# Show Me a Picture, Tell Me A Story

## Harvard Forest Schoolyard Ecology Program:

## Level II & III Data Analysis Workshop

| 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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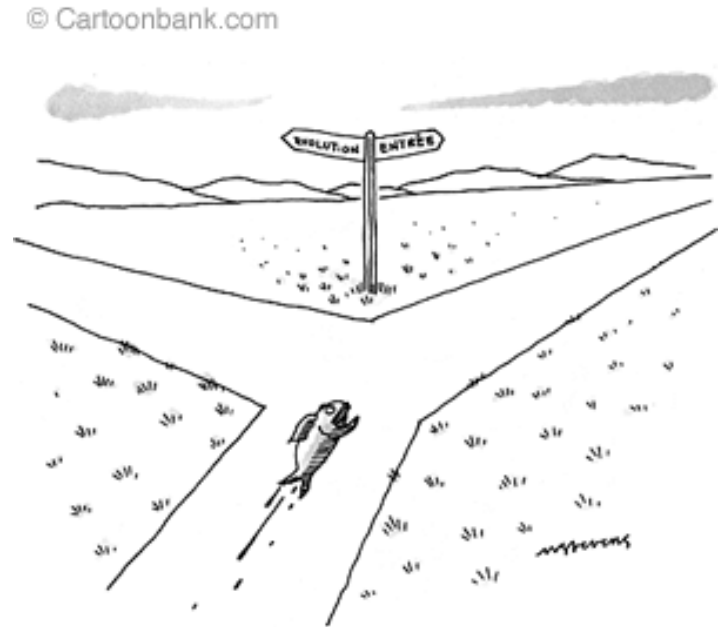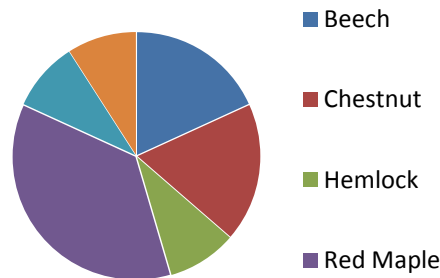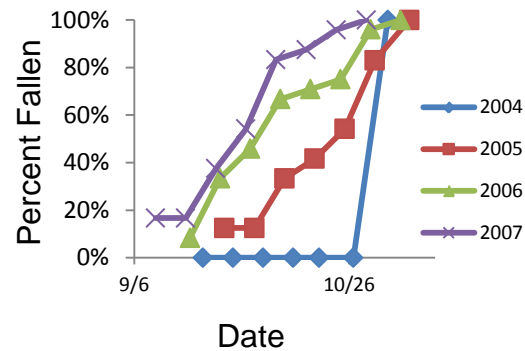
Thursday, January 9, 2014

Harvard Forest, Petersham, MA

Morning Presentation

- Schoolyard Data
- Preparing data for analysis
- Data analysis
- Graphing considerations
- Kinds of graphs – examples from HF research and Schoolyard Ecology data

Level 2 teachers – Creating graphs by hand or using Excel – structured exercises
Level 3 teachers – Organizing your students' data and creating and interpreting
                        graphs of the data

After Lunch

- Additional practice graphing schoolyard data
- Opportunity to practice making calculations and graphing the modified data
- Sharing graphs, ideas, questions

Evaluation and feedback

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

.csv

spreadsheet

```
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
ARM,Miller,2004-09-29,273,1,YB,10,0,NA
ARM,Miller,2004-09-29,273,2,CH,5,0,NA
ARM,Miller,2004-09-29,273,3,RM,5,0,NA
ARM,Miller,2004-09-29,273,4,RM,5,0,NA
ARM,Miller,2004-09-29,273,5,CH,10,0,NA
ARM,Miller,2004-09-29,273,6,WH,10,0,NA
ARM,Miller,2004-09-29,273,7,RM,5,0,NA
ARM,Miller,2004-10-06,280,1,YB,10,0,NA
ARM,Miller,2004-10-06,280,2,CH,10,0,NA
ARM,Miller,2004-10-06,280,3,RM,5,2,NA
```

| 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 |

School
Teacher
Date (Julian)
TreeID
Species
Ltotal
Lfallen
Tcolor

---

Harvard Forest Schoolyard Ecology
**Buds, Leaves, and Global Warming**

## Autumn Student Data Sheet

December 2007

| Name: | | Date: | |
|---|---|---|---|
| Teacher: | | School: | |

| Tree Number:____ Branch letter ____ | | | | | Please measure leaves only once at beginning of season. | |
|---|---|---|---|---|---|---|
| Tree Species: ____ | | | | | | |
| | Leaf 1 | Leaf 2 | Leaf 3 | Leaf 4 | Leaf 5 | Leaf 6 |
| Leaf Length (cm.) | | | | | | |
| Leaf Width(cm.) | | | | | | |

Put a check mark in the correct column below to show Leaf Color and Leaf Drop

| Leaf # | Fraction/ Percent of Leaf Color (not green) | | | | Leaf Drop |
|---|---|---|---|---|---|
| | 0 – 25% | 26 – 50% | 51 – 75% | 76 – 100% | 0-not fallen 1- fallen |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| Whole Tree | | | | | N/A |

| Total number of study leaves observed per branch (fallen and not fallen) | |
|---|---|
| Total number of leaves fallen | |

**Teacher note:** Remember that the branch total above must be added with branch totals from all branches on the same tree to get the total number of leaves dropped per tree to submit to Harvard Forest to post online.

**Optional Field Notes:**

**Weather Notes:**                    **Animal/ Plant notes:**

# Student Research Teams Could Track Their Data

Research Team: CH5
Teacher: Mrs. Miller
Year: 2004
Branch: 1

Tree ID#  5
Tree Species: Chestnut

| Date | # of Leaves Observed | # of Leaves Fallen |
|------|---------------------|--------------------|
| 9/22 | 10 | 0 |
| 9/29 | 10 | 0 |
| 10/6 | 10 | 0 |
| 10/13 | 10 | 0 |
| 10/19 | 10 | 1 |
| 10/26 | 10 | 8 |
| 10/27 | 5 | 4 |
| 11/05 | 10 | 10 |

Project: Buds, Leaves, Global Warming – Fall

Year: 2010

Team: Rachel, Emily, Thomas, Carlos

Tree #: 4      Species: White ash

Branch: A

Fallen   or   Not  Fallen

| Date: | Time (EDT): | | Lf 1 | Lf 2 | Lf 3 | Lf 4 | Lf 5 | | | # obsd. | # fallen | % fallen | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| Sept 30 | 10:00 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | hot and sunny |
| Oct 7 | 10:15 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | |
| Oct 14 | 10:05 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | |
| Oct 21 | 10:20 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | |
| Oct 28 | 10:00 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | |
| Nov 4 | 11:10 | | 1 | 0 | 1 | 1 | 0 | | | 5 | 3 | 60 | very windy yesterday |
| Nov 11 | 11:15 | | 1 | 1 | 1 | 1 | 0 | | | 5 | 4 | 80 | |
| Nov 18 | 14:30 | | 1 | 1 | 1 | 1 | 0 | | | 5 | 4 | 80 | AM assembly, went after school |
| | | | | | | | | | | | | | |

Project:  Buds, Leaves, Global Warming -- Fall

Team:   Rachel, Emily, Thomas, Carlos

Tree #:      4          Species: White ash

Branch:       A

KEY

0 = not fallen

1 = fallen

| Date: | Time (EDT): | | Lf 1 | Lf 2 | Lf 3 | Lf 4 | Lf 5 | | | # obsd. | # fallen | % fallen | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| Sept 30 | 10:00 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | hot and sunny |
| Oct 7 | 10:15 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | |
| Oct 14 | 10:05 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | |
| Oct 21 | 10:20 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | |
| Oct 28 | 10:00 | | 0 | 0 | 0 | 0 | 0 | | | 5 | 0 | 0 | |
| Nov 4 | 11:10 | | 1 | 0 | 1 | 1 | 0 | | | 5 | 3 | 60 | very windy yesterday |
| Nov 11 | 11:15 | | 1 | 1 | 1 | 1 | 0 | | | 5 | 4 | 80 | |
| Nov 18 | 14:30 | | 1 | 1 | 1 | 1 | 0 | | | 5 | 4 | 80 | AM assembly, went after school |
| | | | | | | | | | | | | | |

**Leaf-fall 2010, Tree #4, Branch A**
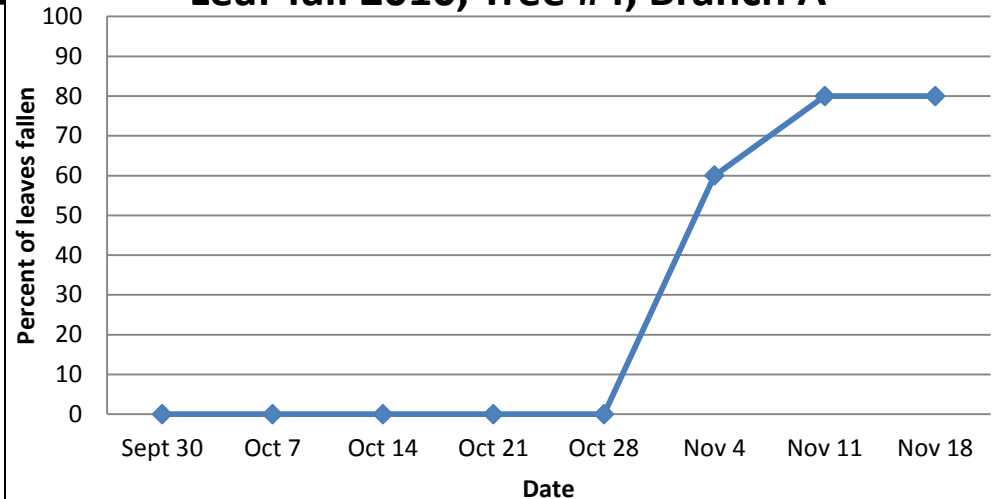
| 2010 Date: | Length Lf 1 | Length Lf 2 | Length Lf 3 | Length Lf 4 | Length Lf 5 | | color If 1 | color If 2 | color If 3 | color If 4 | color If 5 | avg. color |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept 30 | 15 | 17 | 16.5 | 10 | 12 | | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct 7 | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct 14 | | | | | | | 1 | 1 | 1 | 2 | 1 | 1 |
| Oct 21 | | | | | | | 1 | 1 | 2 | 2 | 1 | 1.4 |
| Oct 28 | | | | | | | 4 | 4 | 4 | 4 | 4 | 4 |
| Nov 4 | | | | | | | na | 4 | na | na | 4 | 4 |
| Nov 11 | | | | | | | na | na | na | na | 4 | 4 |
| Nov 18 | | | | | | | na | na | na | na | 4 | 4 |

Color Key:    1 - 0-25% not green
2 - 26-50%
3 - 51-75%
4 - 76 - 100%

| 2010 Date: | Length Lf 1 | Length Lf 2 | Length Lf 3 | Length Lf 4 | Length Lf 5 | | color lf 1 | color lf 2 | color lf 3 | color lf 4 | color lf 5 | avg. color |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept 30 | 15 | 17 | 16.5 | 10 | 12 | | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct 7 | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct 14 | | | | | | | 1 | 1 | 1 | 2 | 1 | 1 |
| Oct 21 | | | | | | | 1 | 1 | 2 | 2 | 1 | 1.4 |
| Oct 28 | | | | | | | 4 | 4 | 4 | 4 | 4 | 4 |
| Nov 4 | | | | | | | na | 4 | na | na | 4 | 4 |
| Nov 11 | | | | | | | na | na | na | na | 4 | 4 |
| Nov 18 | | | | | | | na | na | na | na | 4 | 4 |

Color Key:
1 - 0-25% not green
2 - 26-50%
3 - 51-75%
4 - 76 - 100%


Leaf Color, Tree #4, Branch A, Fall, 2010

| Date: | # color 1 | # color 2 | # color 3 | # color 4 |
|---|---|---|---|---|
| | | | | |
| Sept 30 | 5 | 0 | 0 | 0 |
| Oct 7 | 5 | 0 | 0 | 0 |
| Oct 14 | 4 | 1 | 0 | 0 |
| Oct 21 | 3 | 2 | 0 | 0 |
| Oct 28 | 0 | 0 | 4 | 1 |
| Nov 4 | 0 | 0 | 0 | 2 |
| Nov 11 | 0 | 0 | 0 | 2 |

| color If 1 | color If 2 | color If 3 | color If 4 | color If 5 | avg. color |
|---|---|---|---|---|---|
| | | | | | |
| 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 2 | 1 | 1 |
| 1 | 1 | 2 | 2 | 1 | 1.4 |
| 4 | 4 | 4 | 4 | 4 | 4 |
| na | 4 | na | na | 4 | 4 |
| na | na | na | na | 4 | 4 |
| na | na | na | na | 4 | 4 |

| Date: | # color 1 | # color 2 | # color 3 | # color 4 |
|---|---|---|---|---|
|  |  |  |  |  |
| Sept 30 | 5 | 0 | 0 | 0 |
| Oct 7 | 5 | 0 | 0 | 0 |
| Oct 14 | 4 | 1 | 0 | 0 |
| Oct 21 | 3 | 2 | 0 | 0 |
| Oct 28 | 0 | 0 | 4 | 1 |
| Nov 4 | 0 | 0 | 0 | 2 |
| Nov 11 | 0 | 0 | 0 | 2 |

| color If 1 | color If 2 | color If 3 | color If 4 | color If 5 | avg. color |
|---|---|---|---|---|---|
|  |  |  |  |  |  |
| 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 2 | 1 | 1 |
| 1 | 1 | 2 | 2 | 1 | 1.4 |
| 4 | 4 | 4 | 4 | 4 | 4 |
| na | 4 | na | na | 4 | 4 |
| na | na | na | na | 4 | 4 |
| na | na | na | na | 4 | 4 |



