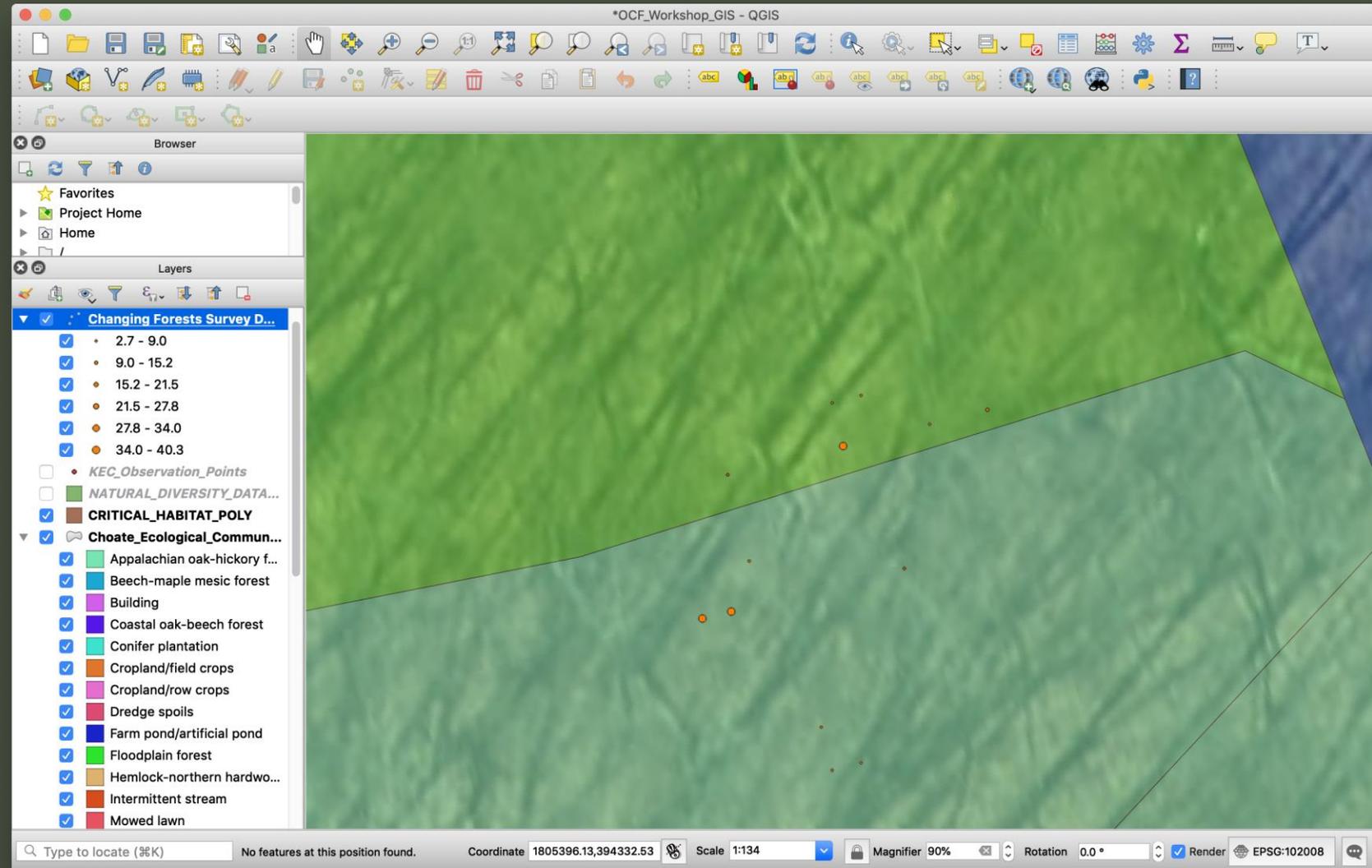


Figure 8: Schoolyard Scale Spatial Analysis of Study Trees by Ecological Community Type



► Description of graph and related data table:

This map shows observation points at Choate School by location, colored according to type of ecological community.

► Teacher/Author:

Joe Scanio

► School:

Choate Rosemary Hall School

► Grade Level:

11,12

► Harvard Forest Mentor:

Lucy Lee

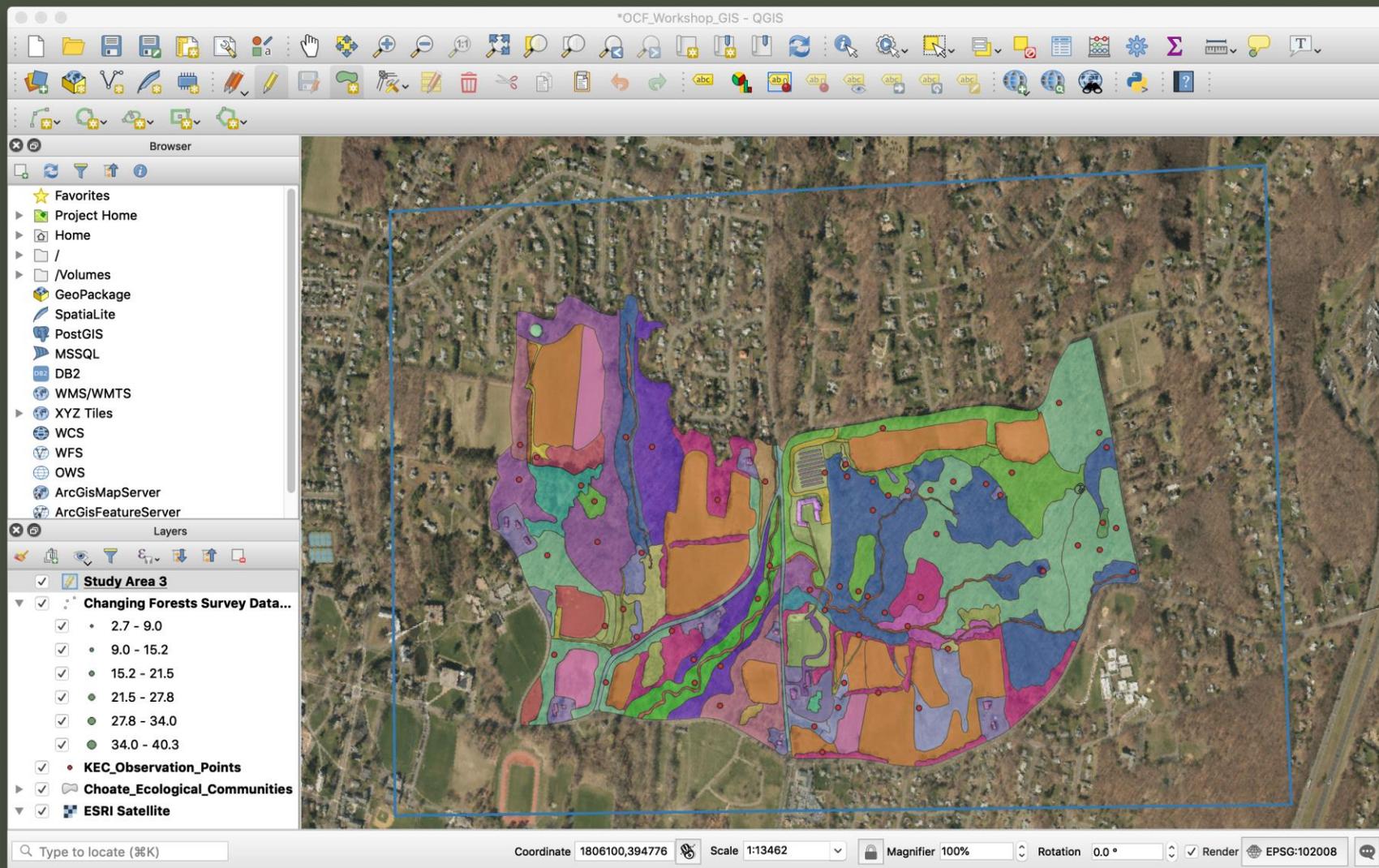




Figure 9: Schoolyard Scale Spatial Analysis of Biomass Study Trees

Description of graph and related data table:

This map shows average carbon biomass by site at all Schoolyard field sites. Tableau software was used to create this map. This figure was developed last year.

