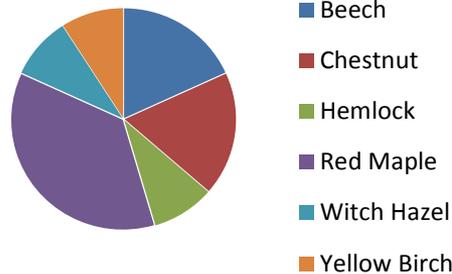
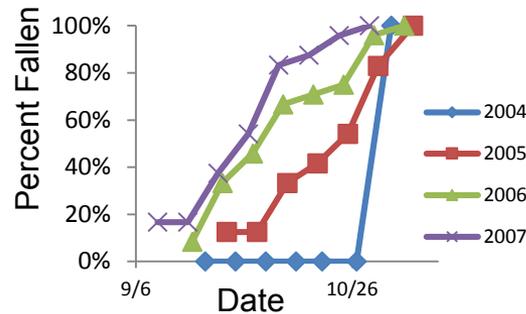


# Show Me a Picture, Tell Me A Story

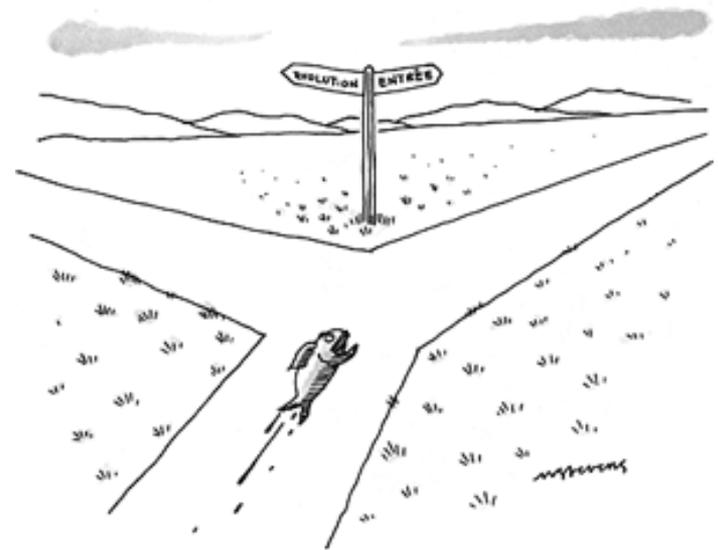
## Harvard Forest Schoolyard Ecology Program: Level II & III Data Visualization and Analysis Workshop

Betsy A. Colburn

Date	Sampled	Fallen
9/22/2004	10	0
9/29/2004	10	0
10/6/2004	10	0
10/13/2004	10	0
10/19/2004	10	0
10/27/2004	10	0
11/4/2004	5	5
9/28/2005	24	3
10/5/2005	24	3
10/12/2005	24	8
10/19/2005	24	10
10/26/2005	24	13
11/2/2005	24	20
11/10/2005	24	24
9/20/2006	24	2
9/27/2006	18	6
10/4/2006	24	11
10/11/2006	24	16
10/18/2006	24	17
10/25/2006	24	18
11/1/2006	24	23
11/8/2006	12	12
9/12/2007	24	4
9/19/2007	24	4
9/26/2007	24	9
10/3/2007	24	13
10/10/2007	24	20
10/17/2007	24	21
10/24/2007	24	23
10/31/2007	6	6



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Friday, January 4, 2019

Harvard Forest, Petersham, MA



Schoolyard Science phenology data set in comma-delimited text (.csv) format, as on the Harvard Forest Schoolyard Science website, and in a spreadsheet.

.CSV

School,Teacher,Date,Julian,TreeID,Species,Ltotal,Lfallen,Tcolor  
 ARM,Miller,2004-09-06,250,2,CH,5,0,NA  
 ARM,Miller,2004-09-22,266,1,YB,10,0,NA  
 ARM,Miller,2004-09-22,266,2,CH,10,0,NA  
 ARM,Miller,2004-09-22,266,3,RM,5,0,NA  
 ARM,Miller,2004-09-22,266,4,RM,5,0,NA  
 ARM,Miller,2004-09-22,266,5,CH,10,0,NA  
 ARM,Miller,2004-09-22,266,6,WH,10,0,NA  
 ARM,Miller,2004-09-22,266,7,RM,5,0,NA  
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 ARM,Miller,2004-09-29,273,7,RM,5,0,NA  
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 ARM,Miller,2004-10-06,280,2,CH,10,0,NA  
 ARM,Miller,2004-10-06,280,3,RM,5,2,NA

spreadsheet

School	Teacher	Date	Julian	TreeID	Species	Ltotal	Lfallen	Tcolor
ARM	Miller	9/6/2004	250	2	CH	5	0	NA
ARM	Miller	9/22/2004	266	1	YB	10	0	NA
ARM	Miller	9/22/2004	266	2	CH	10	0	NA
ARM	Miller	9/22/2004	266	3	RM	5	0	NA
ARM	Miller	9/22/2004	266	4	RM	5	0	NA
ARM	Miller	9/22/2004	266	5	CH	10	0	NA
ARM	Miller	9/22/2004	266	6	WH	10	0	NA
ARM	Miller	9/22/2004	266	7	RM	5	0	NA
ARM	Miller	9/29/2004	273	1	YB	10	0	NA
ARM	Miller	9/29/2004	273	2	CH	5	0	NA
ARM	Miller	9/29/2004	273	3	RM	5	0	NA
ARM	Miller	9/29/2004	273	4	RM	5	0	NA
ARM	Miller	9/29/2004	273	5	CH	10	0	NA
ARM	Miller	9/29/2004	273	6	WH	10	0	NA
ARM	Miller	9/29/2004	273	7	RM	5	0	NA
ARM	Miller	10/6/2004	280	1	YB	10	0	NA
ARM	Miller	10/6/2004	280	2	CH	10	0	NA
ARM	Miller	10/6/2004	280	3	RM	5	2	NA