Leaf-color Change, Tree #4, Branch A, Fall, 2010

Legend:
- 76-100% color
- 51 -75% color
- 26-50% color
- 0-25% color
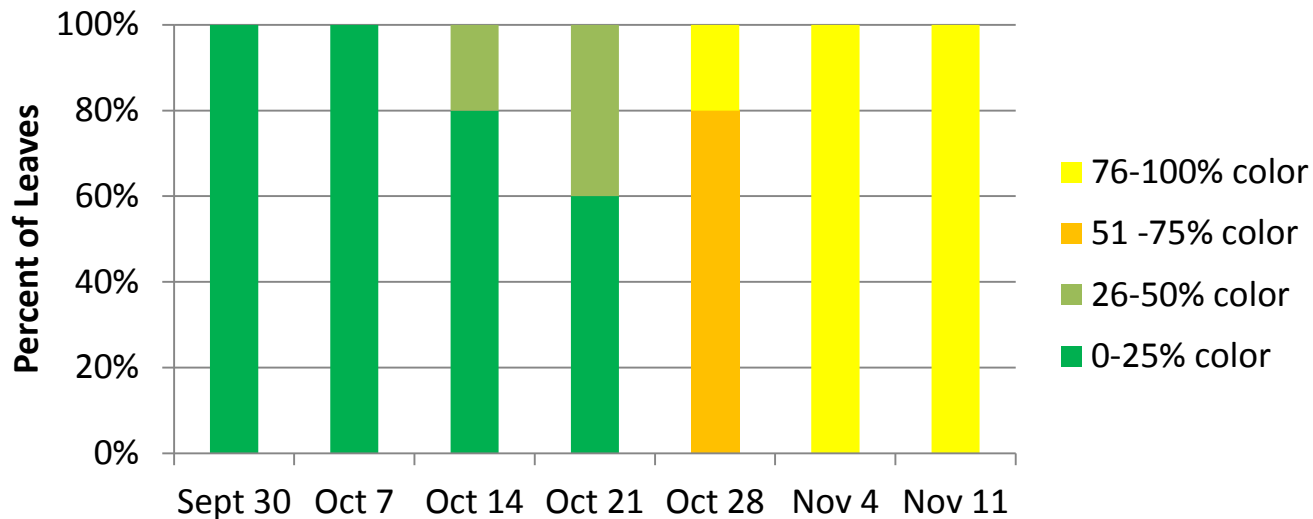
| School |  |
|---|---|
| Teacher |  |
| Year |  |
| Research Team |  |
| Tree Species |  |
| Tree ID |  |
| Branch ID |  |

| Leaf # | Leaf length | Date of length measurement | Date when leaf had fallen from branch |
|---|---|---|---|
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |
| 8 |  |  |  |

School
Teacher
Date
(Julian)
TreeID
Species
Btotal
Bopen
Llength

**Harvard Forest LTER Schoolyard Program**
**Buds, Leaves and Global Warming**

**Student Data Sheet – Spring**
Revised March 2010 by JOK and PS

Names: _____

School: _____ Date: _____

Tree Species: _____

Tree ID (number): _____ Branch ID (letter): _____

1. **Put a check mark** in the correct column below to show the stage of each bud.

| | Bud 1 | Bud 2 | Bud 3 | Bud 4 | Bud 5 | Bud 6 |
|---|---|---|---|---|---|---|
| **Closed**: Bud is closed and not puffy | | | | | | |
| **Puffy**: Bud is swollen or opening with no unfolded leaf | | | | | | |
| **Open**: Bud has opened and whole leaf is visible (budburst) | | | | | | |
| **Bud Fallen Off** | | | | | | |

2. **How many buds were observed in all?** _____
Of these, how many were **Closed?** ____ **Puffy?** _____ **Open?** _____

3. **Look for the open bud with the largest leaf.**
   Measure the leaf length in centimeters: _____

4. **Field notes:**
**Temperature (degrees Celsius):** _____
**Humidity(%):** _____
**Circle one:** Sunny   Cloudy   Rainy
**Other observations and Notes:** _____
_____

**Teacher Note:** Please combine data from all branches on the same tree to create tree-level data for submission to Harvard Forest.

School
Teacher
Date
(Julian)
TreeID
Health
Wool
Eggs
Growth

**Harvard Forest Schoolyard Ecology**
**Hemlock Trees and the Pesky Pest, The Woolly Adelgid**

**Student Data Sheet**

Name(s): _____

School: _____

Date: ____ / ____ / _____

Site Name/location: _____

Tree ID Number: _____

Tree Crown health (0-3): _____
- 0 - Healthy-all green
- 1 – Some bare branches
- 2 –Unhealthy- half or more bare branches
- 3 –Dead- no green needles

| ID Tree/Branch number/letter | White wool present(1) Absent(0) | Number of Egg Sacs Per 10cm segment | New Growth at Branch Tip (cm) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| Summary data for Tree Number: | White wool Present(1) Absent (0) | Average Number of Egg Sacs | Average New Growth (cm) |
| | | | |

Fieldnotes/comments: Please write field observations re: field conditions such as climate, wildlife, presence of other insects, and other plants on the reverse of this form. Note what other types of trees are nearby and may replace hemlock if it dies.

# Crown Health of 10 Hemlock Study Trees, JR Briggs School, Fall 2005



■ Some thinning

■ All green

# Crown Health of 10 Hemlock Study Trees,
## JR Briggs School, Fall 2005 – Fall 2008



**Fall 05**

**Spr 06**

**Fall 06**

**Spr 07**

**Fall 07**

- Some thinning
- All green

**Spr 08**
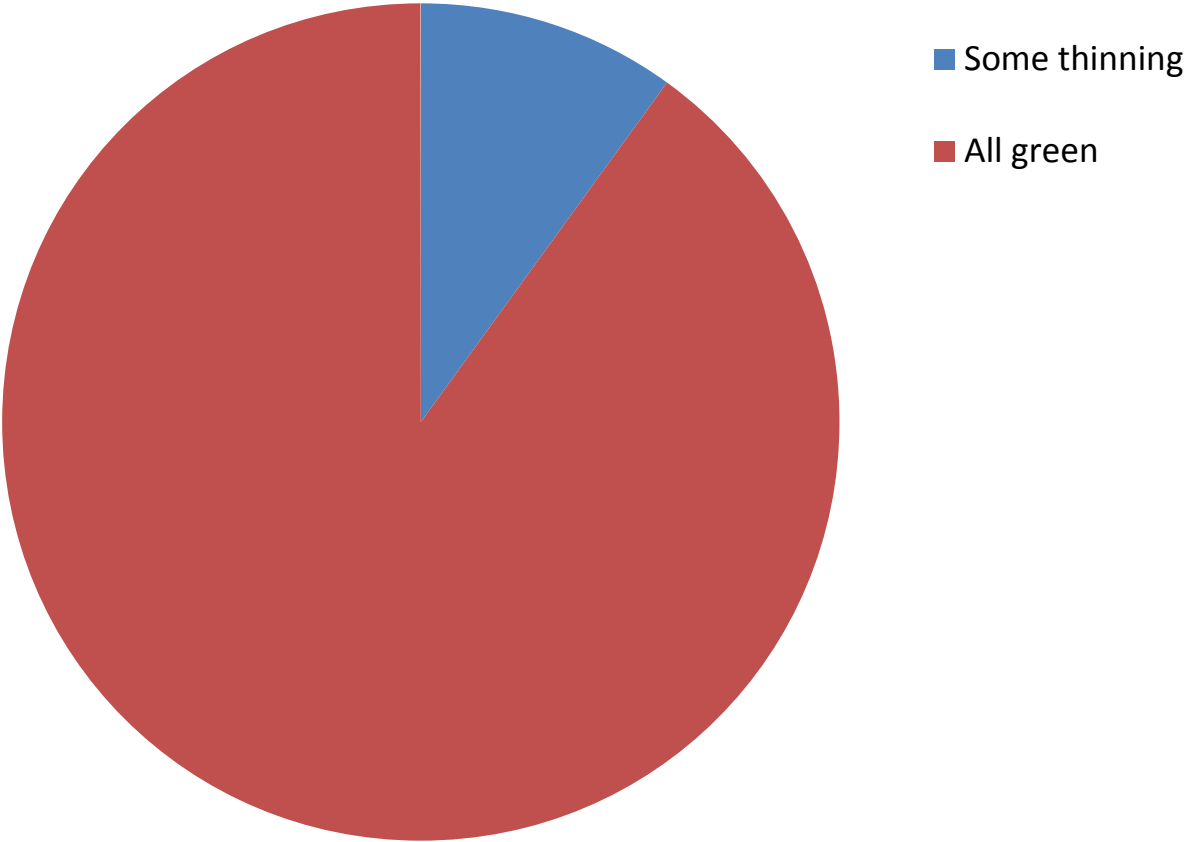
**Fall 08**
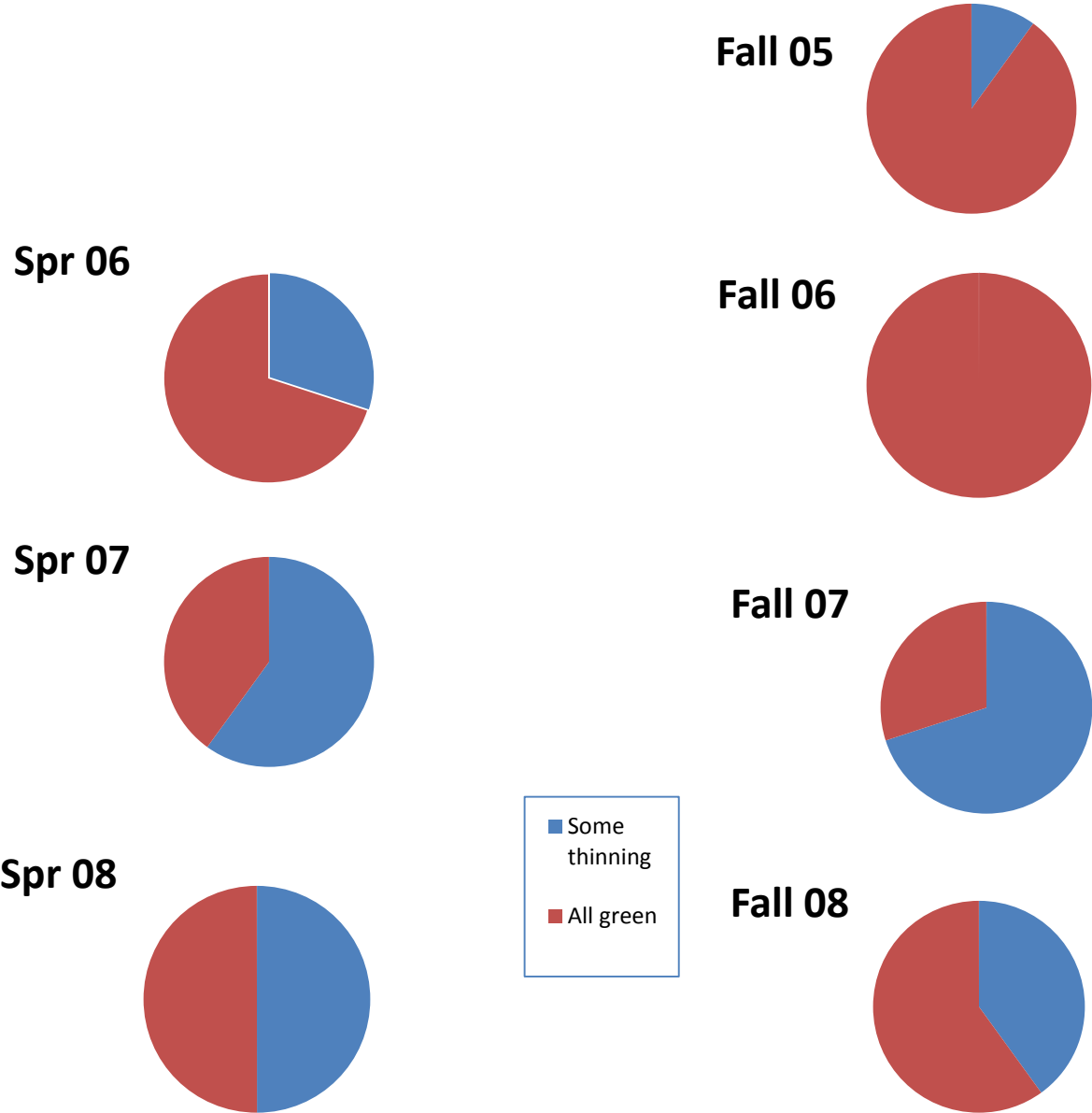
Crown Health in 10 Hemlock Study Trees,
JR Briggs School, Fall 2005 – Fall 2008
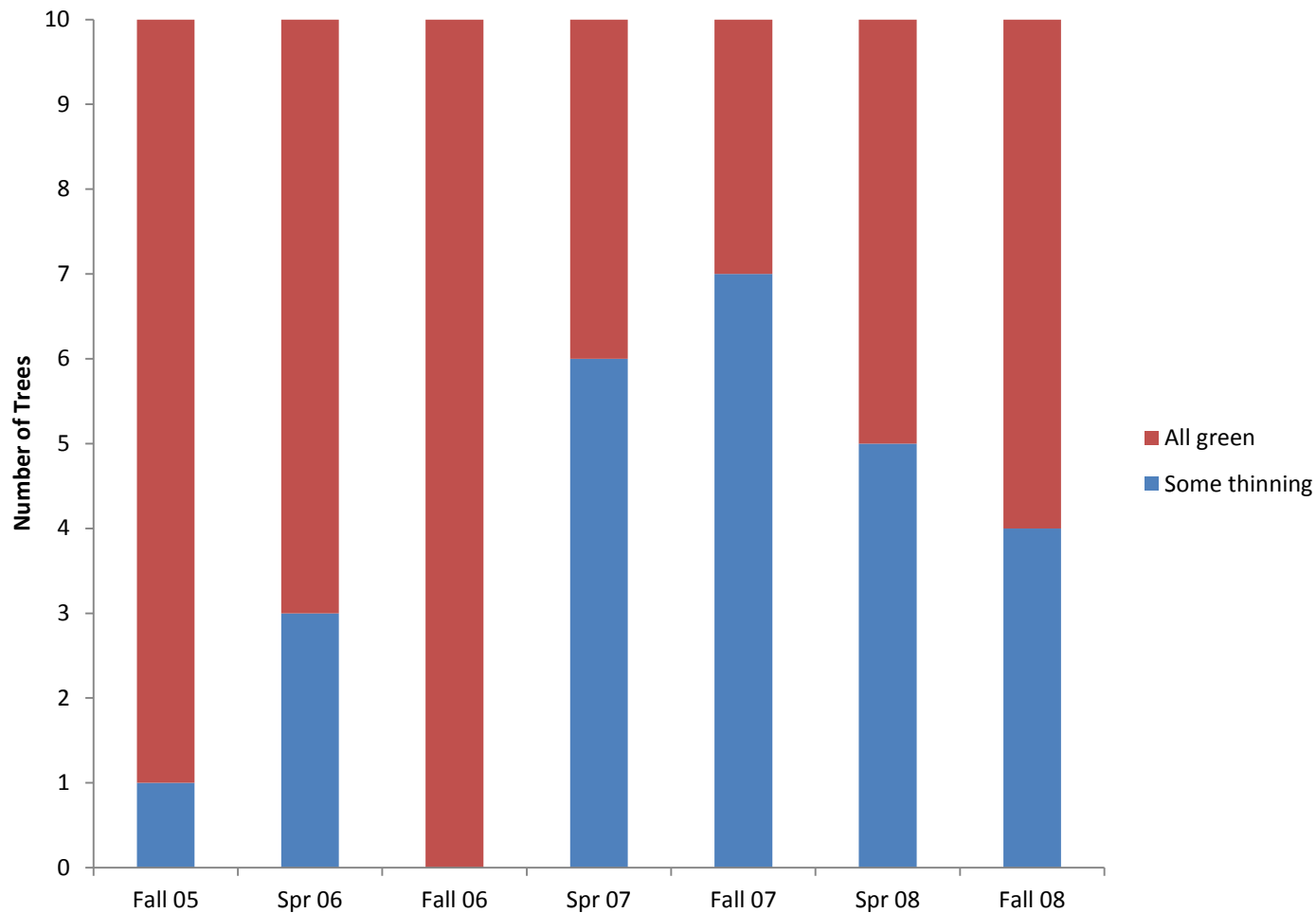
Project:        Woolly Bully