Teacher/Author:

Joe Scanio

School:

Choate Rosemary Hall School

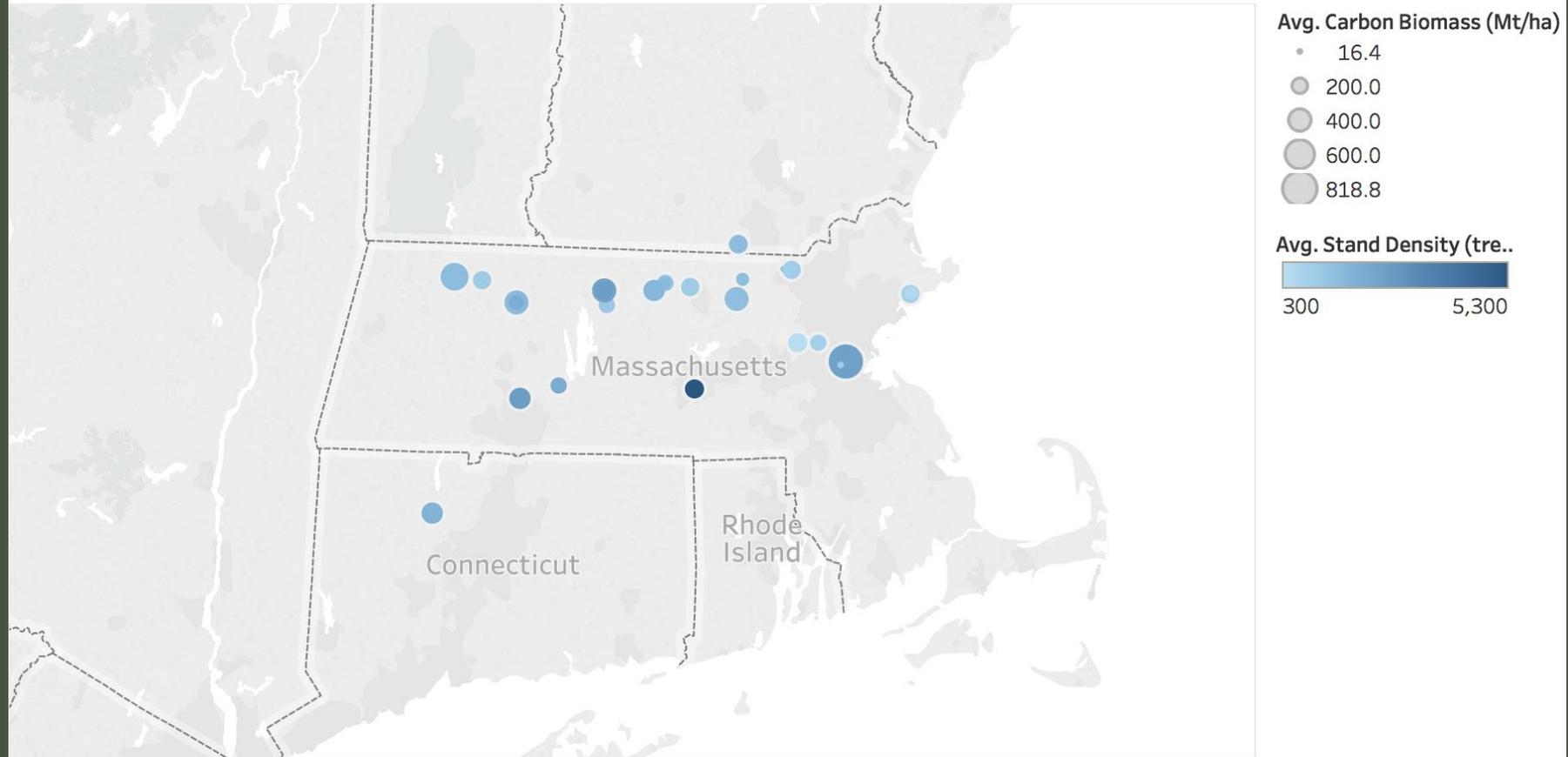
Grade Level:

11,12

Harvard Forest Mentor:

Not Applicable

Carbon Biomass by Site



Map based on average of Longitude (deg) and average of Latitude (deg). Color shows average of Stand Density (trees/ha). Size shows average of Carbon Biomass (Mt/ha). Details are shown for Site Code. The data is filtered on Year, which keeps 2013, 2014, 2015, 2016 and 2017.

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Section Two: Representing Buds, Leaves and Global Warming Project Data

Schoolyard Ecology Teachers: Colleen Casey, Jane Lucia, Elisa Margarita, Lori Primavera, Martha Slone

Harvard Forest Staff and Mentors: Betsy Colburn, John O'Keefe, Lucy Lee, Ann Lewis, Clarisse Hart, Emery Boose



Figure 10 : 50% Leaf Fall 2013-2018

► Description of graph and related data table:

Graph 1 shows leaf fall dates for each season by study tree (Red Maples and Sugar Maple) over 6 years. Each bar here represents an individual tree.

► Teacher/Author:

Lori Primavera

► School:

Trinity Catholic Academy

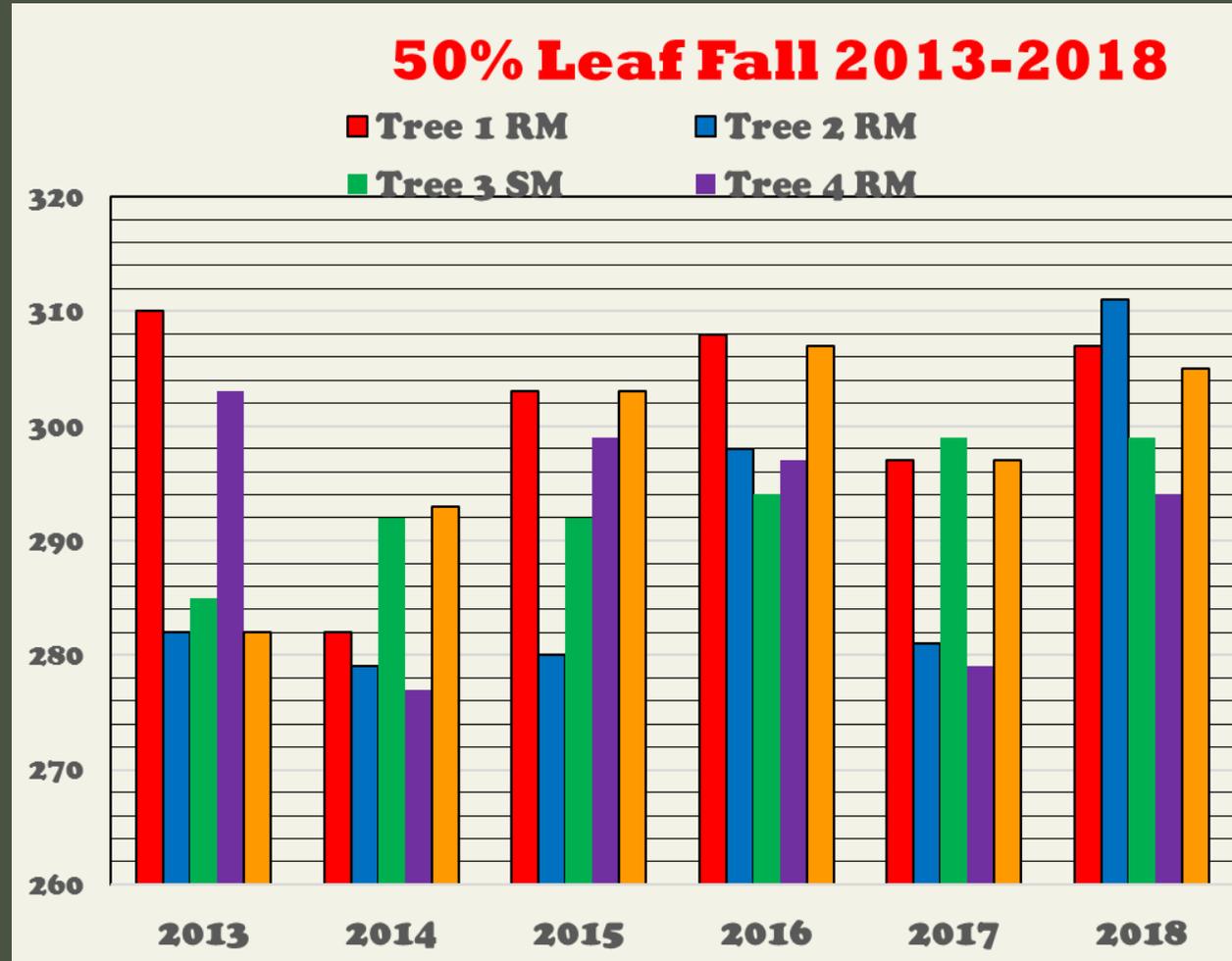
► Grade Level:

4,5

► Harvard Forest Mentors:

Ann Lewis, Betsy Colburn

► Notes : See notes below



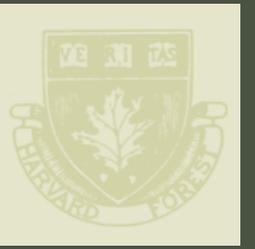


Figure 11: 50% Leaf Fall 2013-2018

► Description of graph and related data table:

Graph 2 shows timing of leaf drop by year for each study tree over 6 years. Each bar here represents the year that tree data was collected, and grouped by tree.