# Data Analysis – Understanding Results of Sampling

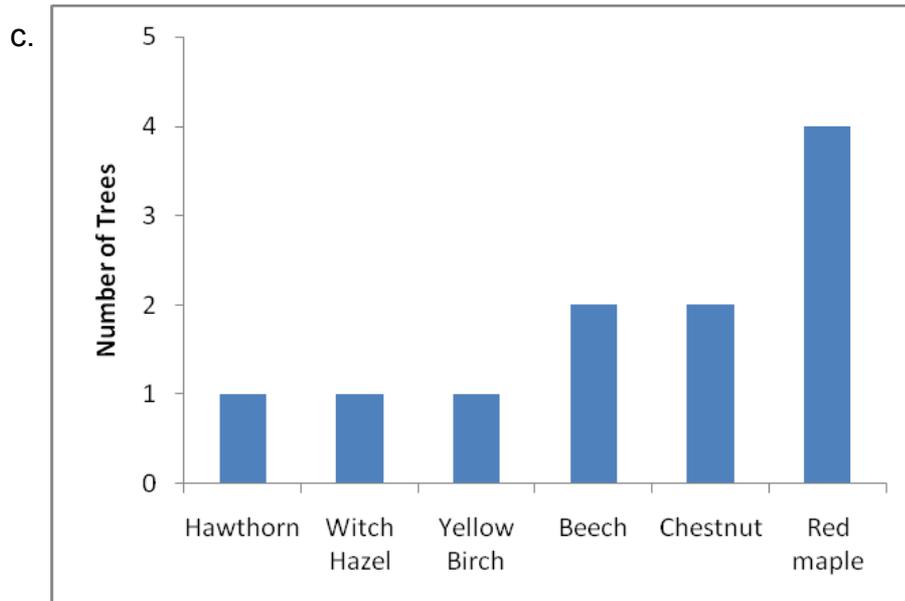
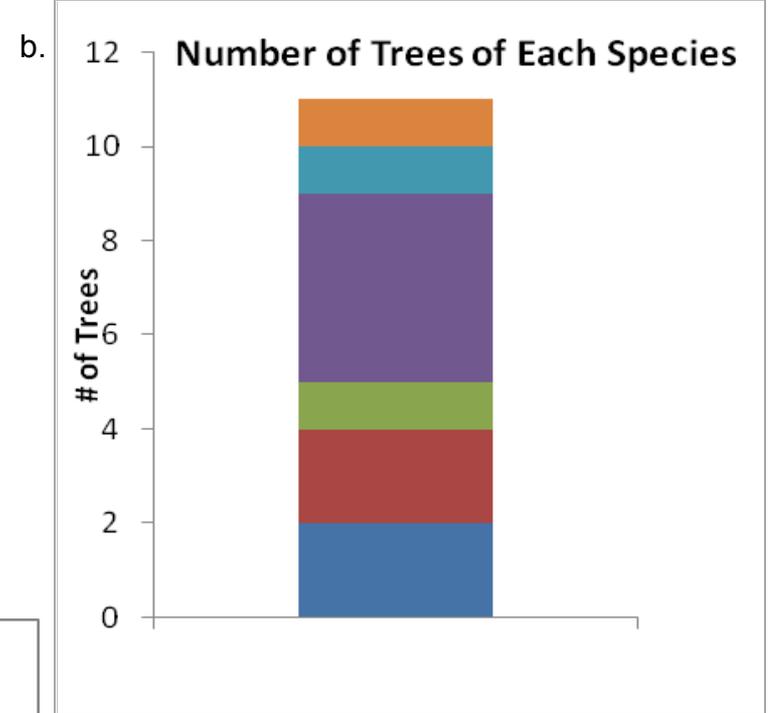
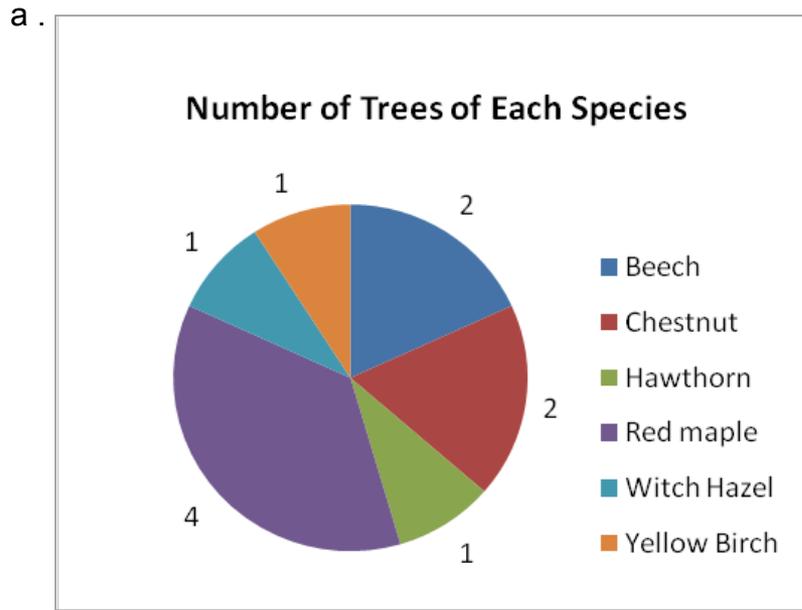
- Spreadsheets and Tables
  - Original data
  - Modified data
  - Additional extracted data
    - e.g., growing season (Buds, Leaves)
    - e.g., biomass accrual for plot or species (Changing Forests)
- Graphs and Figures
- Statistics
- Models



# Considerations for Analyzing & Graphing Data

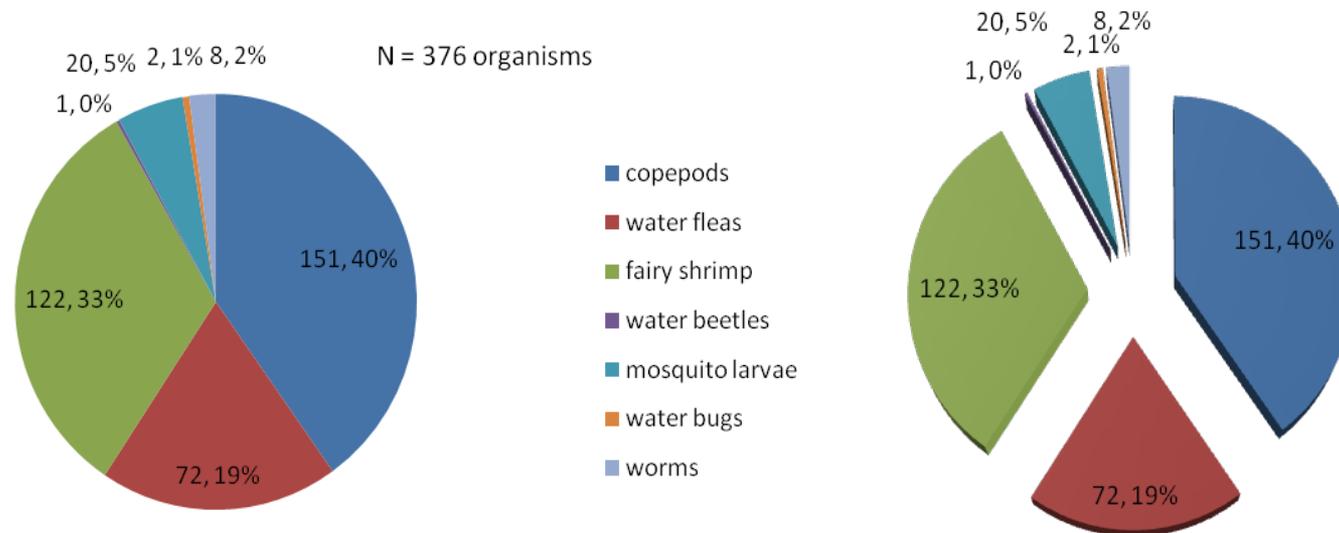
- What do you have for original data?
- What do you want to find out? (What are the questions you are asking of your data?)
- What kinds of additional information can you obtain (from your data or elsewhere) to help answer your questions? (Weather data, other schools' data...)
- What kind of graphs(s) [or statistics, or models] can help you address your questions?
- What graphs [or statistics, or other illustrations] can help you tell your story effectively?