Year:           2010-2011
Team:           Jennifer, Bryan, Heather, Dean

Tree #:         1                                      Hemlock

Branches:    1,2,3,4

Sampling Date:              9/30/2010

| Branch | Wool | Egg Sacs | New Growth | Diameter |
|--------|------|----------|------------|----------|
|        |      |          |            |          |
| 1      | 0    | 0        | 10         |          |
| 2      | 0    | 0        | 14         |          |
| 3      | 0    | 0        | 17         |          |
| 4      | 0    | 0        | 5          |          |
| whole-tree | 0 | 0      | 11.5       | 85       |

## New Growth in Hemlock #1, September 30, 2010
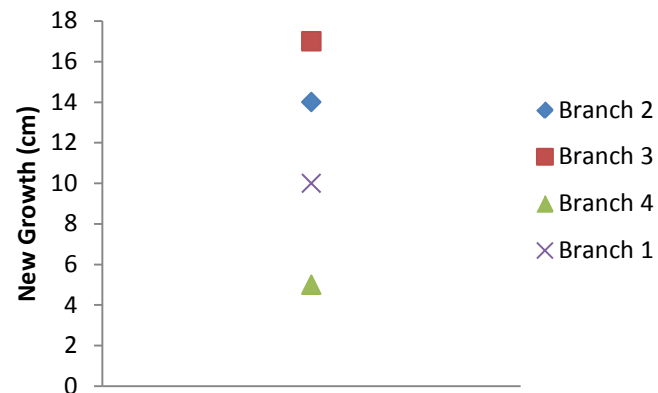
Project:     Woolly Bully

Tree #:                    1          Tree Species:    Eastern Hemlock
Branches:    1,2,3,4

| Year | Date | 1 | Branch Growth 2 | 3 | 4 | | Diameter | Diameter change |
|------|------|---|-----------------|---|---|---|----------|-----------------|
| | | | | | | | | |
| 2007 | 11/7/2007 | 6 | 11 | 14 | 4 | | 80 | |
| 2008 | 10/7/2008 | 11 | 15 | 20 | 7 | | 83 | 3 |
| 2009 | 10/12/2009 | 12 | 12 | 18 | 6 | | 84 | 1 |
| 2010 | 9/30/2010 | 10 | 14 | 17 | 5 | | 85 | 1 |

| | | Branch # 1 | 2 | 3 | 4 | all | | |
|---|---|---|---|---|---|-----|---|---|
| average annual growth | | 10 | 13 | 17 | 6 | 11.4 | mean annual diameter change since 2007 | 1.7 |
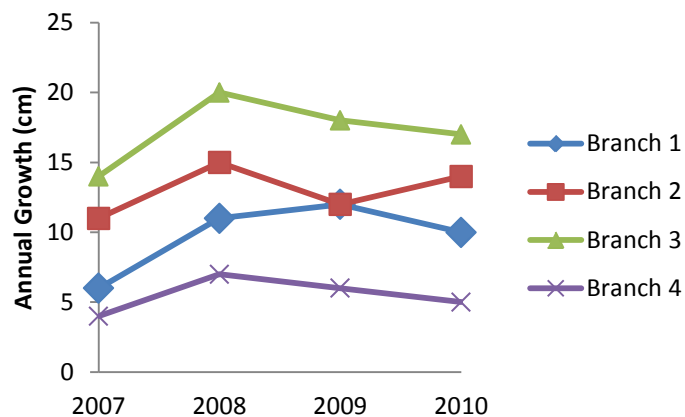
## Harvard Forest Schoolyard Ecology
## Vernal Pool Characteristics Student Data Sheet

**Name(s):**_____

_____

**School:**_____ **Teacher:**_____

**Class:**_____ **Grade:**_____

**Vernal Pool Name:**_____

**Date:**_____ **Time:**_____

| Maximum Diameter (meters) | Current Diameter (meters) | Water Depth (centimeters) | Air Temp. (Celsius) | Water Temp. (Celsius) | |
|---|---|---|---|---|---|
| | | | | | |

**FIELD NOTES**

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Project:   Vernal Pools

Team:   Rico, Emily, Jeannette, Thomas          Sample Site:          3
Pool:   Schoolyard Pool
Year:   2010-2011

| Date: | Time (EDT): | Depth | Diameter | Max. Diameter | Difference | Air temp | Water Temp |
|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |
| Sept 30 | 10:00 | 0 | 0 | 25 | -25 | 22 | 14 |
| Oct 7 | 10:15 | 0 | 0 | 25 | -25 | 18 | 12 |
| Oct 14 | 10:05 | 8 | 1 | 25 | -24 | 24 | 14 |
| Oct 21 | 10:20 | 18 | 4 | 25 | -21 | 18 | 13 |
| Oct 28 | 10:00 | 22 | 5.5 | 25 | -19.5 | 14 | 10 |
| Nov 4 | 11:10 | 30 | 18 | 25 | -7 | 7 | 5 |
| Nov 11 | 11:15 | 31 | 19 | 25 | -6 | 5 | 5 |
| Nov 18 | 14:30 | 31 | 19 | 25 | -6 | 15 | 5 |
|  |  |  |  |  |  |  |  |

Project:   Vernal Pools

Team:    Rico, Emily, Jeannette, Thomas          Sample Site:        3

Pool:    Schoolyard Pool

Year:    2010-2011

| Date: | Time (EDT): | Depth | Diameter | Max. Diameter | Difference | Air temp | Water Temp |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Sept 30 | 10:00 | 0 | 0 | 25 | -25 | 22 | 14 |
| Oct 7 | 10:15 | 0 | 0 | 25 | -25 | 18 | 12 |
| Oct 14 | 10:05 | 8 | 1 | 25 | -24 | 24 | 14 |
| Oct 21 | 10:20 | 18 | 4 | 25 | -21 | 18 | 13 |
| Oct 28 | 10:00 | 22 | 5.5 | 25 | -19.5 | 14 | 10 |
| Nov 4 | 11:10 | 30 | 18 | 25 | -7 | 7 | 5 |
| Nov 11 | 11:15 | 31 | 19 | 25 | -6 | 5 | 5 |
| Nov 18 | 14:30 | 31 | 19 | 25 | -6 | 15 | 5 |
| | | | | | | | |

## Water Depth, Fall 2010
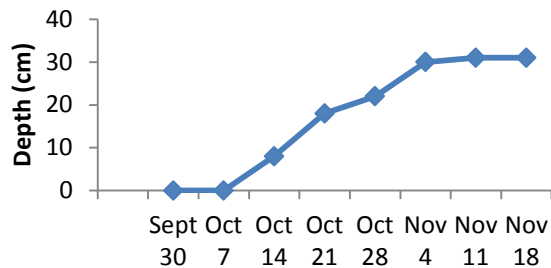


## Depth-Diameter Relationships
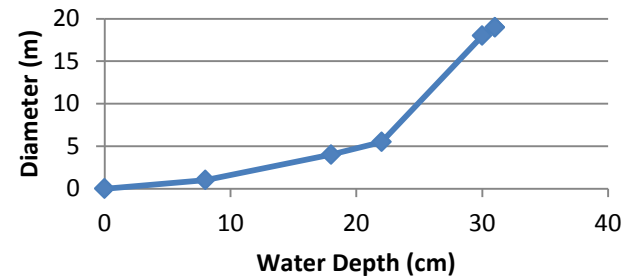
# Presence/Absence of Fauna

| 2010-11 Date: | Caddis | Back-swimmer | Dragon | Damsel | worm | Midge | Crawl Beetle | Large black beetle | wood frog eggs | salaman-der eggs | fairy shrimp | daphnia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nov 4 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nov 11 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| Nov 18 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

# Data Analysis – Understanding Results of Sampling

- Spreadsheets and Tables

- Graphs and Figures

- Statistics

# Considerations for Analyzing & Graphing Data

- What do you have for data?

- What do you want to find out? (What are the questions you are asking of your data?)

- What kind of graphs(s) [or statistics] can help you address your questions?

- What graphs [or statistics] can help you tell your story effectively?