► Teacher/Author:

Lori Primavera

► School:

Trinity Catholic Academy

► Grade Level:

4,5

► Harvard Forest Mentors:

Ann Lewis and Betsy Colburn

► Notes : See notes below

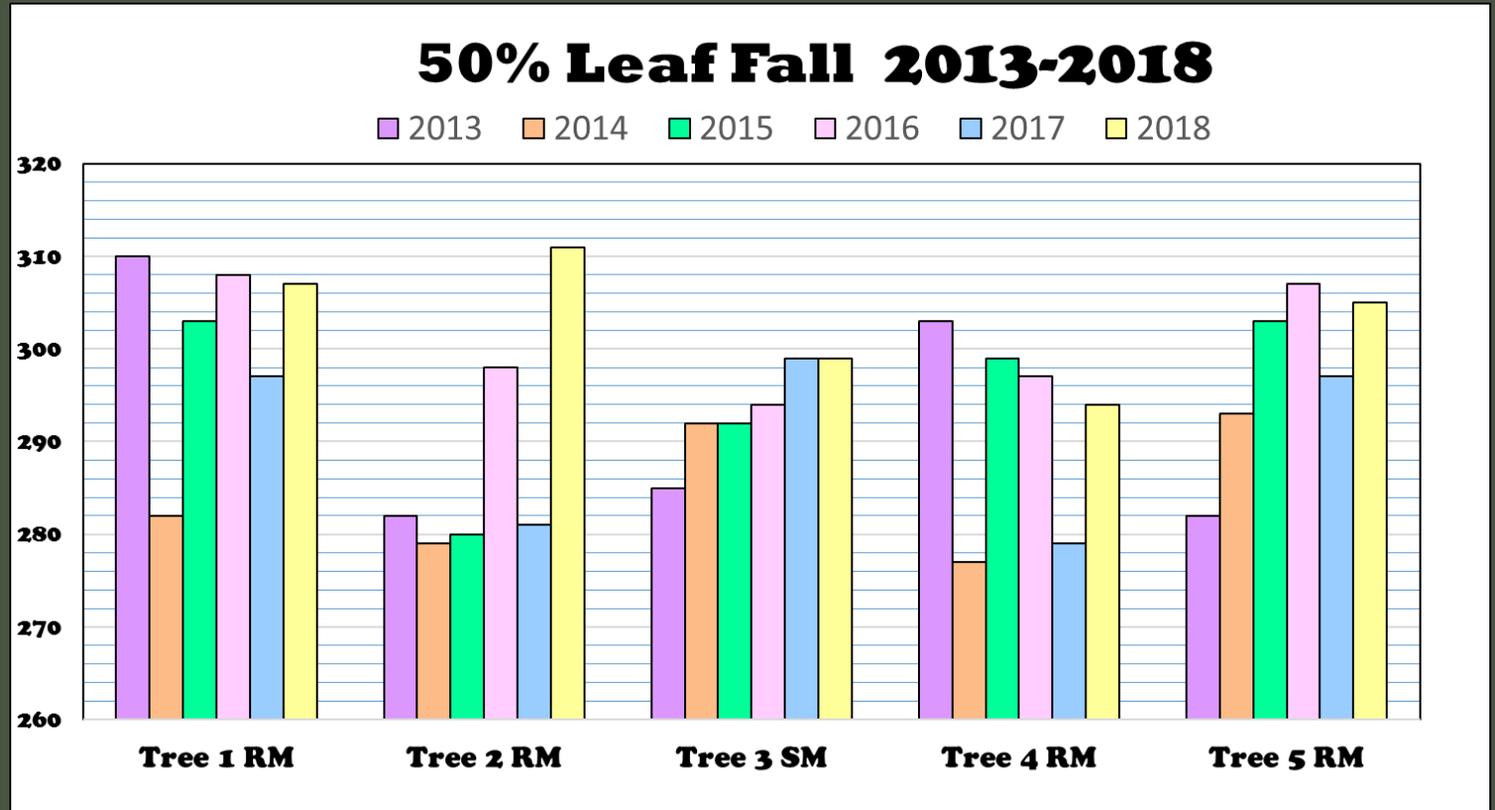
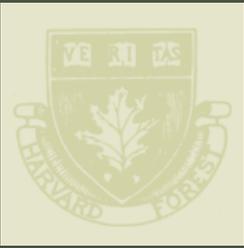


Figure 12: Growing Season by Tree 2014-2018



► **Description of graph and related data table:**

Graph 3 shows the length of the growing season by study tree over 5 years at Trinity Catholic Academy field site. Each bar shows the length of the growing season for that year (by tree).

► **Teacher/Author**

Colleen Casey

► **School:**

Trinity Catholic Academy

► **Grade Level:** 4,5

► **Harvard Forest Mentors:**

Ann Lewis, Betsy Colburn

► **Notes :** See notes below

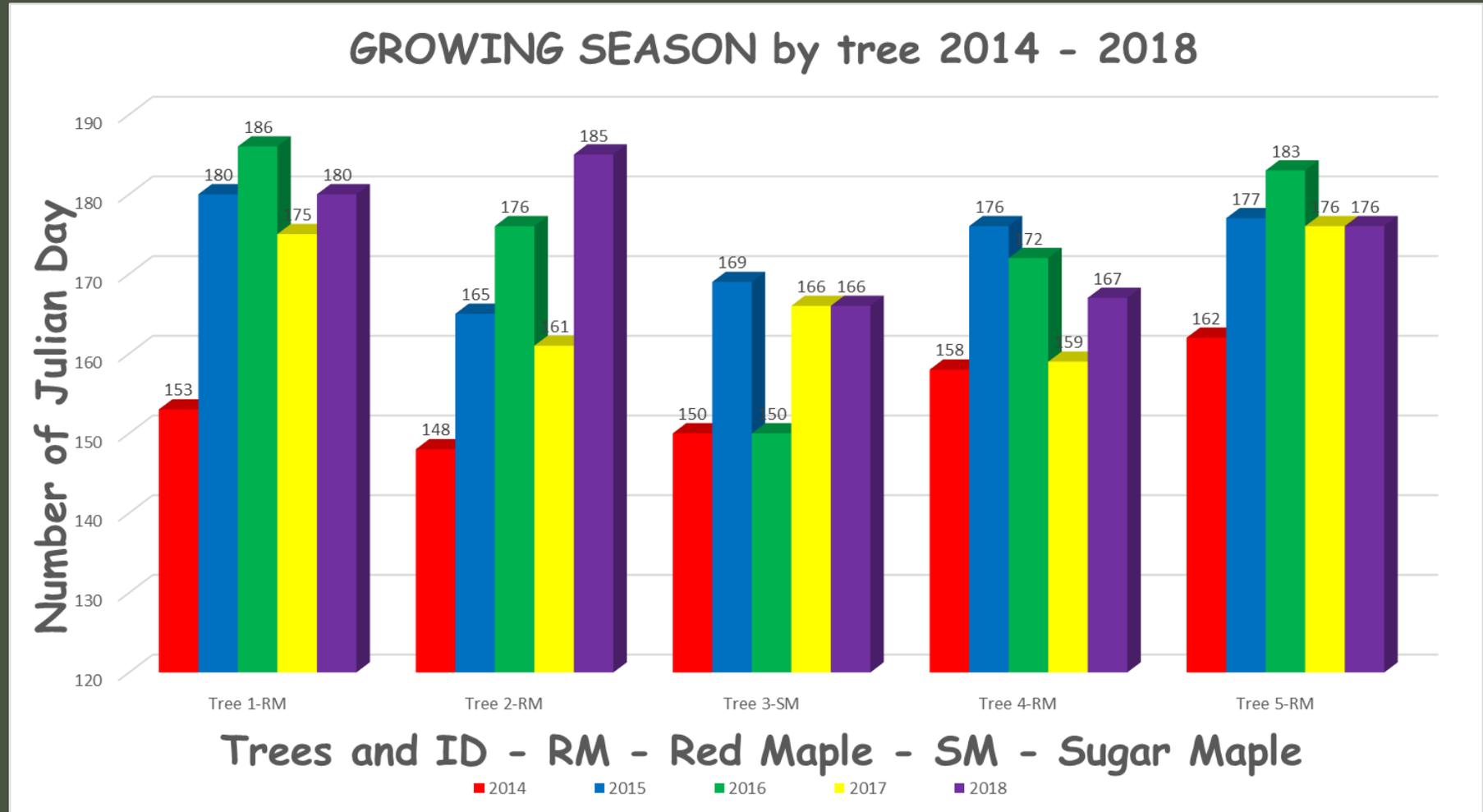


Figure 13: Growing Season by Year 2014-2015 at Trinity



► **Description of graph and related data table:**

This graph also shows growing season of each study tree over 5 years. However the individual bars are representing individual trees and are grouped by year.