Tree species sampled in a schoolyard phenology study. ARM Schoolyard data. a. Pie graph. b. Stacked bar graph. (Species codes as in a.) c. Bar graph.



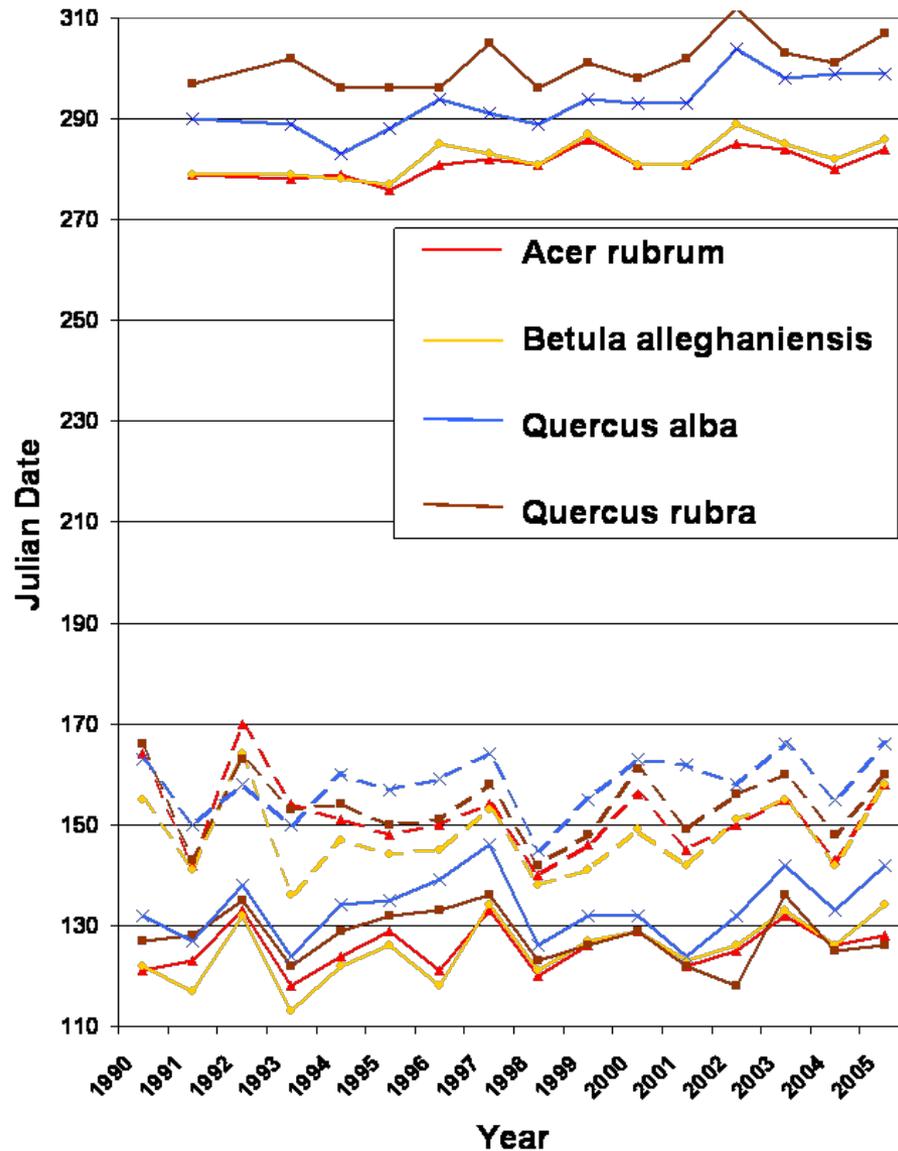
These graphs could apply equally well to data on tree species in plots sampled for Our Changing Forests – Level 2 exercises will look at both kinds of data sets

Aquatic Macroinvertebrates in a Cape Cod Vernal Pool in April, 1996.  
Data from EA Colburn



To a very large extent, the choice of how to present data graphically is simply a matter of the investigator's preferences – much of the time, there is no "right" or "wrong" way to illustrate results. What graphical presentation is most informative? What graphs are easiest to understand and interpret?

# Spring leaf emergence and autumn leaf fall in four tree species at the Harvard Forest. Data from J O'Keefe



Fall:

— Date of 50% leaf drop

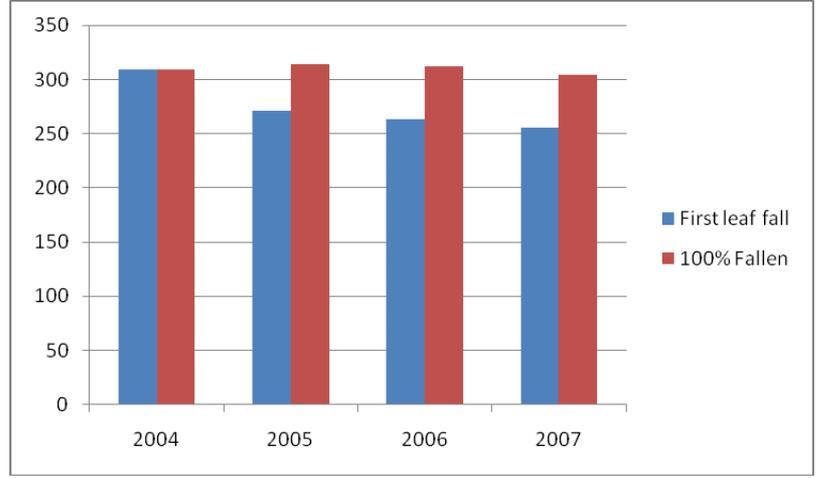
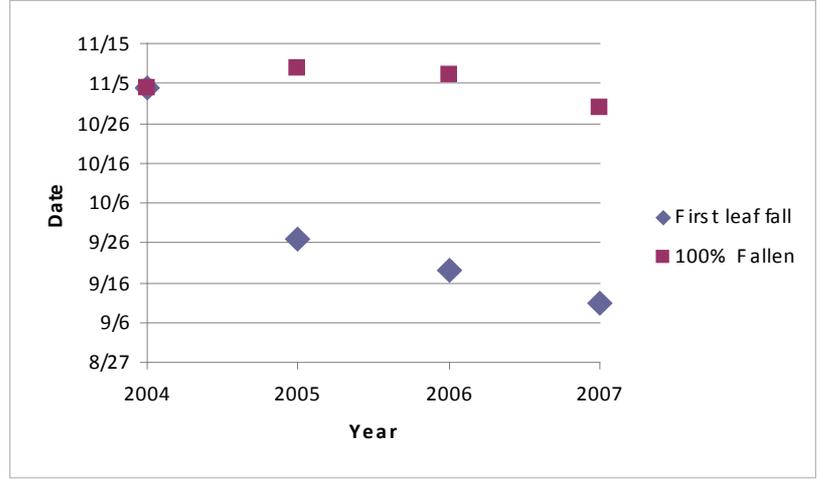
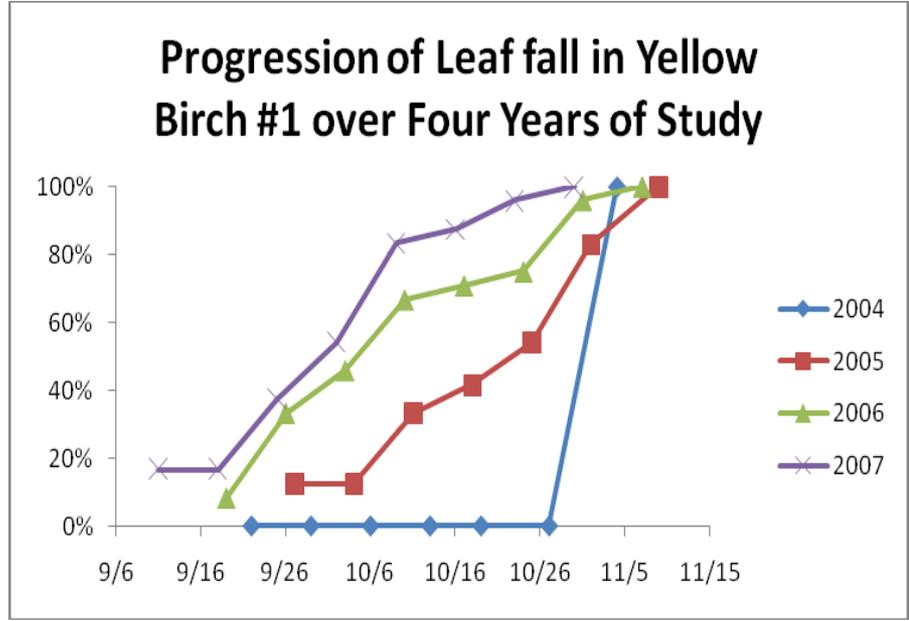
Spring:

- - - Date of 75% leaf development

— Date of 50% bud break

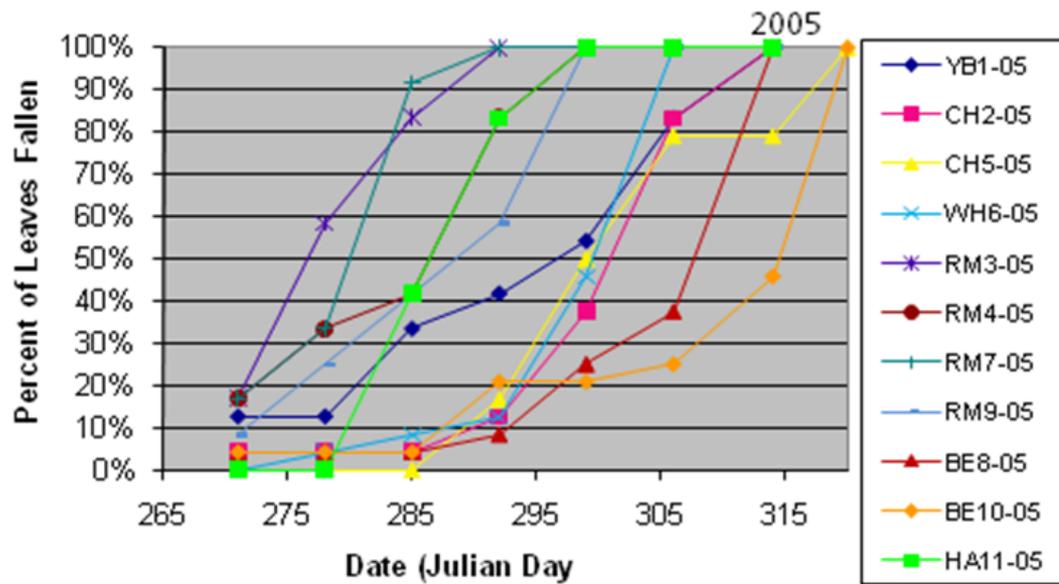
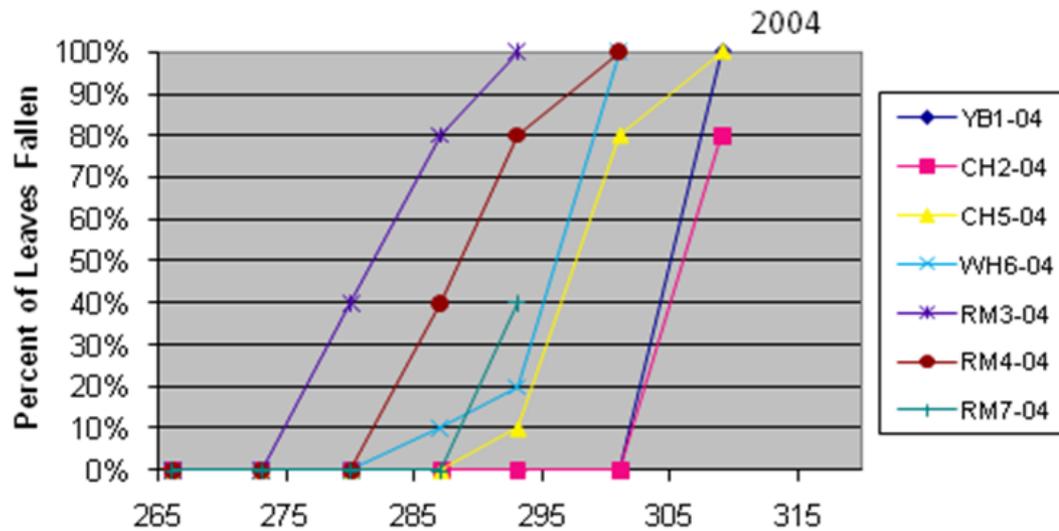


Leaf fall in one tree over four years of sampling.  
ARM Schoolyard data.