Date of last leaf fall in four trees, 2005
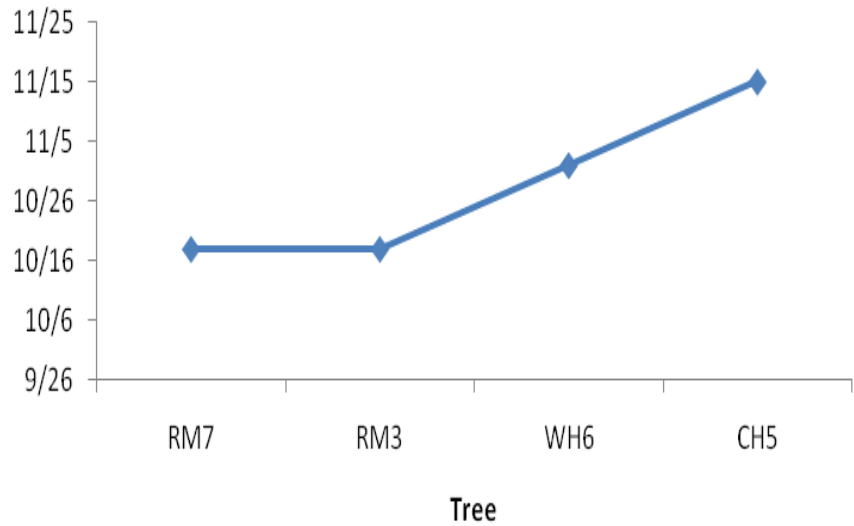


Date of last leaf fall in four trees, 2005
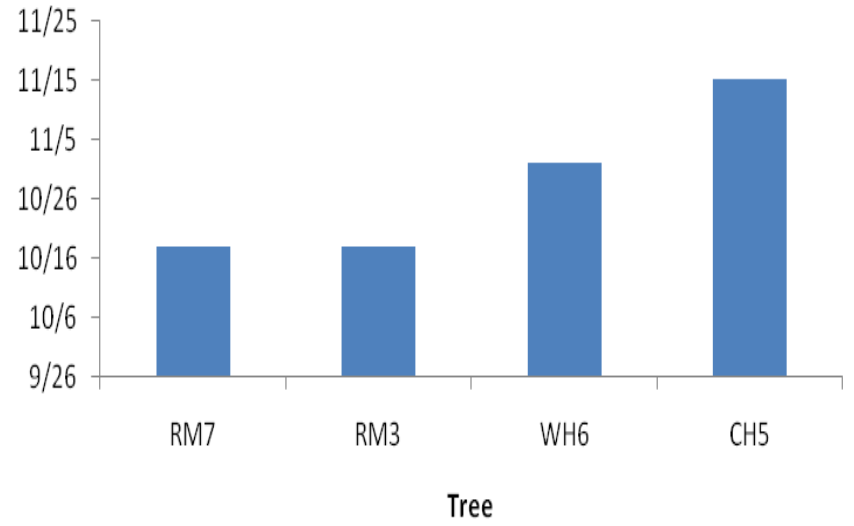
a. Line graph – not appropriate    b. Bar graph – appropriate
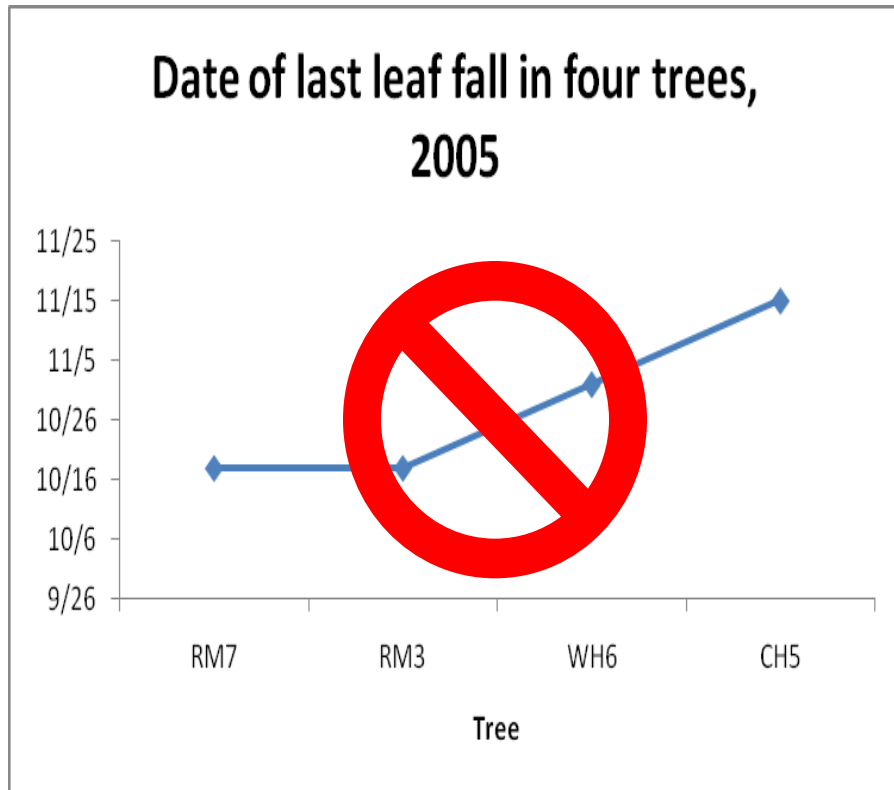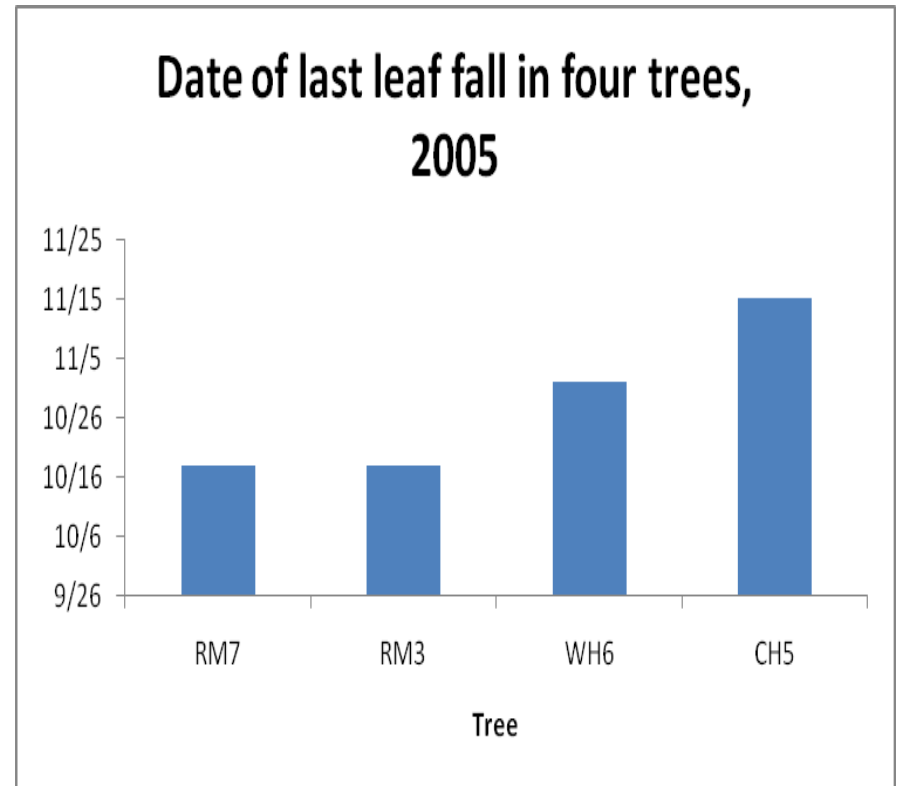
Aquatic Macroinvertebrates in a Cape Cod Vernal Pool in April, 1996. Data from EA Colburn
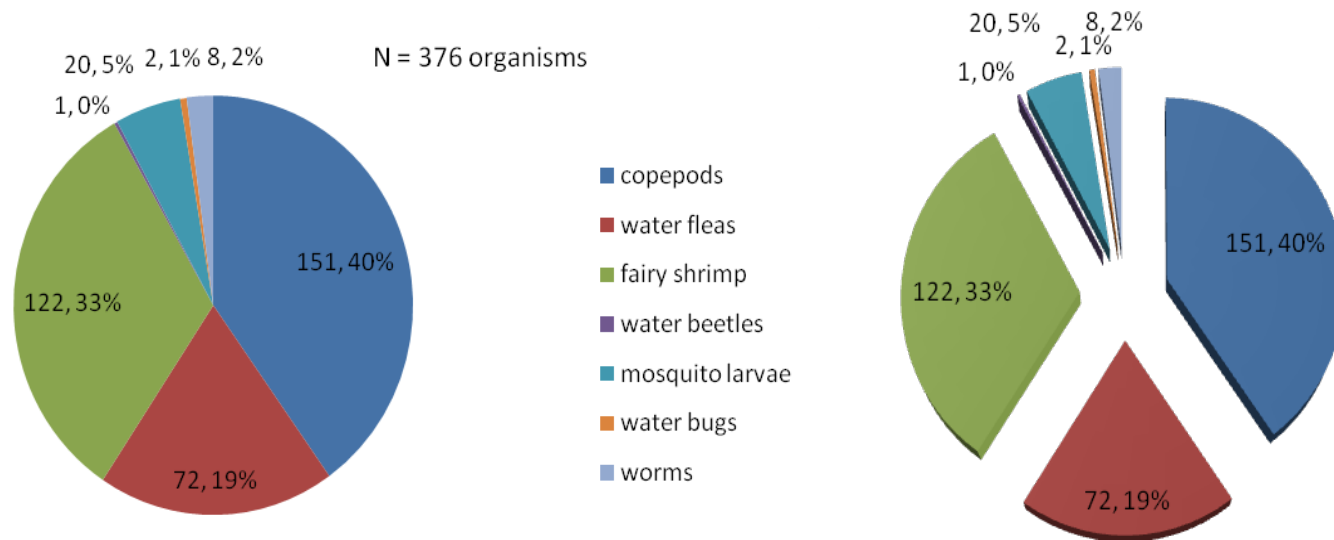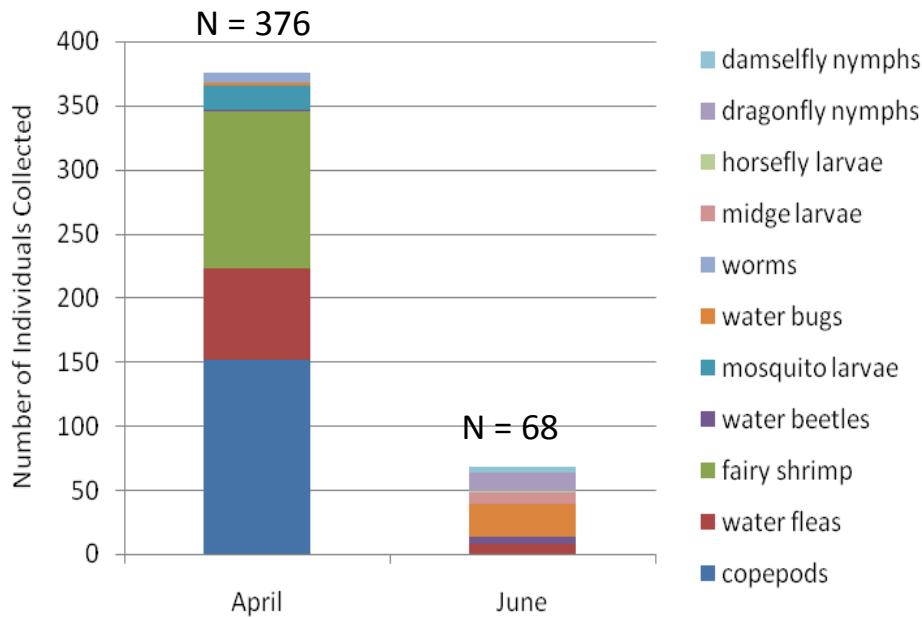
Macroinvertebrate communities in a Cape Cod Vernal pool in April and June, 1996. Data from EA Colburn
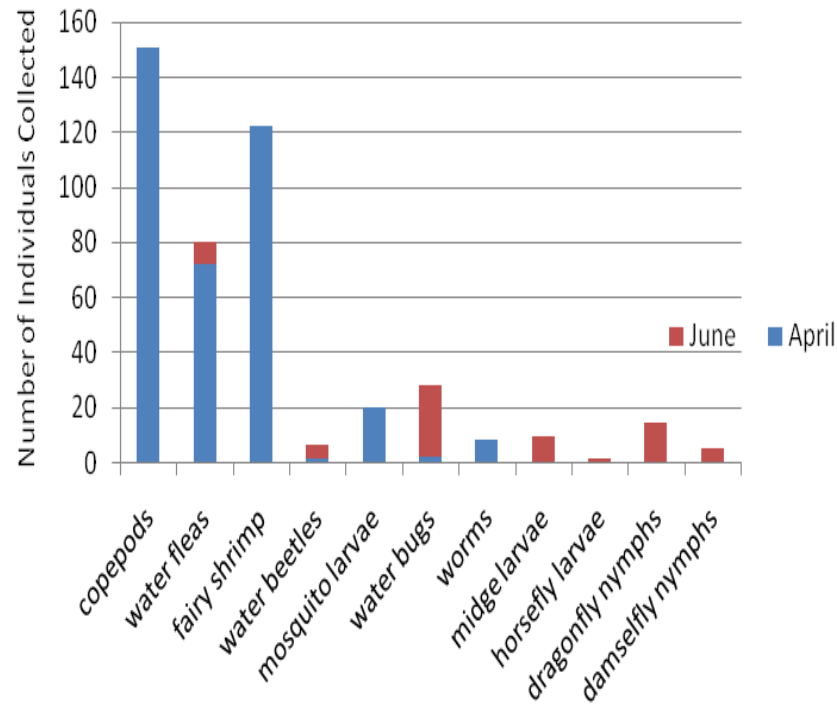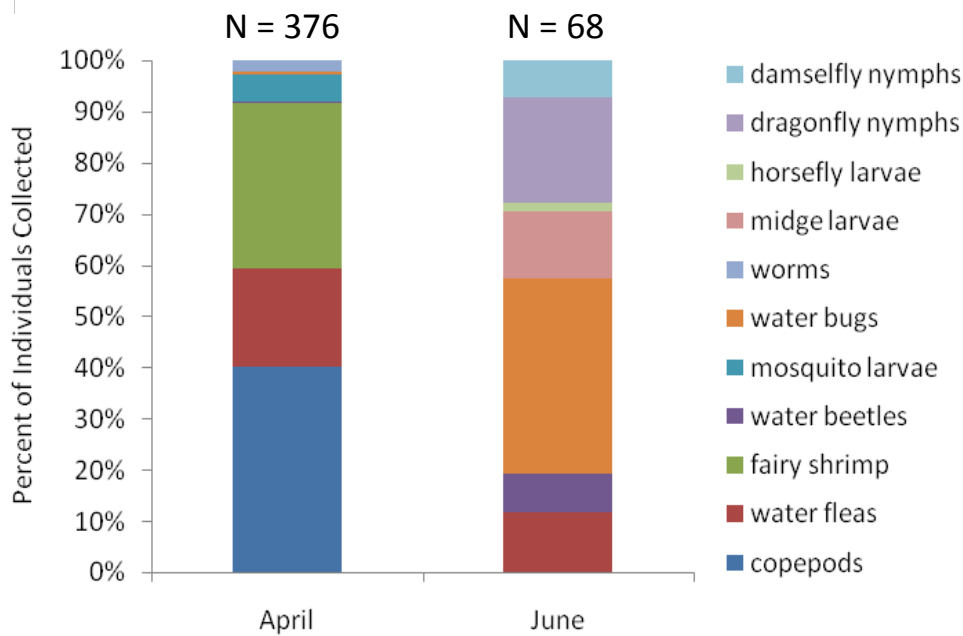
Age and diameter of trees on Mt Wachusett. Data from DA Orwig.
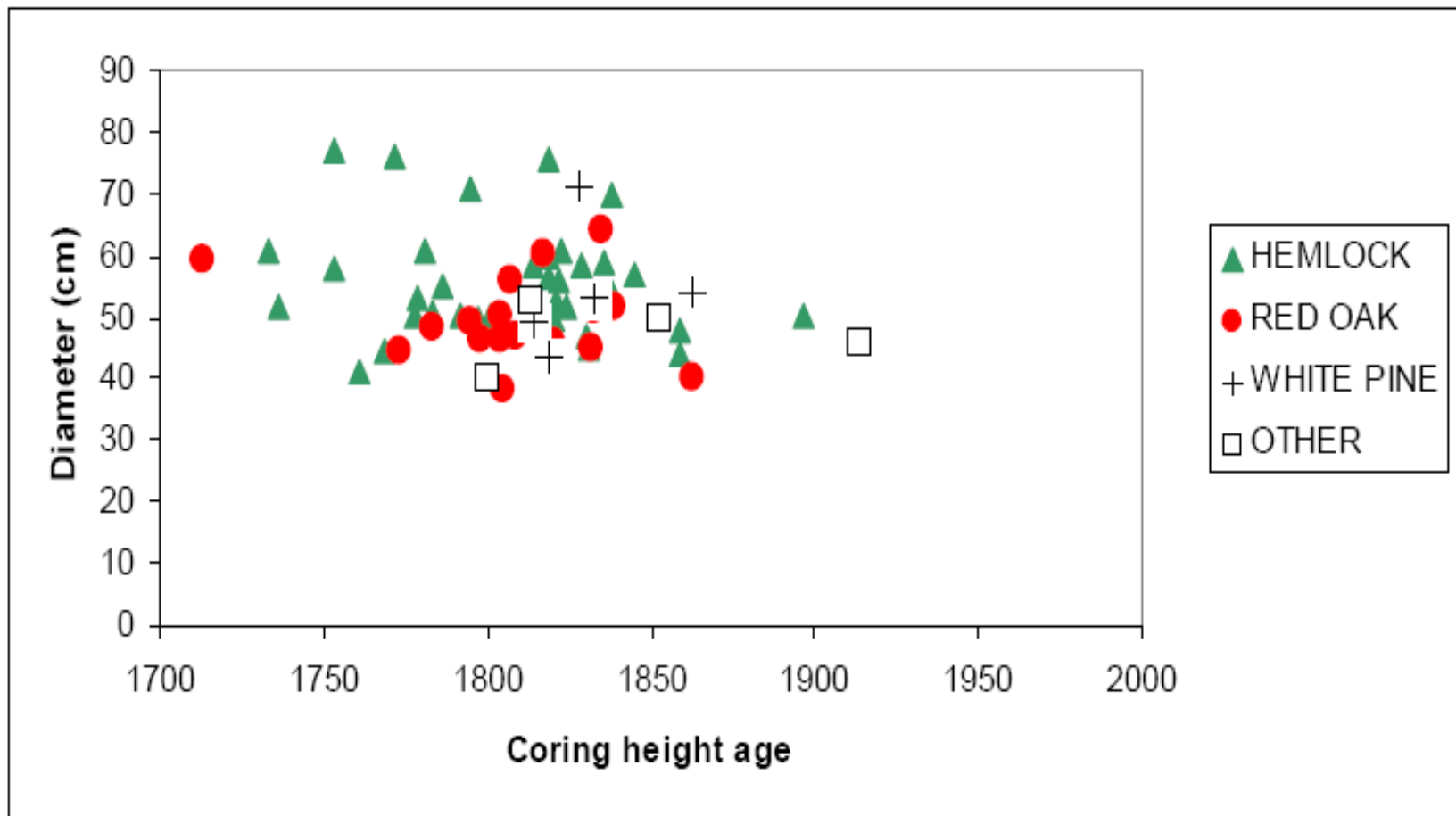
# Spring leaf emergence and autumn leaf fall in four tree species at the Harvard Forest. Data from J O'Keefe
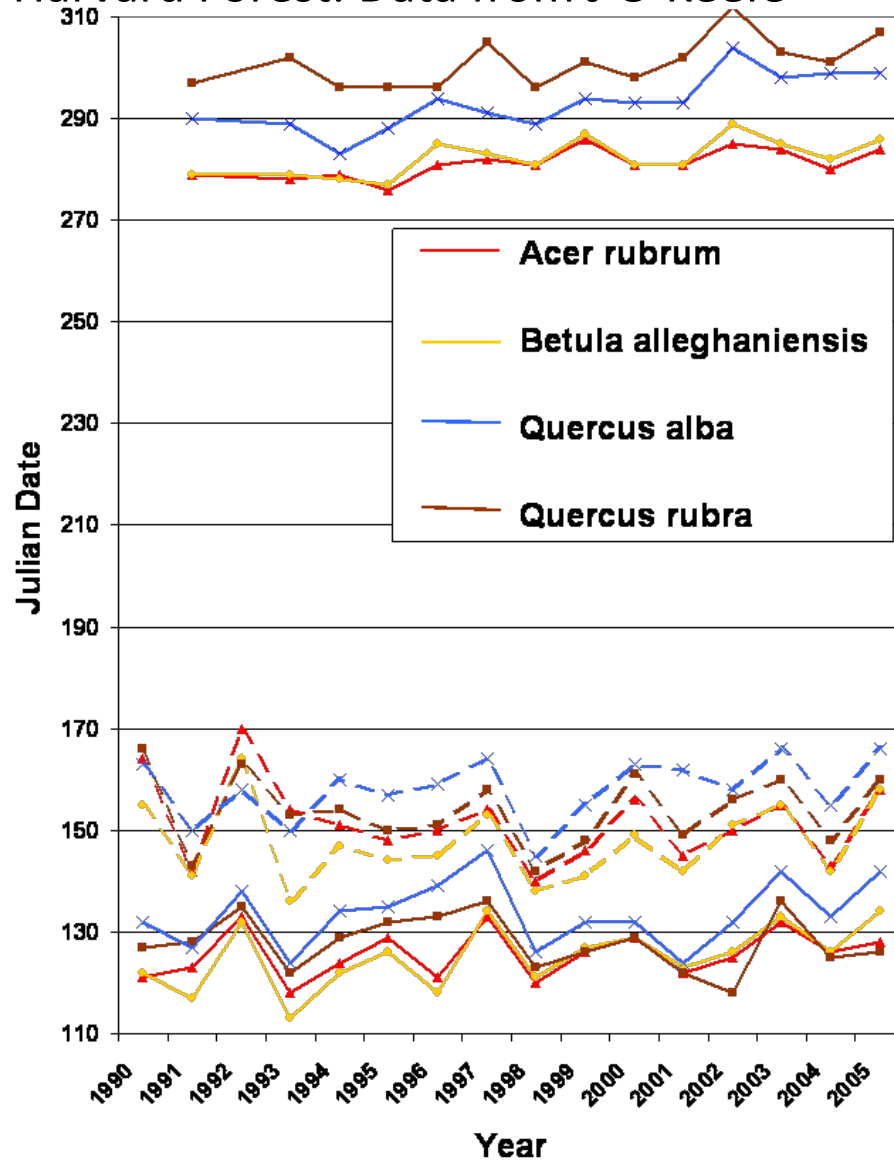