► **Teacher/Author:**

Colleen Casey

► **School:**

Trinity Catholic Academy

► **Grade Level:** 4,5

► **Harvard Forest Mentors:**

Ann Lewis, Betsy Colburn

► **Notes:** See Notes below

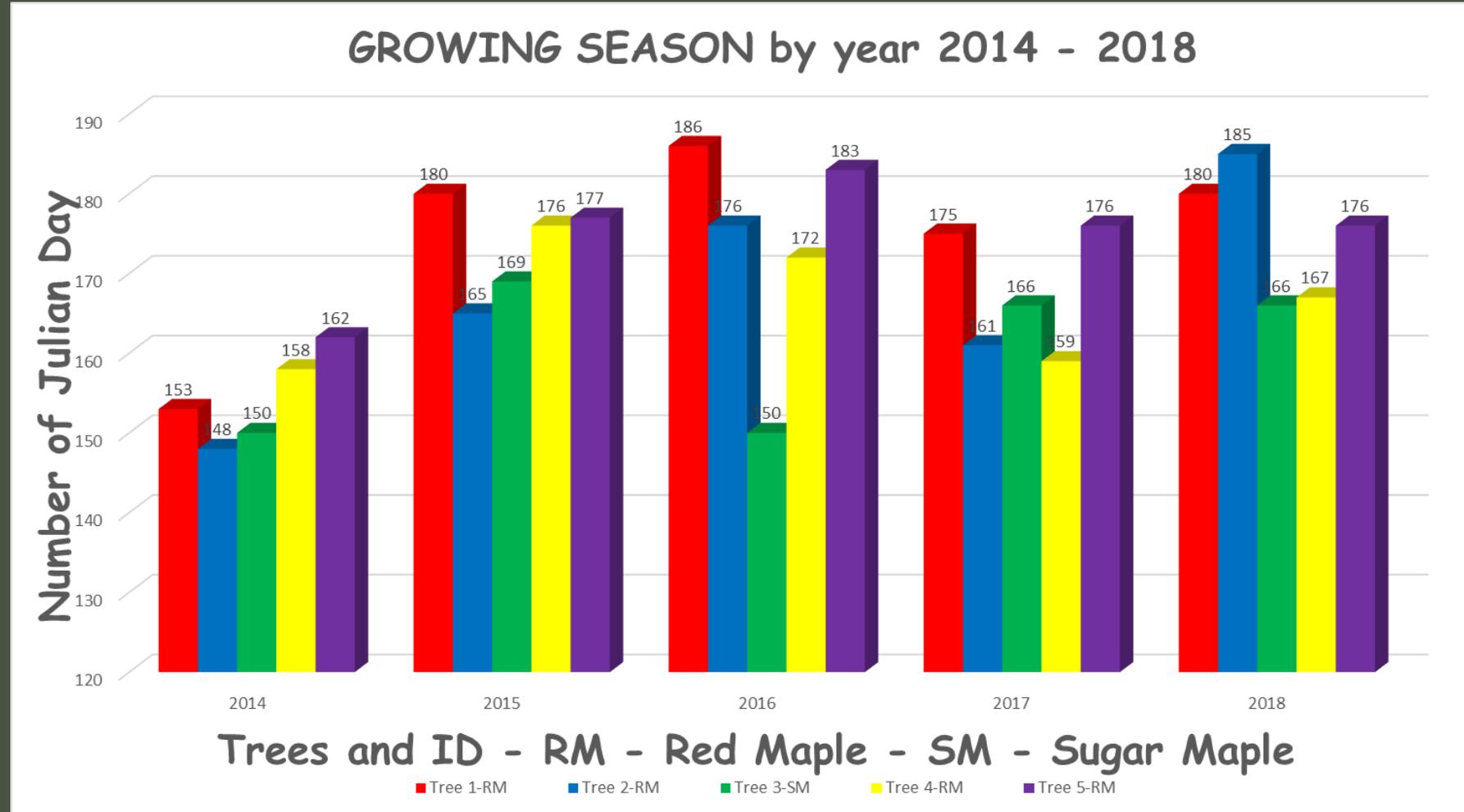


Figure 14: Building Data Literacy at Brooklyn Technical School



Description of graph and related data table:

In working towards the learning goal of supporting students more effectively in data representation, Elisa Margarita developed this set of questions to help them better see what their project data is saying. These questions will be answered by students as they refer to the set of graphs that follows in the next slides.

Teacher/Author:

Elisa Margarita

School:

Brooklyn Technical School

Grade Level:

High School

Harvard Forest Mentors:

Ann Lewis, John O'Keefe, Betsy Colburn

Student Page:

Look at the data and what questions do you have?

Five Questions: 50 % Leaf drop by date for the trees.

1. Why did we only have results for 5 trees from 2016-2018?
2. What is the 50 % drop date range by tree from 2016-2018?
3. How does the data compare by different species from 2016-2018?
4. How does the data compare by same species from 2016-2018?
5. How does our tree data compare to another campus with similar trees? Or How does our trees compare to Dr. O'Keefe's data?



Figure 15: Timing of Leaf Fall at Brooklyn Technical School 2018

► **Description of graph and related data table:**

► This graph shows the timing of leaf fall in Autumn of 2018 by tree. It was created using the Harvard Forest online graphing tool.

► **Teacher/Author:**

Elisa Margarita

► **School:**

Brooklyn Technical School

► **Grade Level:**

High School

► **Harvard Forest Mentors:**

Ann Lewis, John O'Keefe, Betsy Colburn

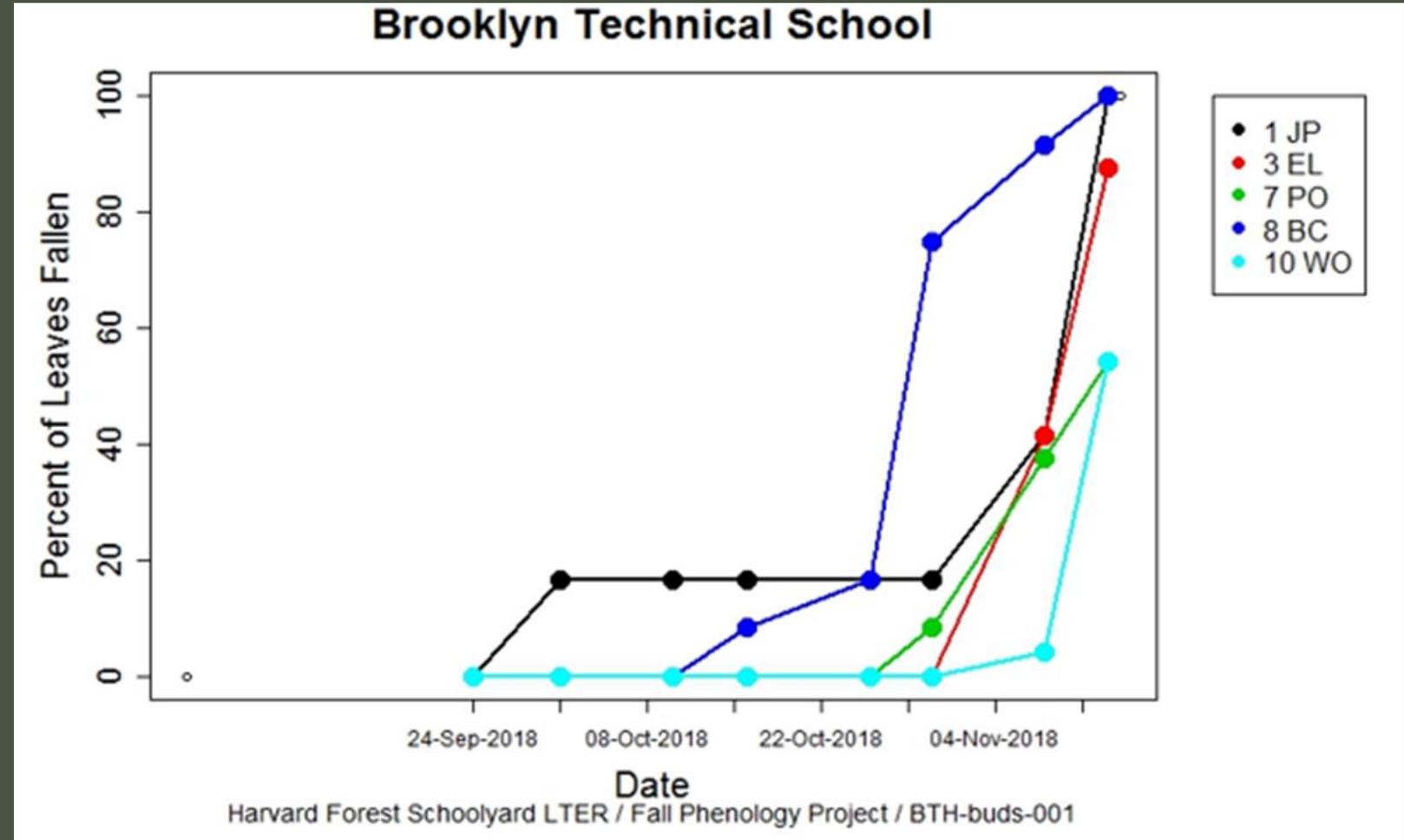
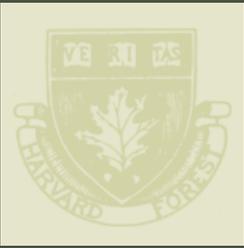


Figure 16: Timing of Leaf Color Change at Brooklyn Technical School 2018



► **Description of graph and related data table:**

► This graph shows the timing of leaf color change by tree in 2018. It was created using the Harvard Forest online graphing tool.