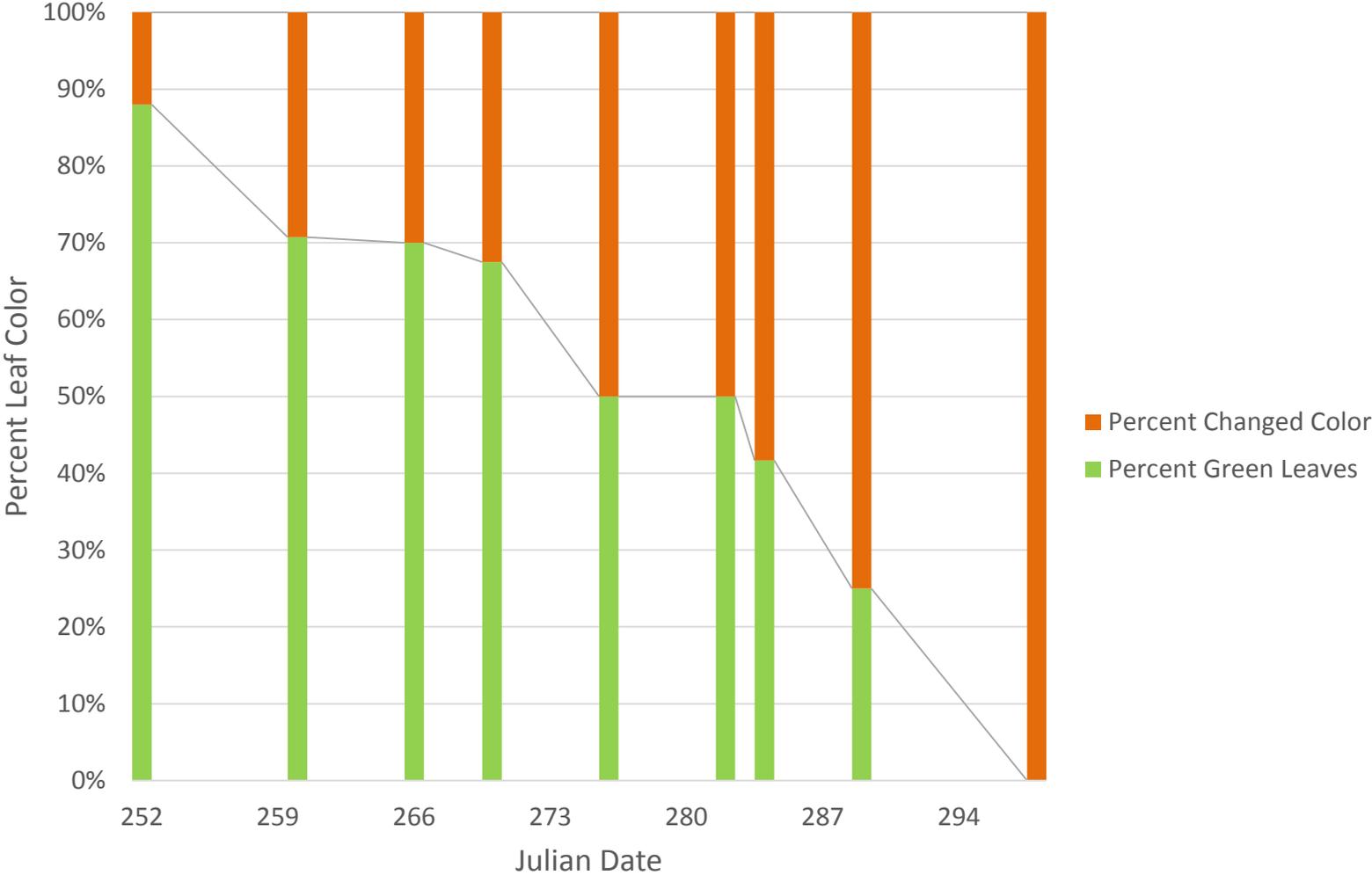
What kinds of data from Our Changing Forests or Woolly Bully could be shown with a similar graph? What would be different on the graph?