Fall:

—— Date of 50% leaf drop

Spring:

- - - - Date of 75% leaf development

—— Date of 50% bud break

# Stream discharge and environmental variables at Upper Bigelow Brook, Harvard Forest, Petersham, MA, Spring-summer, 2008. Data from E Boose.
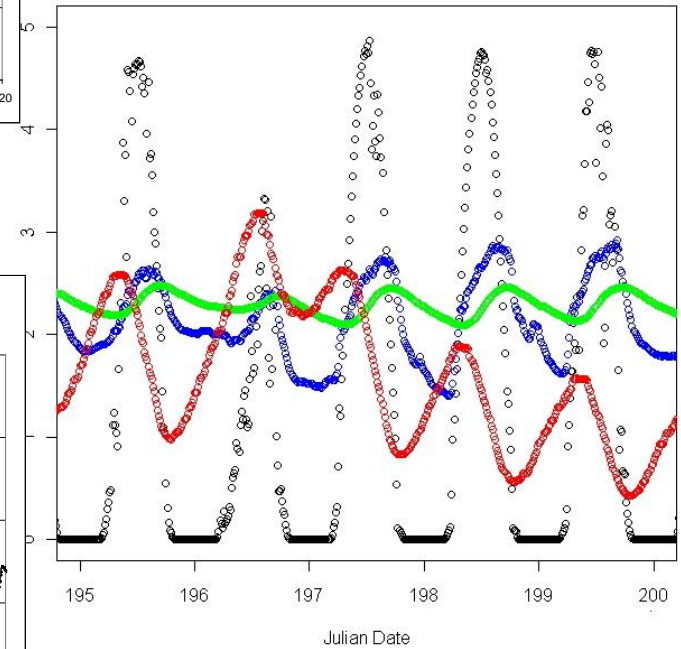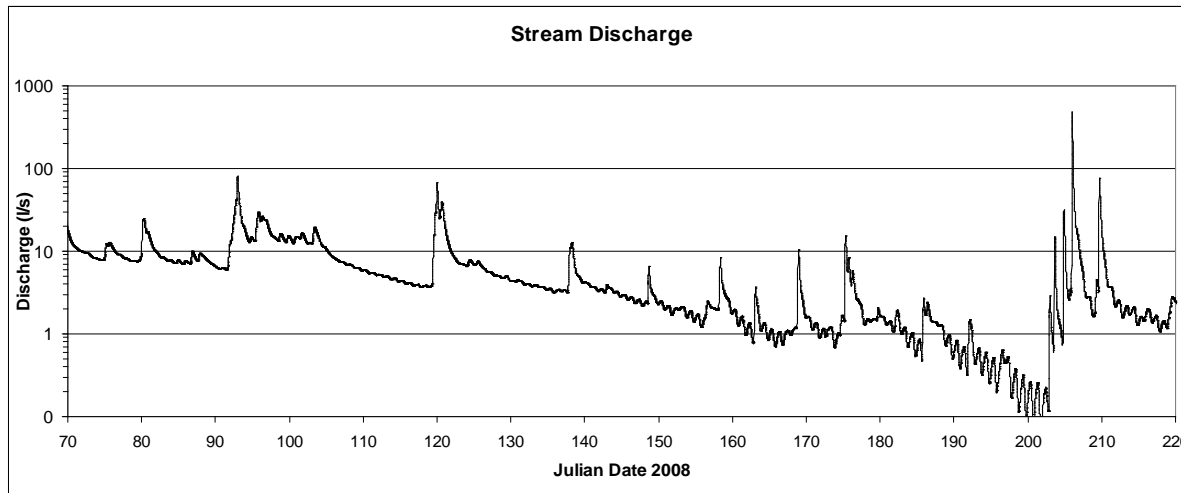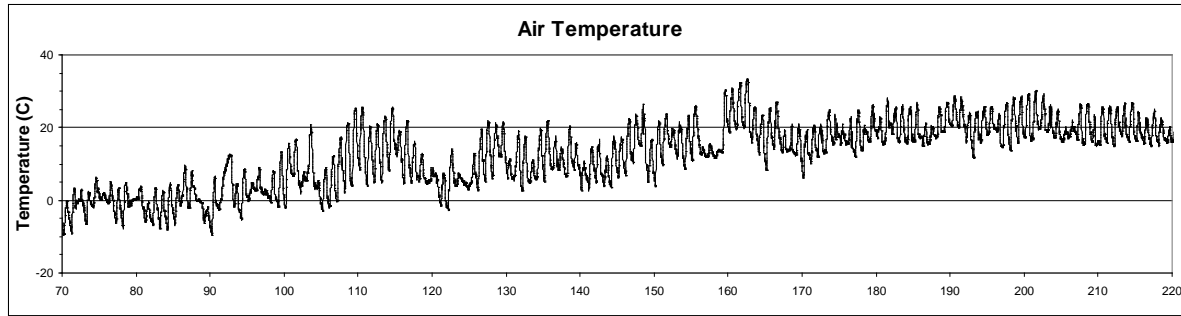