► **Teacher/Author:**

Elisa Margarita

► **School:**

Brooklyn Technical School

► **Grade Level:**

High School

► **Harvard Forest Mentors:**

Ann Lewis, John O'Keefe, Betsy Colburn

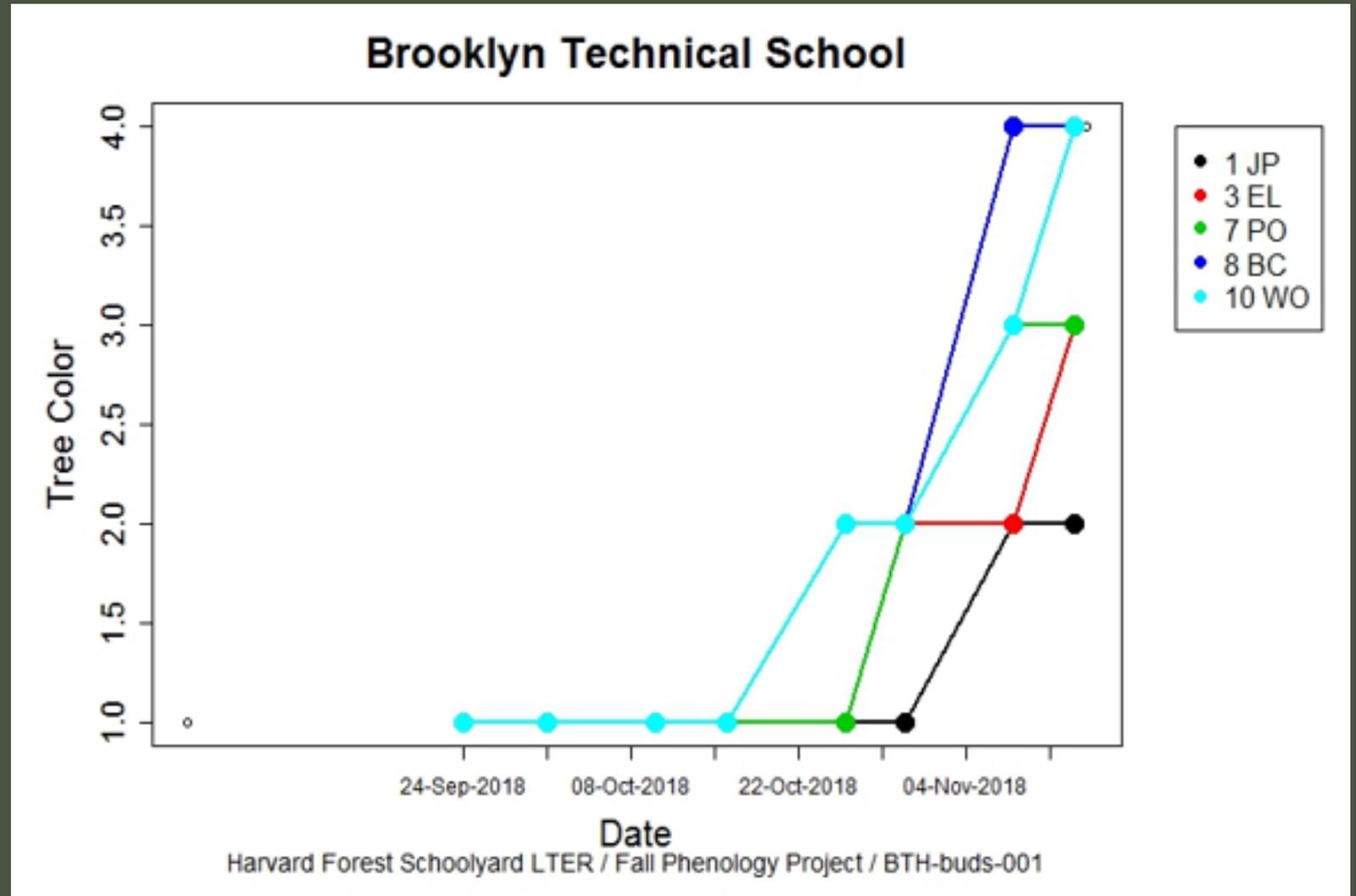
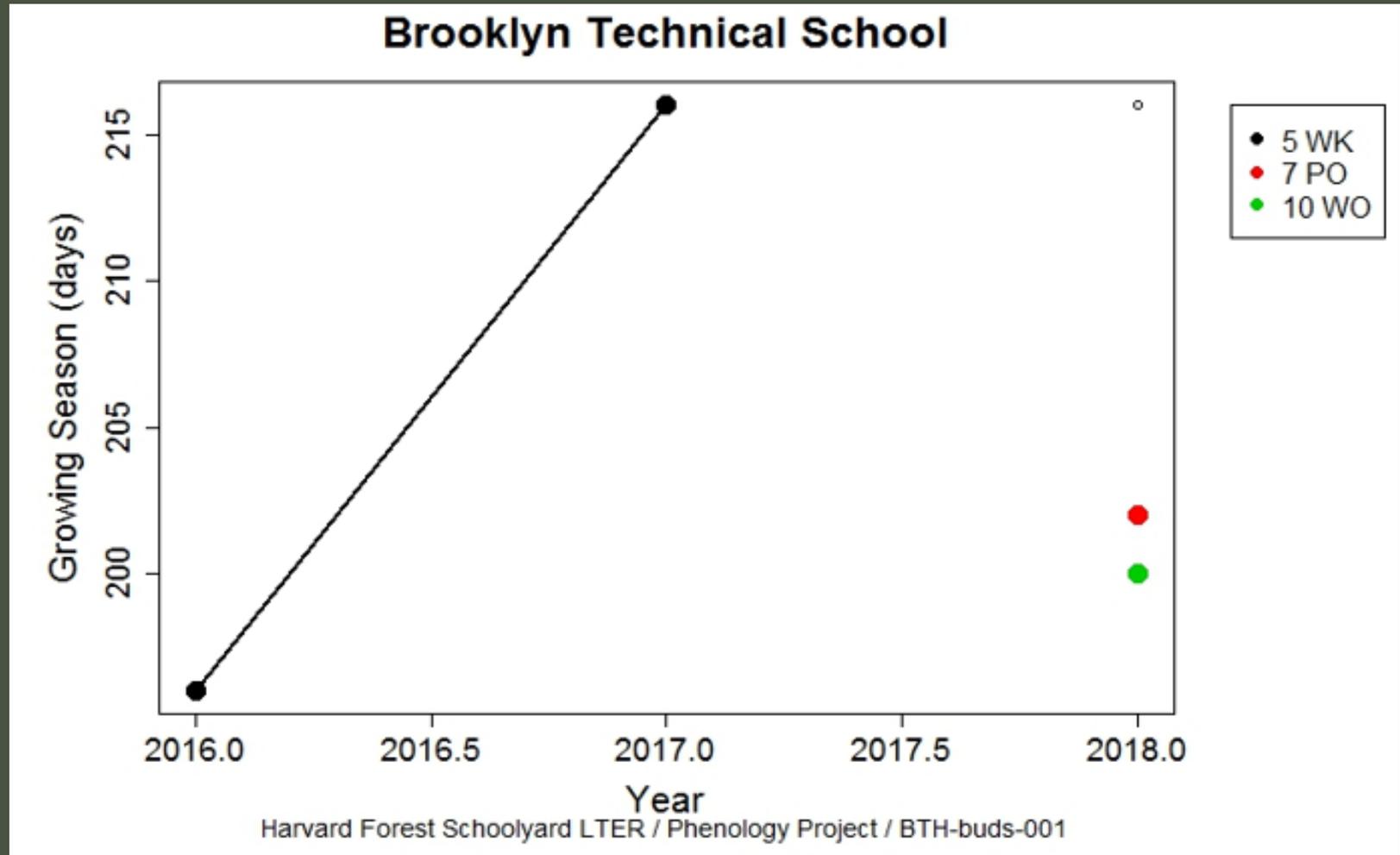