# Leaf fall in Multiple Trees. ARM Schoolyard data.





Leaf Color Change Over Time



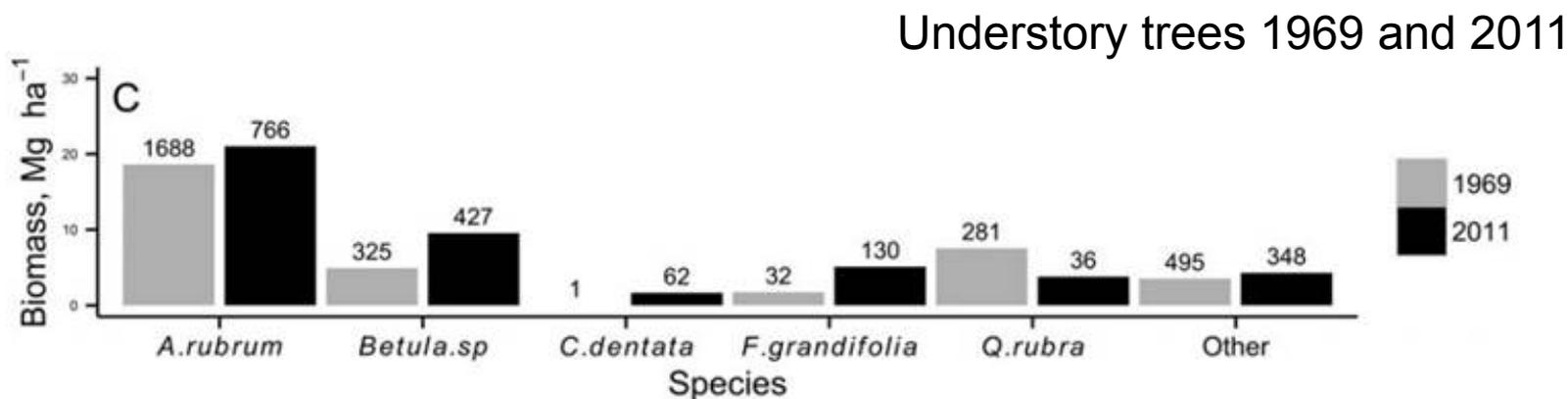
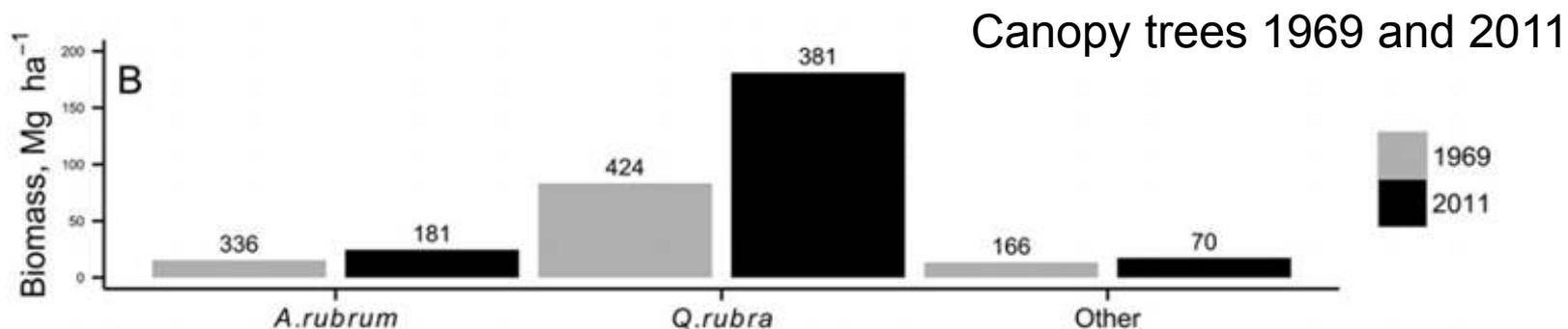
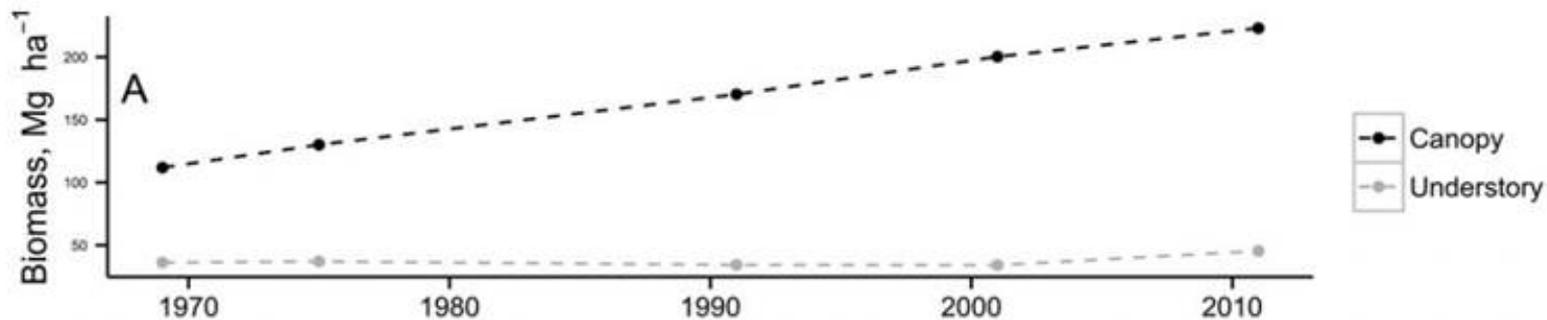
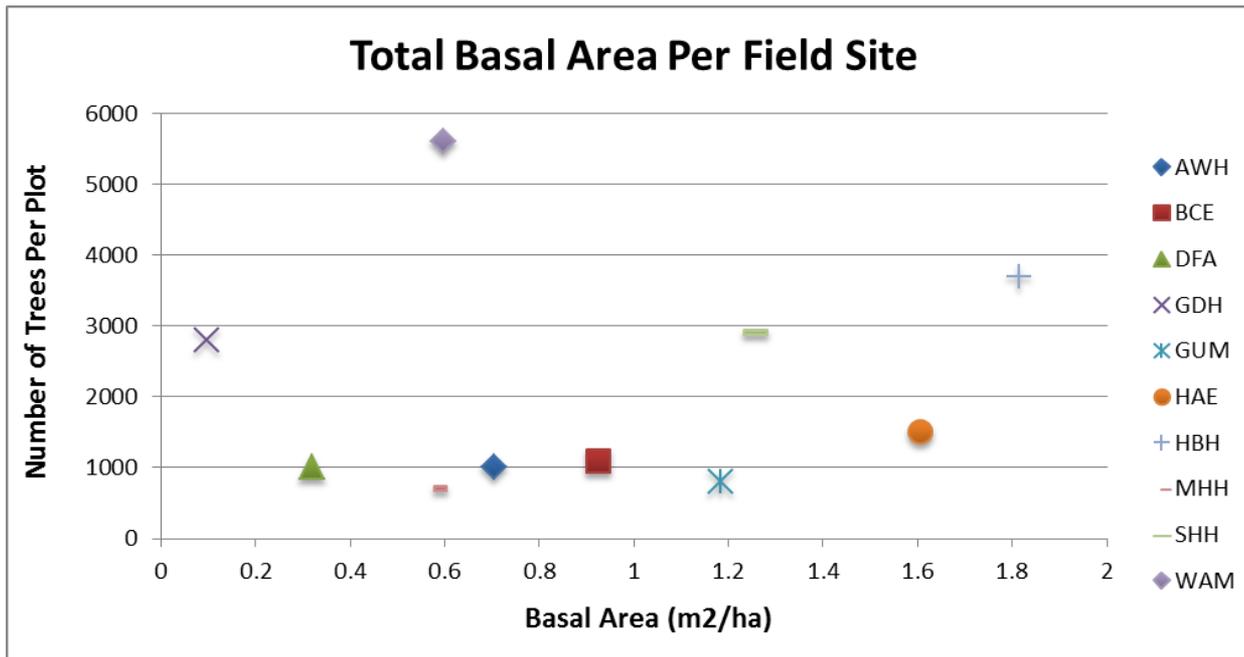
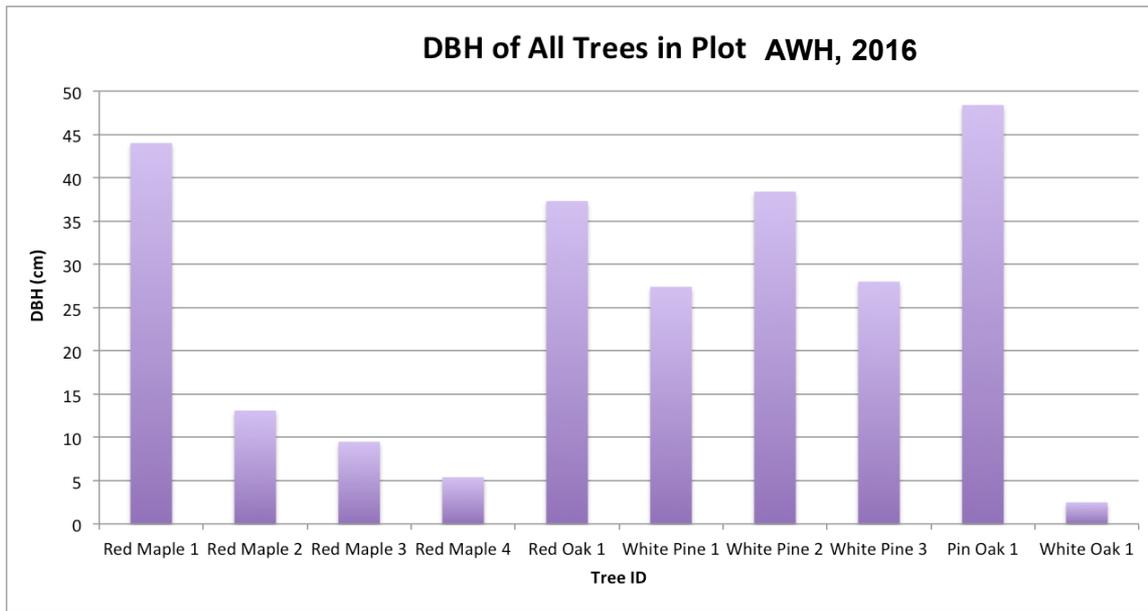
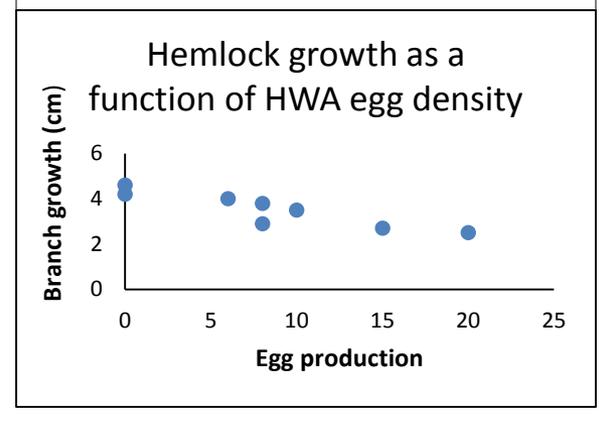