Soil temperature
Air temperature
Stream discharge
Solar radiation

# Stream discharge and environmental variables at Upper Bigelow Brook, Harvard Forest, Petersham, MA, Spring-summer, 2008. Data from E Boose.
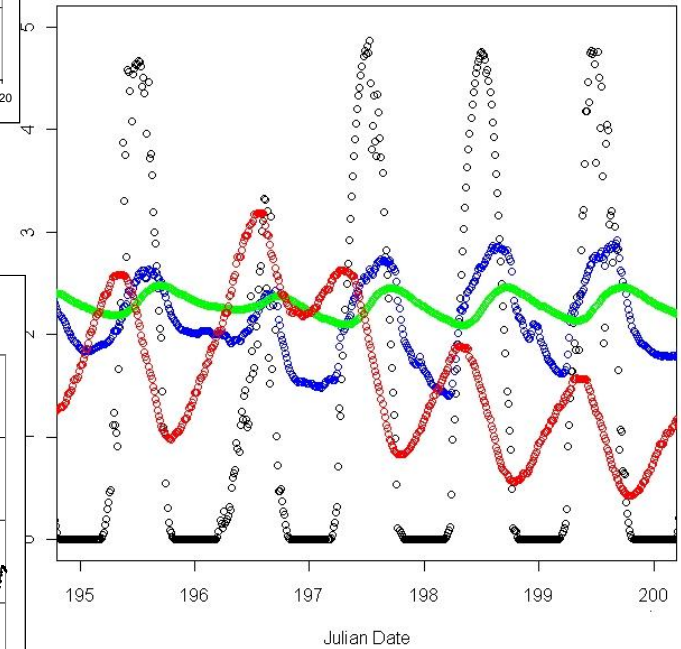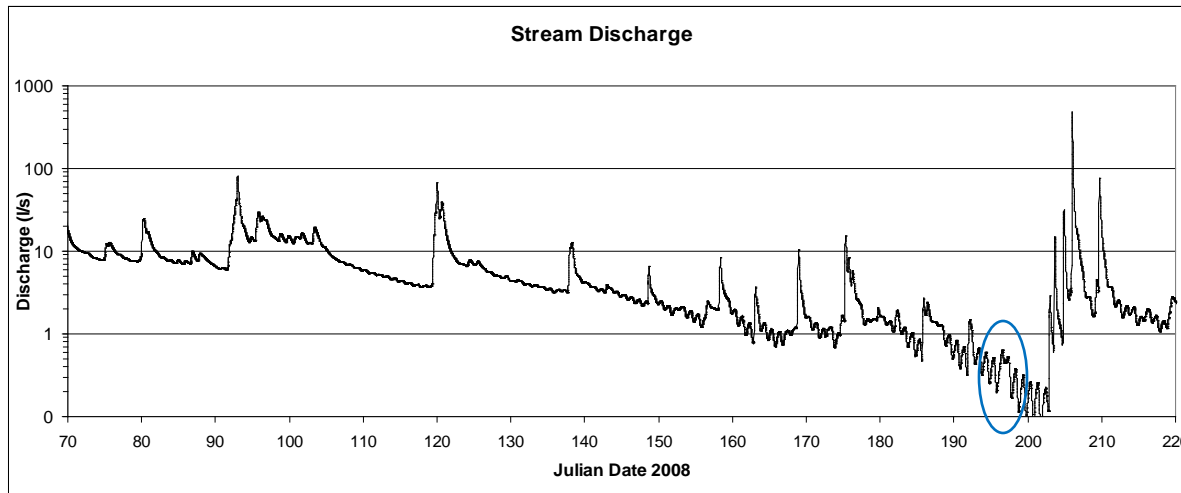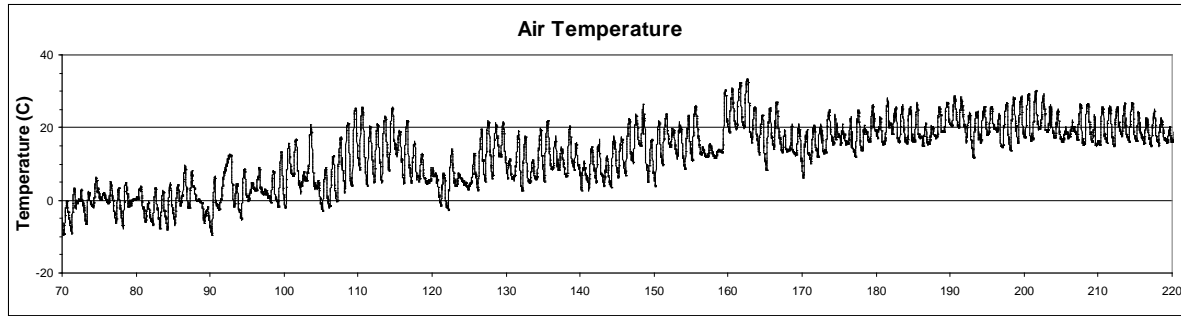


Soil temperature
Air temperature
Stream discharge
Solar radiation

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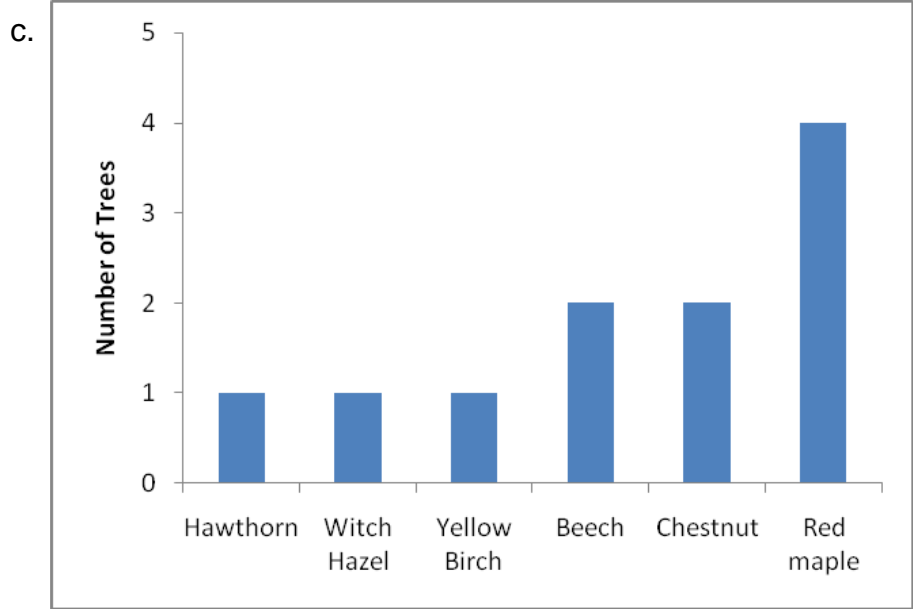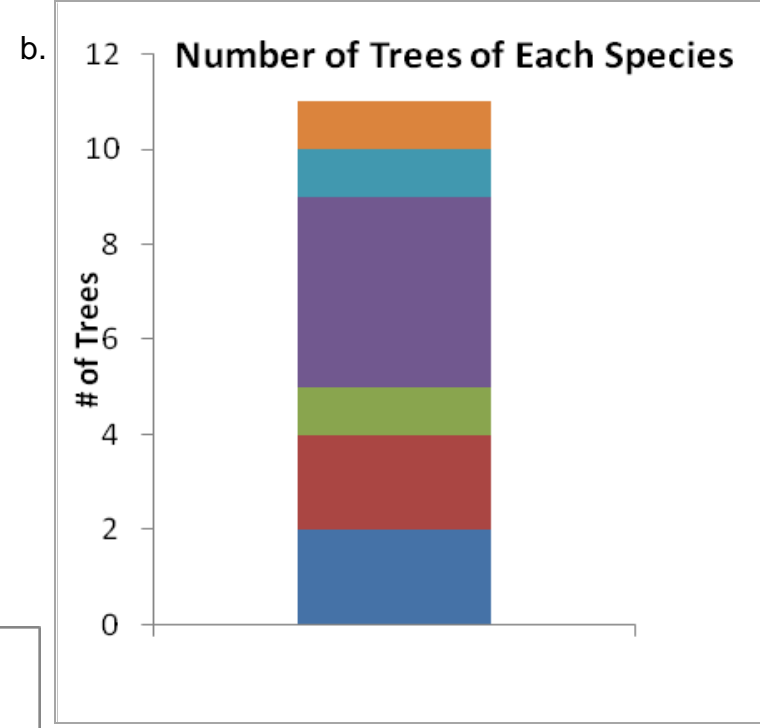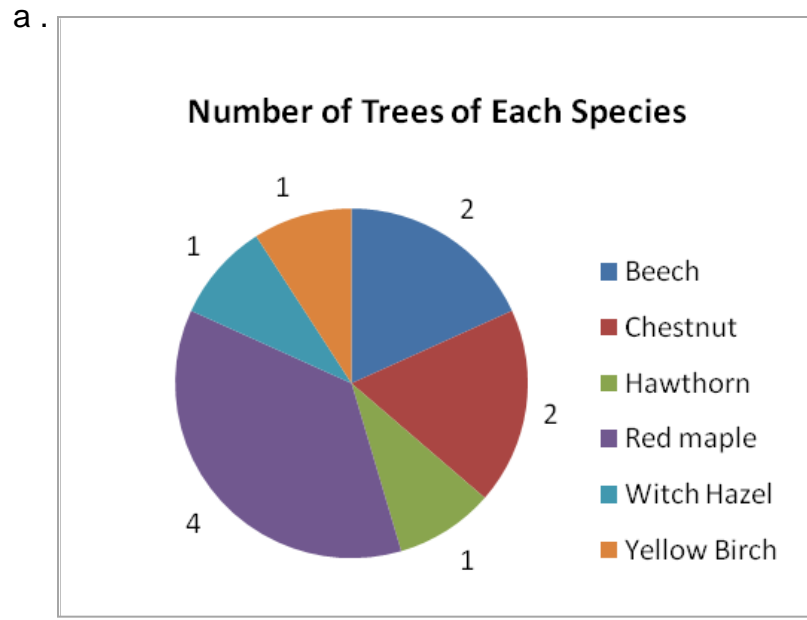
Leaf fall in one tree over four years of sampling. ARM Schoolyard data.



Progression of Leaf fall in Yellow Birch #1 over Four Years of Study

Leaf fall in Multiple Trees. ARM Schoolyard data.