Figure 17: Length of the Growing Season at Brooklyn Technical School 2016-18

- ▶ **Description of graph and related data table:**
- ▶ This graph shows the length of the growing season for study trees from 2016 to 2018. It was created using the Harvard Forest online graphing tool.
- ▶ **Teacher/Author:**
Elisa Margarita
- ▶ **School:**
Brooklyn Technical School
- ▶ **Grade Level:**
High School
- ▶ **Harvard Forest Mentors:**
Ann Lewis, John O'Keefe, Betsy Colburn



▶ See Notes Below

Figure 18: Length of the Growing Season at Belchertown High School 2009-17



Description of graph and related data table:

This graph shows data from a school in the HF Schoolyard Ecology network that has significantly more data than Brooklyn Technical. Here the lengths of the growing season by study trees from 2009 to 2017 are shown. This graph was created using the Harvard Forest online graphing tool.

Teacher/Author:

Elisa Margarita

School:

For use at Brooklyn Technical School

Grade Level:

High School

Harvard Forest Mentors:

Ann Lewis, John O'Keefe, Betsy Colburn

See Notes Below

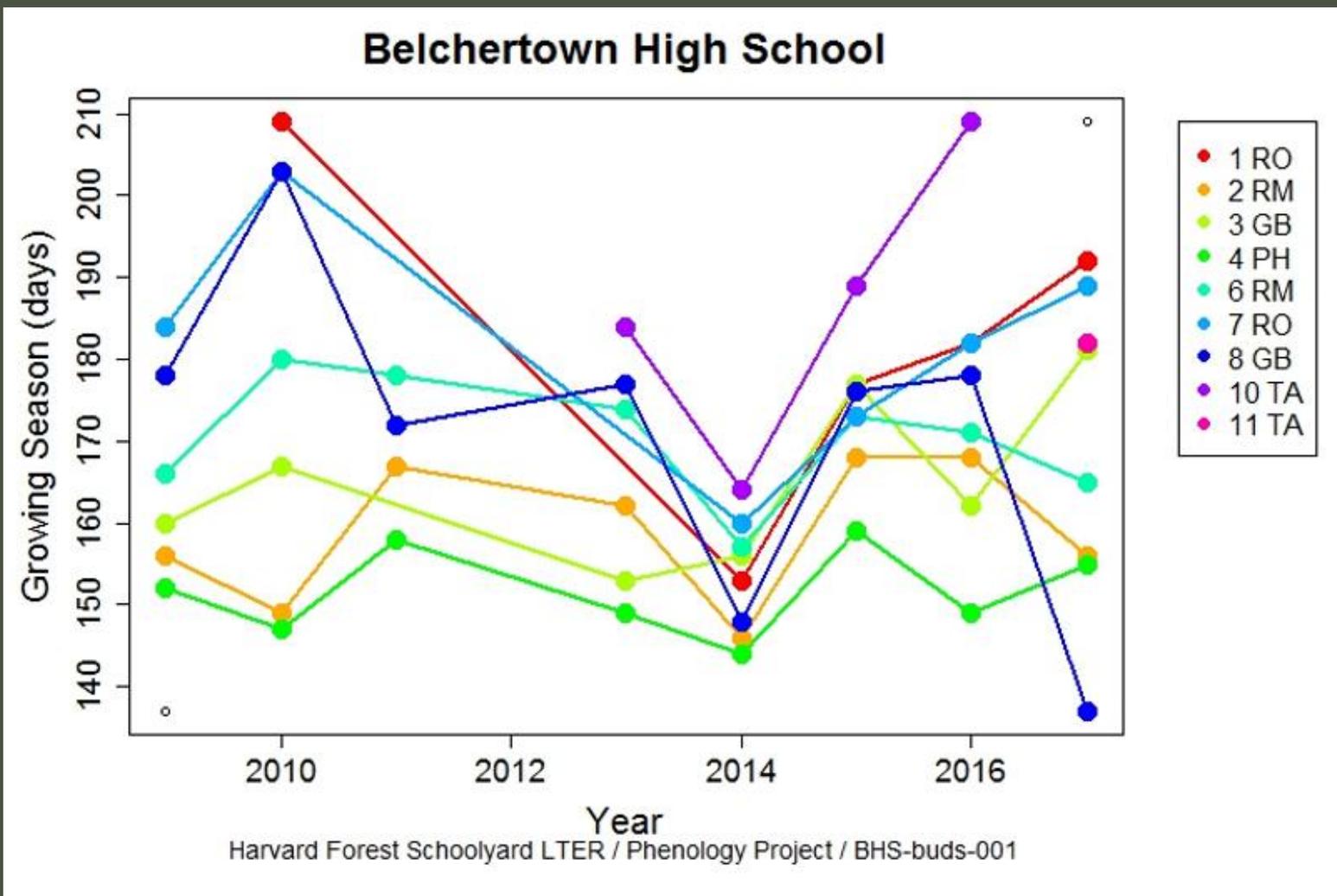




Figure 19: 50% Leaf Drop Williston School 2018

► Description of graph and related data table:

This graph shows timing of 50% of leaves dropped by study tree in 2018. Note that the range of Julian dates when 50% of the leaves on study trees at this site had fallen was between 304 and 316. Both Julian Date and Day of the Week are shown on the X axis. See Notes for more on this and the following graph.

► Teacher/Author:

Jane Lucia

► School:

Williston, Northampton

► Grade Level: 7

► Harvard Forest Mentors:

Ann Lewis, John O'Keefe,
Betsy Colburn

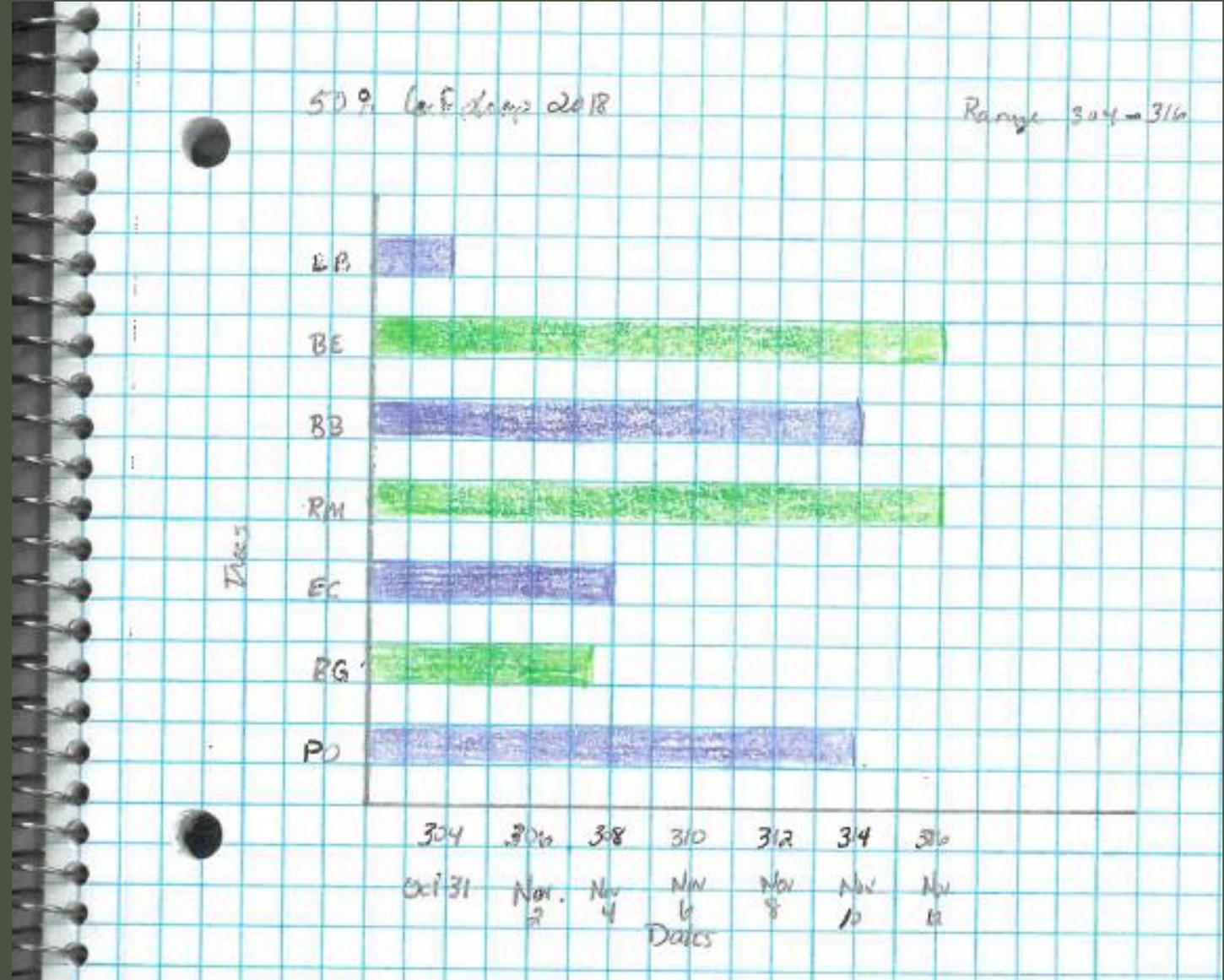


Figure 20: 50% Leaf Drop Graph with Rotated Axis



Description of graph and related data table:

This is the same graph as shown in figure 19 except that it has been rotated so that trees are on X axis and Day of Year on Y axis in reverse of the last version. See Notes for more on this.

Teacher/Author:

Jane Lucia

School:

Williston, Northampton

Grade Level:

7

Harvard Forest Mentors:

Ann Lewis, John O'Keefe,
Betsy Colburn

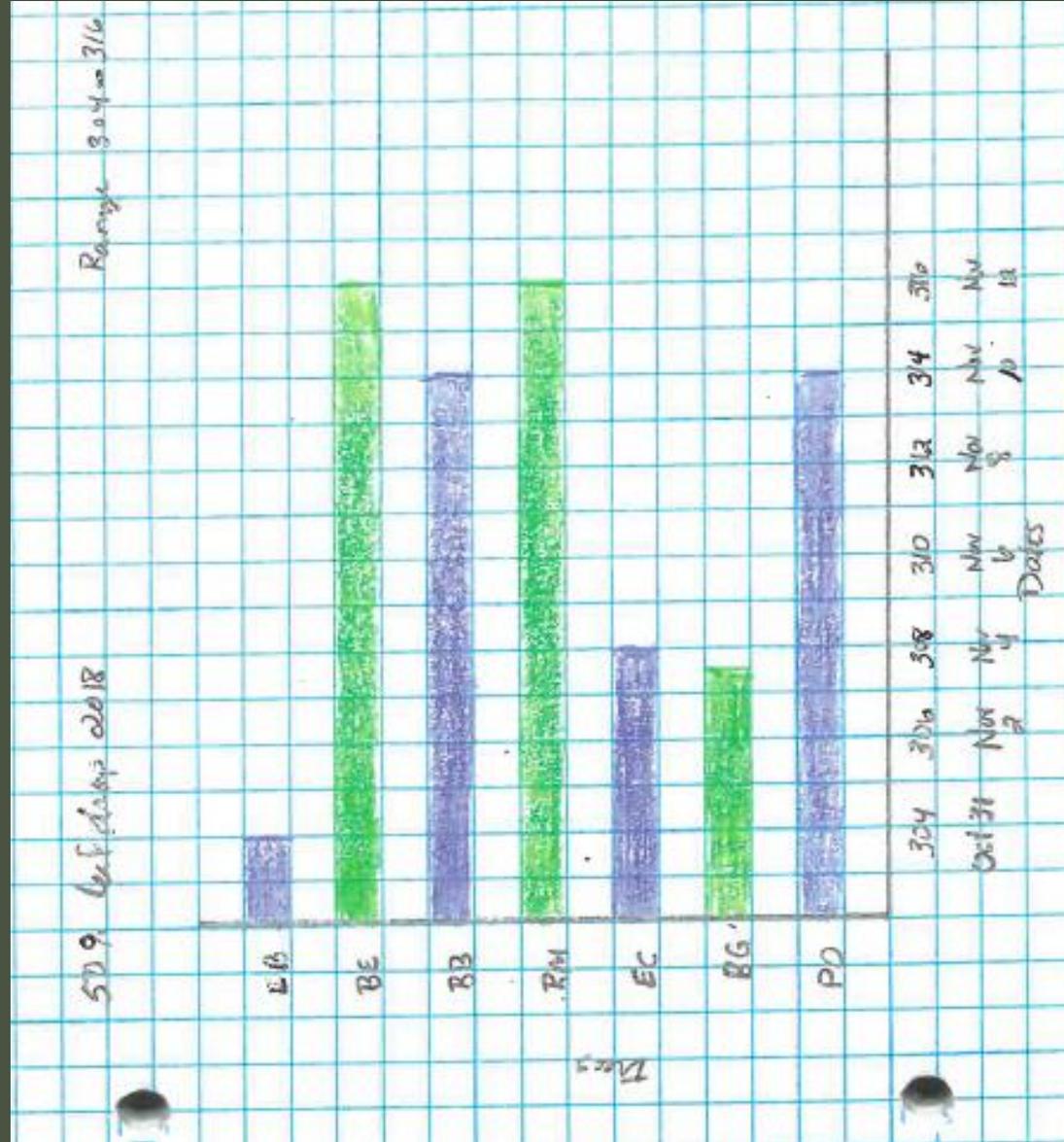


Figure 21: Sketches of Phenology Data Correlations



► Description of graph and related data table:

Martha worked towards developing conceptual sketches of possible ways she can engage Elementary aged students in looking at their Phenology data to make meaning of the ecological processes involved in leaf color change and leaf drop. She sketched possible graphs of # of leaves on branch; Hours of Daylight; Air Temperature and Wind Speed.

► Teacher/Author:

Martha Slone

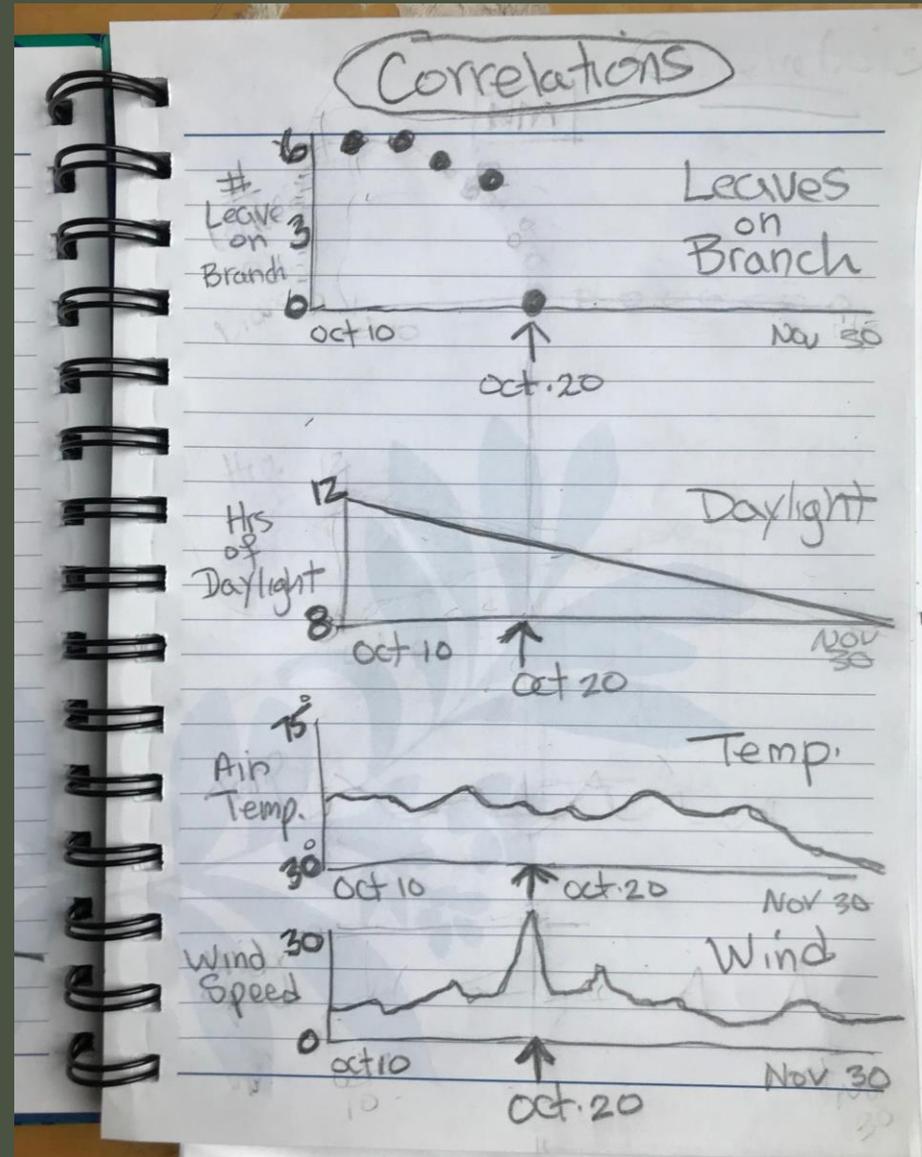
► School:

J. Shaughnessy Elementary School, Lowell

► Grade Level: 3,4

► Harvard Forest Mentors:

John O'Keefe, Betsy Colburn



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Section Three: Notes and Tables

Representing Buds, Leaves and Global Warming Project Data

General Notes on Teacher-Created Data Visualizations, 2019:

Teachers spent approximately 3 hours of the Looking at Data Workshop for Teachers working independently on creating visual representations of Schoolyard Ecology data collected by their students. Teachers were asked to develop educational goals for themselves prior to the workshop so that they could spend their time with Harvard Forest mentors most effectively. Each teacher chose their own priorities and educational objectives in working with project data collected by students in the Harvard Forest Schoolyard Ecology program.