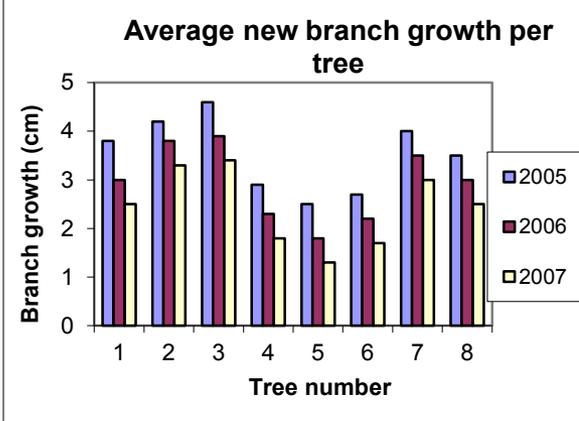
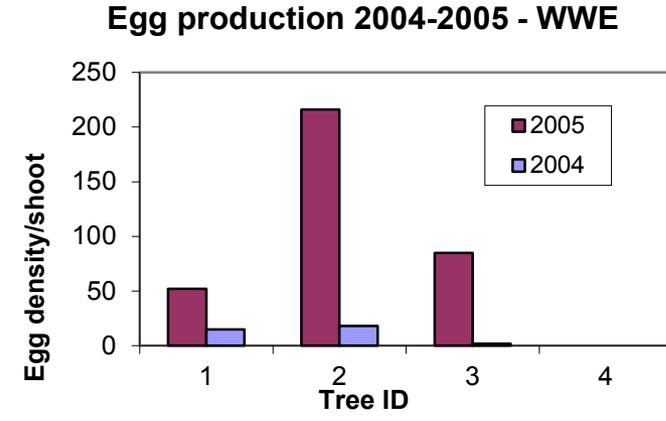
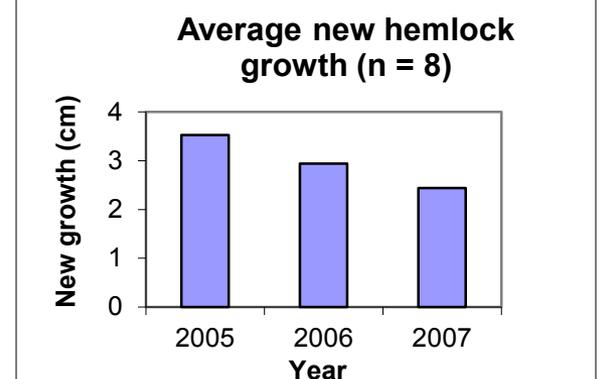
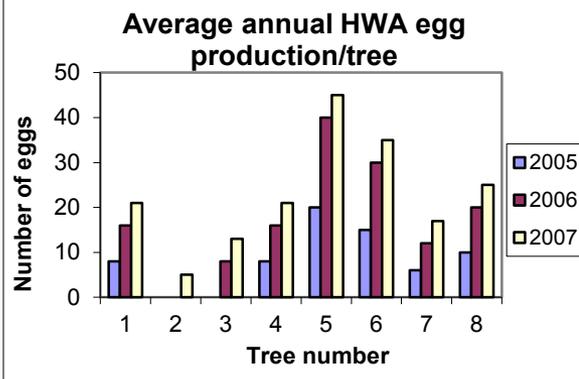
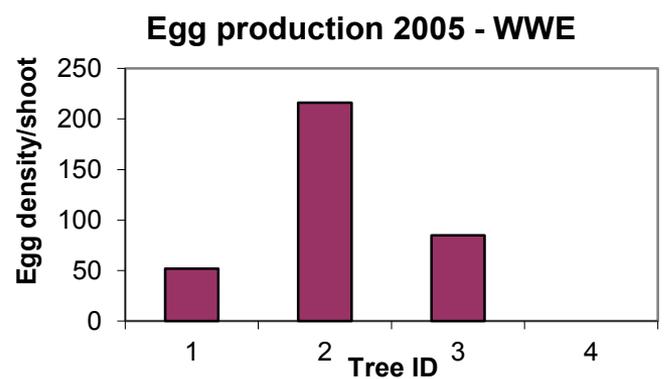
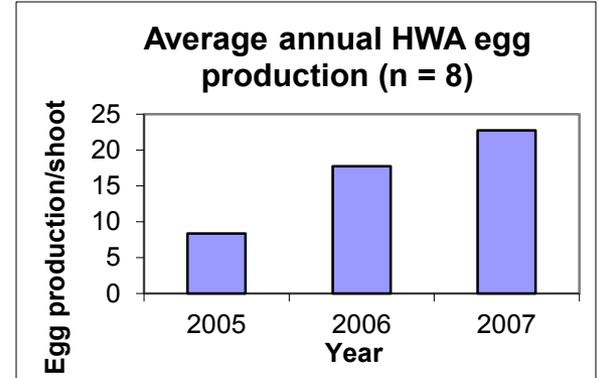
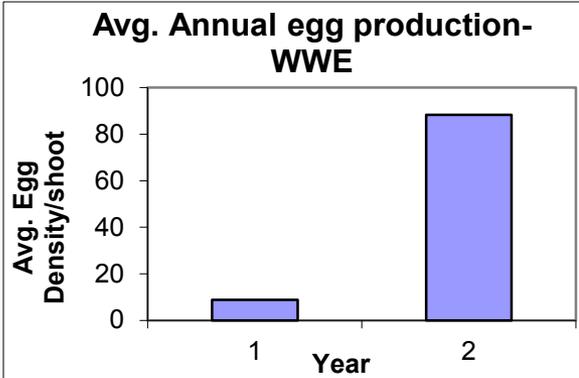
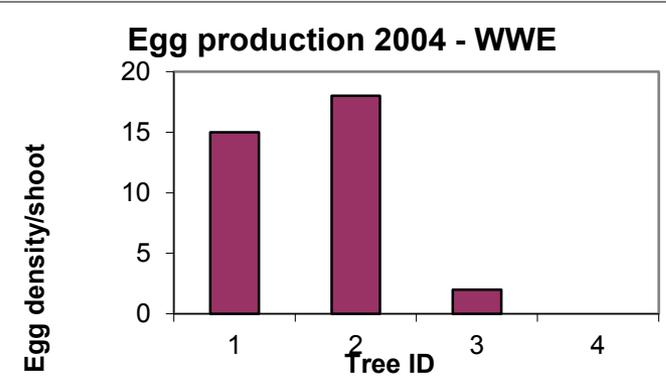