After HF Ecologist, Betsy Colburn shared her “Looking at Data” presentation to help orient teachers in representing project data, eight teachers worked in a conference room with 4 Harvard Forest staff serving as mentors to support teachers in achieving their preset goals, and or helping them focus their goals in a way that would allow some completion in this brief time.

Some specific notes on the process and outcome of each of the data representations that were shared at the end of that Data Workshop are outlined below.

Figures 1-5 Notes:

Groton Dunstable HS Teacher, Melanie McCracken has developed graphing skills over several years of participation in the Harvard Forest Schoolyard Ecology program. While Melanie has created a variety of graphs using Excel and Google Sheets in the past, she has found it challenging to fit in the time needed for her students to create their own graphs using those tools. This year, she chose to simplify the process in the classroom, by focusing student time on using the Harvard Forest online graphing tools found on the HF Online Database.

Having spent a good deal of time and energy focused on how best to engage students in developing data literacy, Melanie has chosen to put most of the class time on data literacy spent interpreting graphs both from the classroom and field observations. Note that Melanie co-presented about her approaches to Data Literacy at a national Long Term Ecological Research conference, prior to the Data Workshop for Teachers.

Figure 6 Notes:

- Figure 6, created by Emily Chamas from the Applewild School in Fitchburg, Ma., is a bar graph showing diameter of each study tree over 2 years. As this is Emily's second year participating in our Data workshop, she chose to complete a series of graphing exercises developed for the Our Changing Forests project. This is one of a group of graphs Emily was able to create in this time. The graph does not tell much of a story of change over time yet, given only 2 years of data. The HF graphing tool allows students to create graphs that compare biomass, density, etc. using each year's data.

Data Table for Figure 6

Emily Chamas, Applewild School

Date	Julian	Survey	Tree ID	Species Co	Health	Dbh (cm)	Species Type	Number of Organisms	
10/18/2016	292	1	1	RM	1	44	RM	4	
10/18/2016	292	1	2	RM	1	13.1	RO	1	
10/18/2016	292	1	3	RM	1	9.5	WP	3	
10/18/2016	292	1	4	RM	1	6.4	PO	1	
10/18/2016	292	1	5	RO	1	37.3	WO	1	
10/18/2016	292	1	6	WP	1	27.4			
10/18/2016	292	1	7	WP	1	38.4	Tree ID	DBH 2016	DBH 2017
10/18/2016	292	1	8	WP	1	28	Red Maple 1	44	45
10/18/2016	292	1	9	PO	1	48.4	Red Maple 2	13.1	14
10/18/2016	292	1	10	WO	1	2.5	Red Maple 3	9.5	9.6
10/31/2017	304	2	1	RM	1	45	Red Maple 4	6.4	6.5
10/31/2017	304	2	2	RM	1	14	Red Oak 1	37.3	38.5
10/31/2017	304	2	3	RM	1	9.6	White Pine 1	27.4	27.5
10/31/2017	304	2	4	RM	1	6.5	White Pine 2	38.4	40
10/31/2017	304	2	5	RO	1	38.5	White Pine 3	28	28.2
10/31/2017	304	2	6	WP	1	27.5	Pink Oak	48.4	49.2
10/31/2017	304	2	7	WP	1	40	White Oak	2.5	4
10/31/2017	304	2	8	WP	1	28.2			
10/31/2017	304	2	9	PO	1	49.2			
10/31/2017	304	2	10	WO	1	4			

Figures 7,8 Notes:

Data Representations 6 and 7 take a different approach in visually showing project data from the Our Changing Forests project. Choate Teacher, Joe Scanio, used QGIS technology tool to show what his school's trees look like over space and ecological community types. In Graph 8, He used Tableau to show average carbon biomass across all *Our Changing Forests* project field sites from 2013-17 in New England. In Figure 7, He was able to divide trees up into diameter classes so the size of the circle showing the trees on the map are sized according to diameter classes. These circles representing individual study trees, show the geographical location of the trees. Colors are used to show areas where different ecological communities exist on the landscape. This way, students can try to eventually determine if there is a relationship between community type and size and species of trees. Joe notes that they don't have enough data yet to look across community types, but that this relationship may become evident over time.

Figures 10-13 Notes:

- Graphs 10-13 were created by Trinity Catholic School teachers Lori Primavera and Colleen Casey who are Elementary teachers working as part of the Buds, Leaves and Global Warming project. These teachers work closely as a team. Their goals were to update bar graphs that they had created in previous Harvard Forest workshops. They usually prefer to work in bar graph format, largely based on the developmental level of their students. This team tends to work quite independently at Harvard Forest for the past few years, and have developed a comfort level in creating graphs using Excel.
- Note that they chose to graph 50% Leaf Fall. This is a common way of showing timing of leaf drop because the rate of leaf drop is usually highest at the 50% mark. If you look at another teacher's graph, figure 15, you can see how the curve of the lines are steepest at the 50% point. This is the way Project Ecologist, John O'Keefe recommends showing leaf drop timing.

Figures 10-13 Notes Cont'd

- ▶ In looking at the graphs created this year, Harvard Forest mentors questioned whether Colleen and Lori might consider using line or scatter plots to show this data in a way that might be easier to interpret change over time. One mentor questioned whether the choice of color was making it challenging to interpret the data. Teachers explained that the bold colors help attract the attention of young learners.

Figure 17,18 Notes:

The graph in figure 17 shows Growing season length over 3 years (2016-18). It is important to note that there was insufficient data to calculate the length of the growing season in 2018 at this site. In order to calculate the length of the growing season, students must record data both prior to and after all study leaves have fallen off or turned color.

In this case, we are missing data for the end of the growing season, so we cannot calculate length. It is helpful for teachers and students to see their data shown this way in order to understand concretely the importance of recording and submitting a complete data set each season.

For the reason above, teacher, Elisa Margarita chose to graph the growing season at another school in the HF Schoolyard Eco. network that has significantly more data. That way, students can see what a longer term, more complete dataset looks like visually. By looking at a graph of a site with many data points over time, It is easier to tell what story the data is telling. Elisa and her students benefit from being part of a larger network of sites who can compare data across sites.

Figure 19 Notes:

Attached is a scan of my handmade graph and its “inversion” suggested by Ann Lewis.

I made the graph with the dependent variable (date) on the x-axis as it “pictured” length of time better to me than when the bars were drawn vertically- thinking as a student trying to tell the story of the data. Ann commented that holding the paper up to the light and looking on the back side revealed the inverse image, with the independent variable on the x-axis, the way it is done by scientists.

My class room plan is to have my students all graph this year’s leaf drop data on axes that I make and copy for them. Then, divide the class into smaller groups and have each group graph leaf drop data for the same trees but for a different year, each group graphing a different past year’s data.

I will print these graphs on transparency sheets and overlay them to compare the ends of the growing season for our trees, looking for trends, asking new questions.

Ann Lewis was very helpful in helping me think through how this can be accomplished. My preprinted axes will be spaced such that the bars for each year lay next to each other for the same tree. Once the students accomplish it, I’ll send you a photo!

▶ Jane Lucia

Figure 21 Notes:

With these sketch I was thinking of ways to get students (3rd and 4th grade) thinking about what influences leaf drop and how scientists use graphing to try to answer these questions. The students would graph their tree data themselves and I would provide the daylight, temperature and wind graphs showing daily changes. As the students do collect temperature and weather data I would incorporate their observations into the daily graph (they went out once a week to record)

Martha Slone

Mass. Audubon and J. Shaughnessy Afterschool Program