FIG. 3. (A) Aboveground biomass in living stems in the canopy (black) and the subordinate level (grey), (B) and biomass in the canopy, (C) and subordinate level by species. The values above the bars in panels B and C indicate the number of stems that comprise the biomass represented in each bar.





For results from Woolly Bully sampling, there are various ways to graph data on branch growth and HWA infestation. Some of these are also appropriate for graphing tree growth in plots for Our Changing Forests



## Before Data Analysis:

Look at data

Evaluate for:

- errors
- missing information
- corrections that are necessary

Adjust accordingly

Extract additional information – e.g., length of growing season, biomass for each species, growth since prior measurement, percent of leaves fallen, etc.

***The data base calculates some of these variables for you; you may want to calculate or obtain additional ones and/or to manipulate your data in various ways***

Take time to look at the graph(s) you create:

- What pattern(s) do you see?
- How do patterns relate to the basic questions your study is trying to answer?
- What factors might explain the patterns? What might be causing them?
- How can you use the graphs with your students?

Go to it –  
Happy Data  
Visualization!

# Calculating Growing Season Length From Schoolyard Data

## Growing Season Calculation:

1. Determine 50% bud burst and 50% leaf-fall dates for each tree, or Alternatively, you could calculate the average for each species, or average for all trees at a site, depending on your analysis goals.
2. Subtract budburst date from leaf-fall date; this gives the number of days in the growing season for the selected tree(s)
3. This approach could also be used to estimate average duration of flooding in some vernal pools, if data are available on both the increase in water depth in spring, and the decline in water levels as the hydrologic year progresses

## Calculating Julian Date from Standard Date: use the Excel formula below

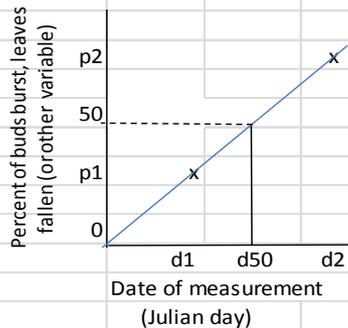
Date	Julian
4/8/1992	99
5/7/1999	127
6/4/1998	155
2/2/2002	33
5/5/1988	126
DATE	#VALUE!
DATE	#VALUE!
DATE	#VALUE!

Julian Date:  
=K6-DATE(YEAR(K6),1,0)

NOTE: "K6" refers to the cell with the standard date

← REPLACE "DATE" IN COLUMN A WITH AN ACTUAL DATE, AND THE JULIAN DAY WILL BE CALCULATED IN COLUMN B

## Estimating date of 50% leaf fall, bud burst, pool filling or drying, or other event



Use data measuring change in factor of interest -- water depth, growth, leaf fall, etc.

Look at the data, and choose two points bracketing the 50% level -- the formula below finds the 50% point between them

d1 and d2 are the Julian days when measurements were made before and after the 50% level was reached

p1 and p2 are the percent of leaf-fall estimated for measurement dates d1 and d2, respectively

Plug the values for d1, d2, p1, and p2 into the following formula:

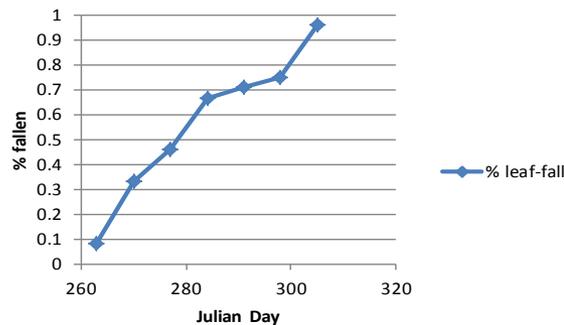
50% Leaf-fall or bud-burst Julian Date:  
 $d1 + [(d2 - d1)(50 - p1) / (p2 - p1)]$

NOTE: For measurements of water depth, growth, etc., plug in the comparable Julian days

<b>EXAMPLE:</b> Spring	d1 = 95	d2 = 122	50% bud burst = $95 + ((122 - 95)(50 - 47) / (62 - 47)) = 100.4$
	p1 = 47	p2 = 62	
Fall	d1 = 277	d2 = 284	50% leaf fall = $277 + ((284 - 277)(50 - 46) / (67 - 46)) = 278.3$
	p1 = 46	p2 = 67	

**If 50% bud-burst was at day 100 (April 10 in a non-leap year), and if 50% leaf-fall was day 278, then  $278 - 100 = 178$ : the growing season was 178 days long for this particular tree or group of trees**

## % leaf fall YB1 2005



<http://harvardforest.fas.harvard.edu/schoolyard/data-analysis>

INSERT YOUR SPRING AND FALL DATA:					
	d1	p1	d2	p2	50%
Spring					#DIV/0!
Fall					#DIV/0!

Growing season length (number of days) #DIV/0!