Leaf fall in Multiple Trees. ARM Schoolyard Data.
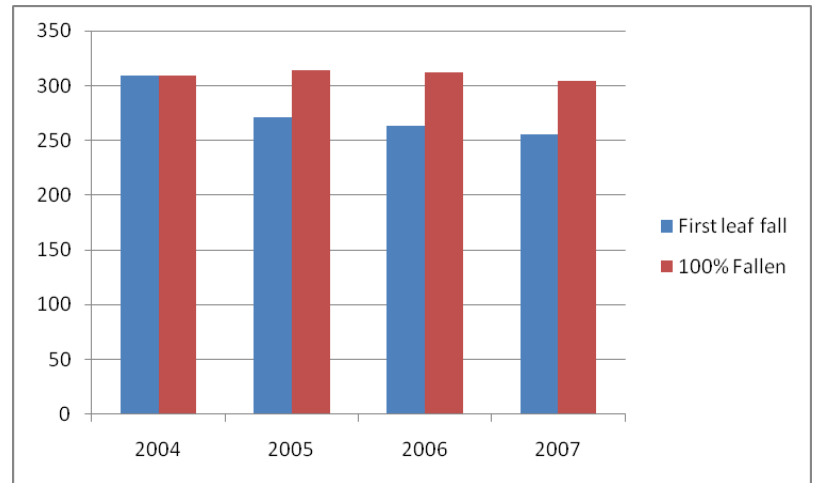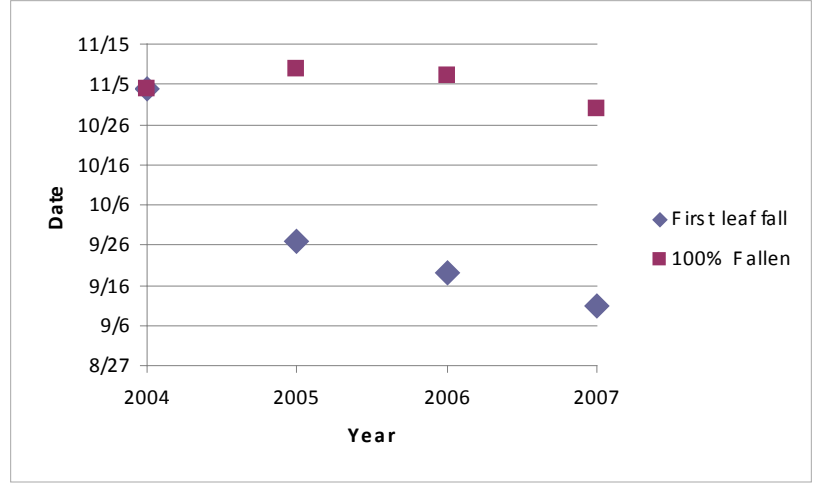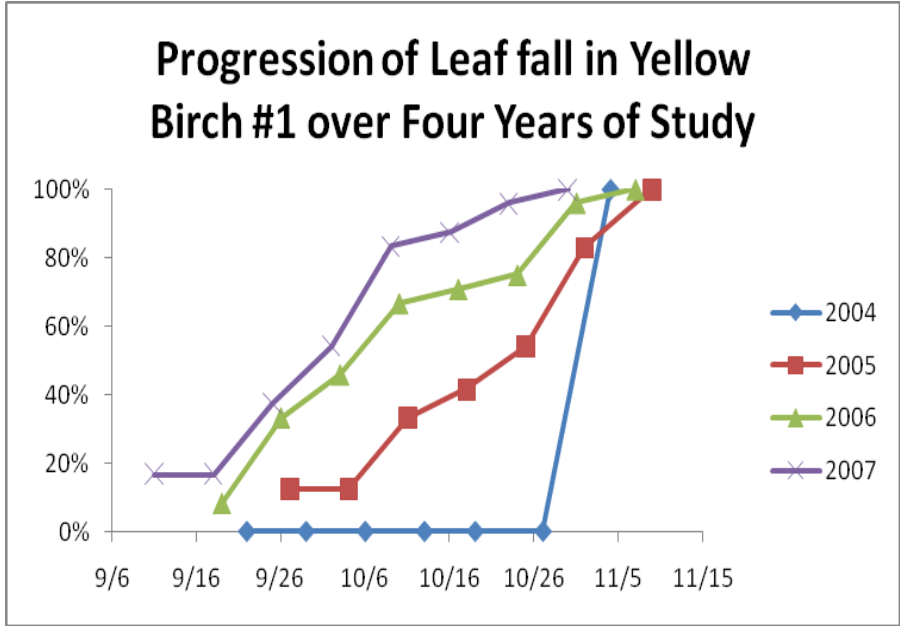
Egg production in Hemlock Woolly Adelgid in Three Hemlock Trees, 2004. WWE schoolyard data.
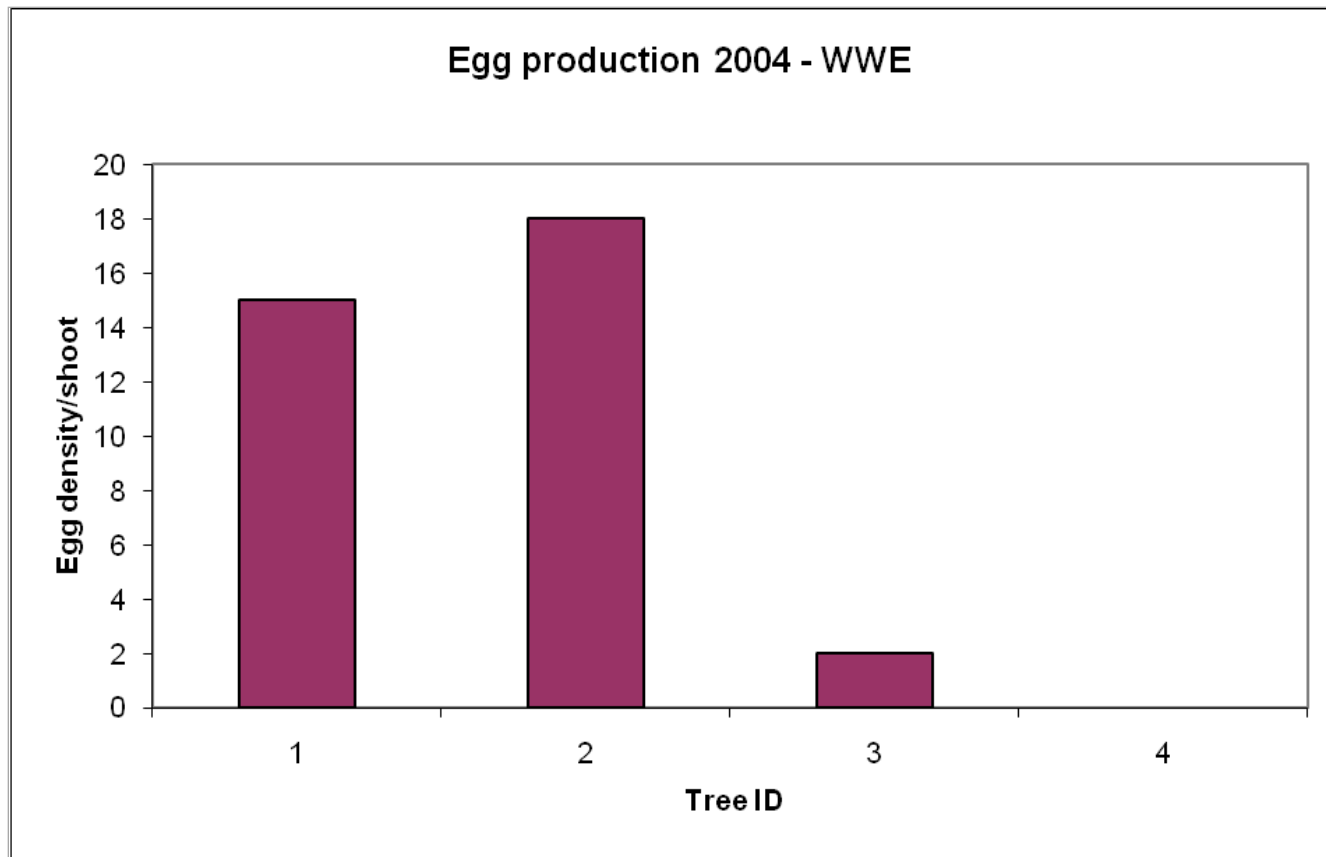
Stream depth at 4 sampling locations, 2006-2007. PES Schoolyard data.



Sample Graph of Depth Variation at Four Locations in PES Stream During the 2006-2007 Schoolyear



Bar Graph of Water Depths Measured at Four Locations in PES stream during the 2006-2007 Schoolyear
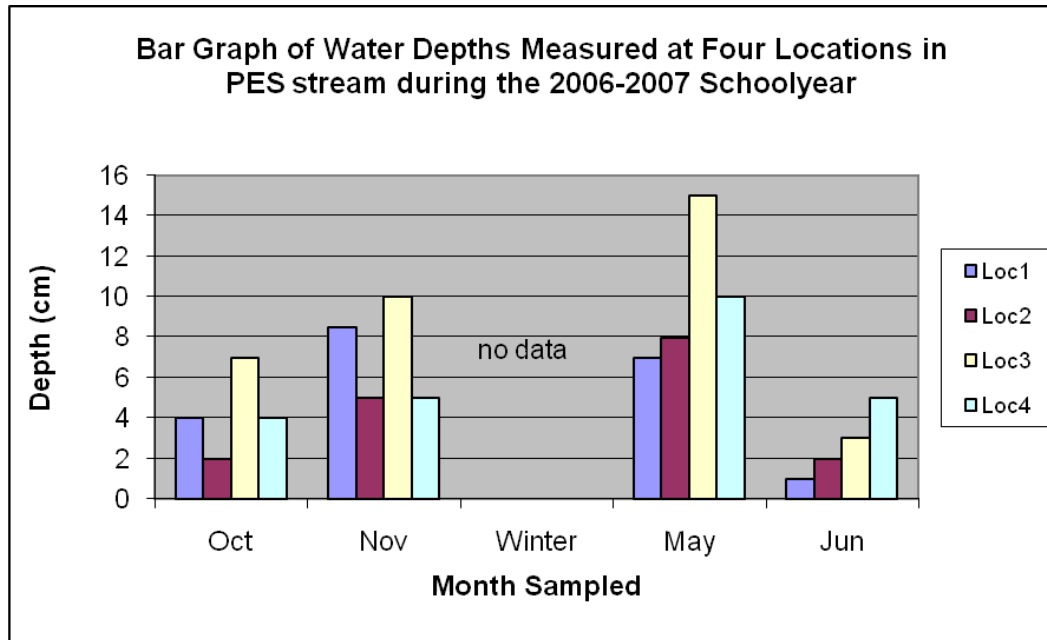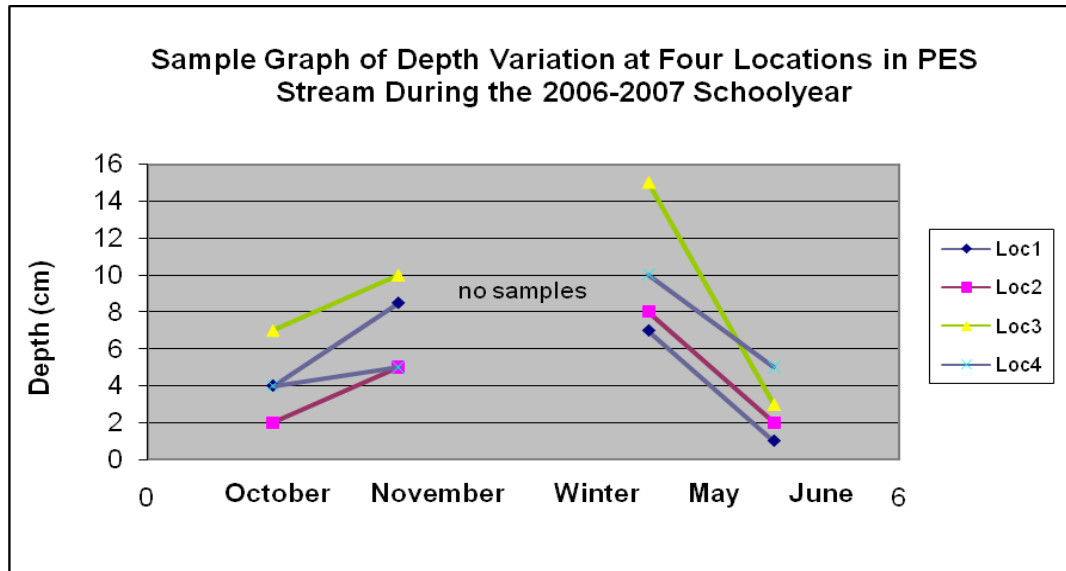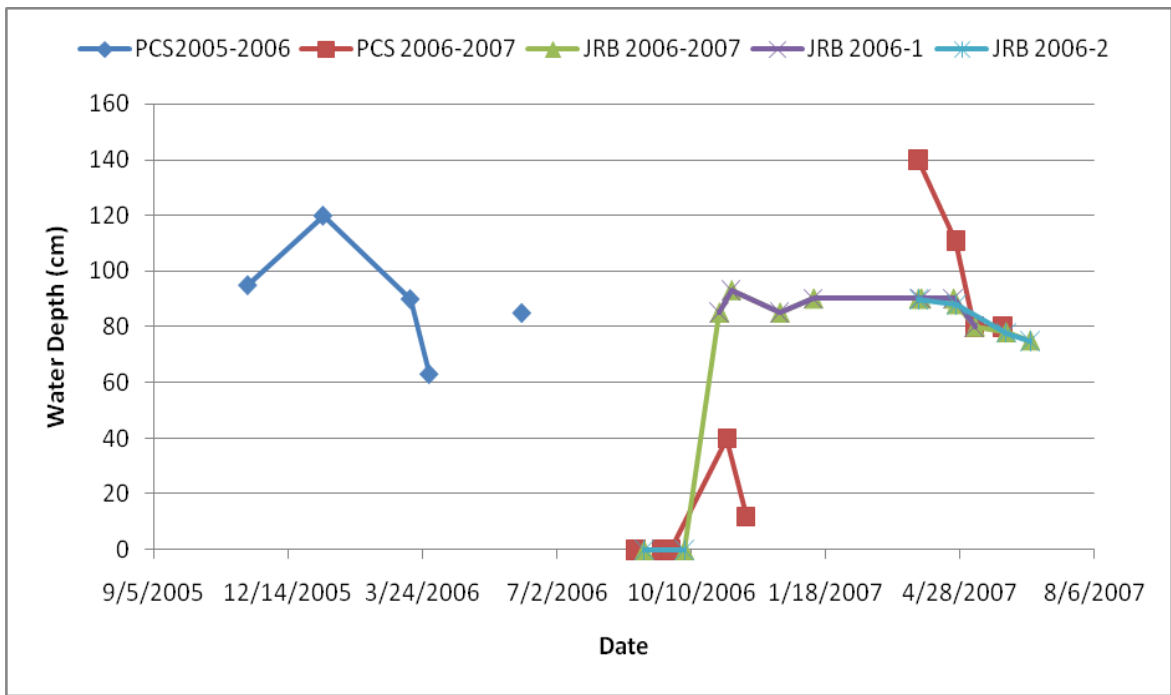
Water Depth and Pool Diameter In two vernal pools. JRB and PCS Schoolyard data.
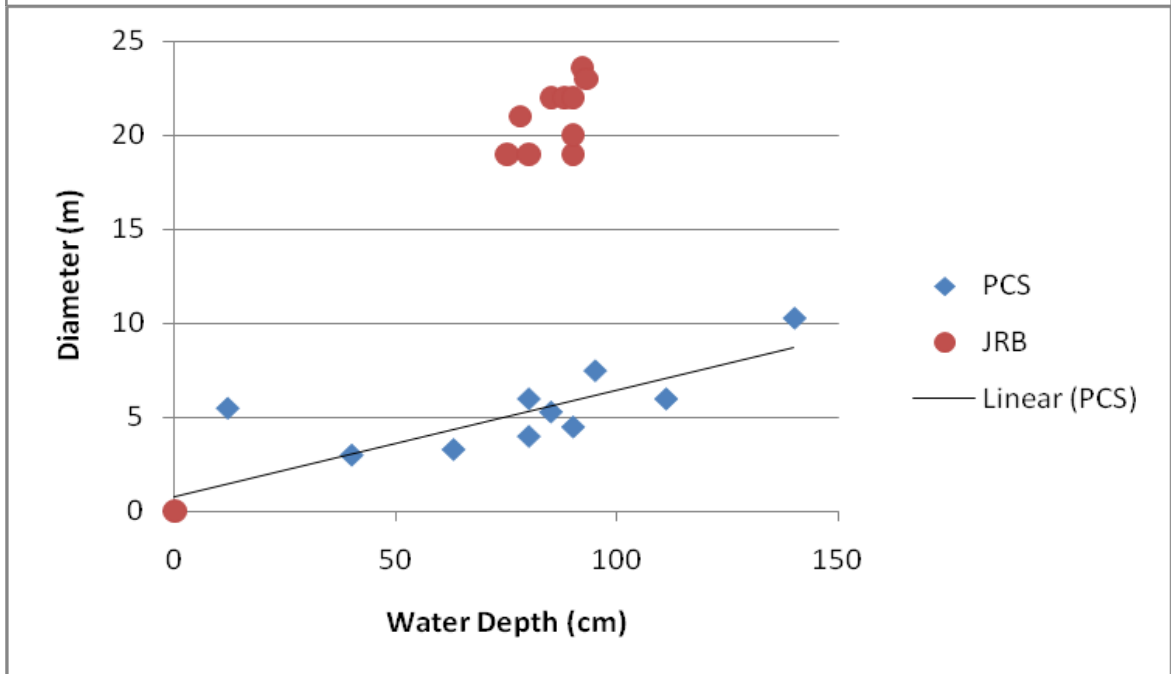
# Before Data Analysis:

Look at data

Evaluate for:
- errors
- missing information
- corrections that are necessary

Adjust accordingly

Extract additional information – e.g., length of growing season, percent of leaves fallen, etc.

# 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
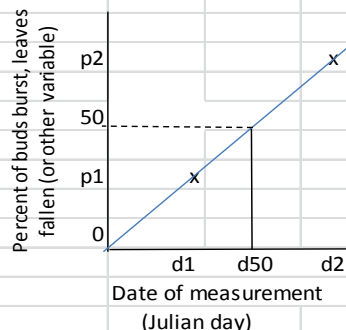


Use data measuring change in factor of interest -- water depth, growth, leaf fall, etc.
Look at the data, and choose two points bracketing the 50% level -- the formula below finds the 50% point between them
d1 and d2 are the julian days when measurements were made before and after the 50% level was reached
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

**EXAMPLE:** 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
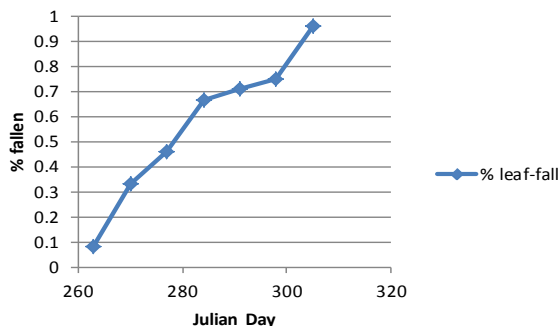
INSERT YOUR SPRING AND FALL DATA:

| | d1 | p1 | d2 | p2 | 50% |
|--------|----|----|----|----|--------|
| Spring | | | | | #DIV/0! |
| Fall | | | | | #DIV/0! |

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

# What next?

Go over data set to be used in making graphs (Level 2, download data from HF Schoolyard website).



**Level 2 teachers: <u>Work on graphing exercises</u>:**

1. Simple pie chart of tree species, by hand or by selecting an Excel data table
2. Stacked bar graph of tree species, by hand or Source Data dialog boxes.
3. Simple bar graph by species, by hand or using Chart Type dialog to change an existing graph.
4. Graph leaf-fall in a single tree over a four-year period, by hand or using the Source Data dialog boxes. (a) calculate percent of leaves fallen and remaining on tree. (b) graph data.
5. Graph first and last leaf-fall dates for one tree over a four-year period
6. If time permits, graph leaf-fall in multiple trees, your own data, or other data.
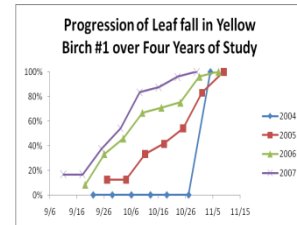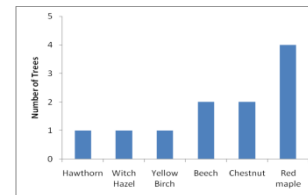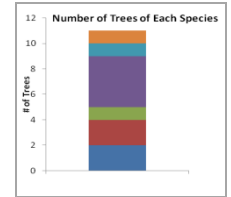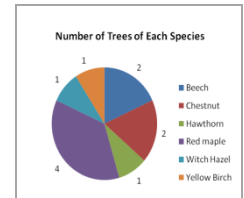






**Level 3 teachers: <u>Create and interpret graphs of your own data</u>**

**LUNCH at 12:30**

**<u>Continue after lunch until 2:30; HF staff will load Level 3 graphs for projection</u>**

**2:40 – 3:15   Teachers share graphs/insights/questions**

**3:15  Evaluation and wrap-up.**

Go to Harvard Forest website, Click on Educational Opportunities, Select K-12 and Schoolyard, Click on Schoolyard LTER Database
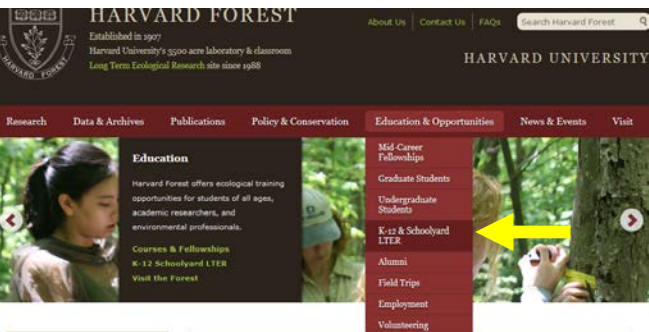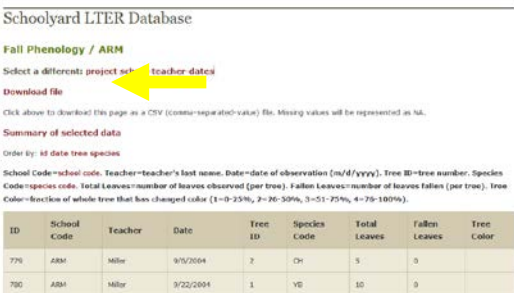


Choose Download Data
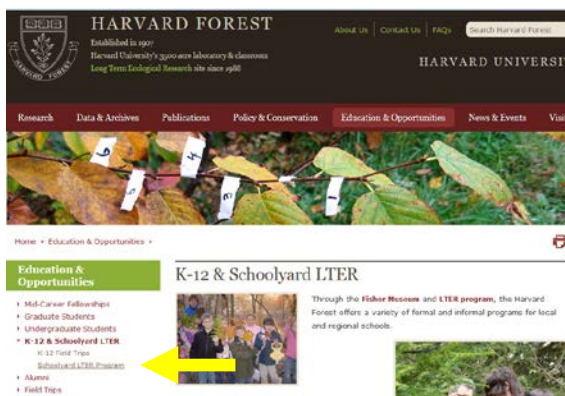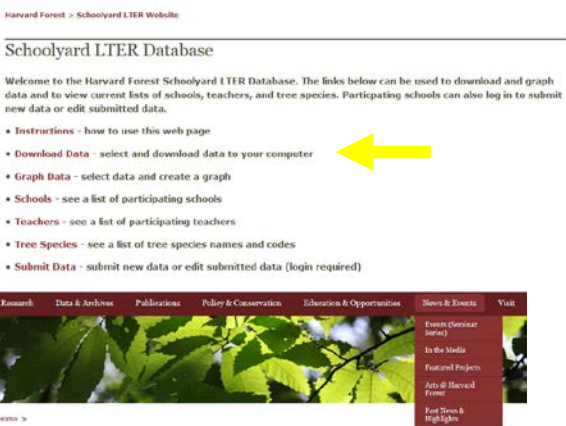


Select Fall Phenology
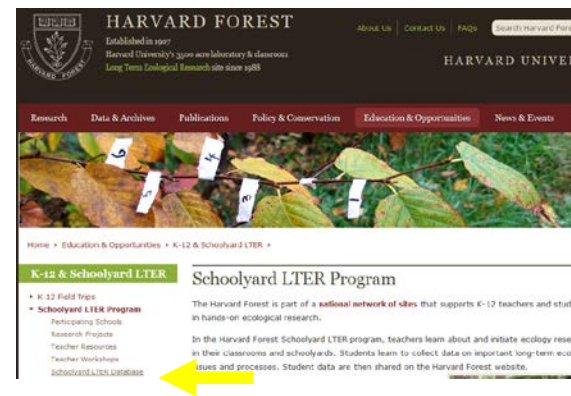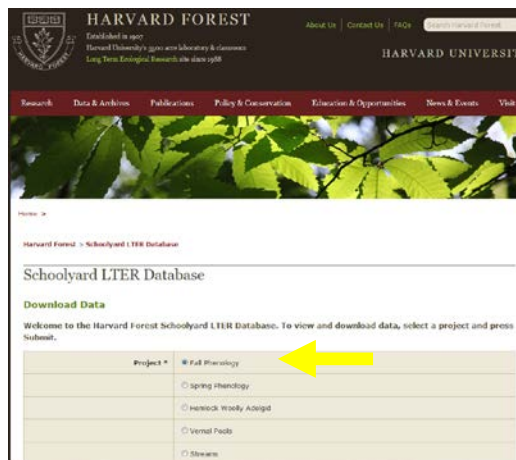
Choose Athol Royalston (ARM)
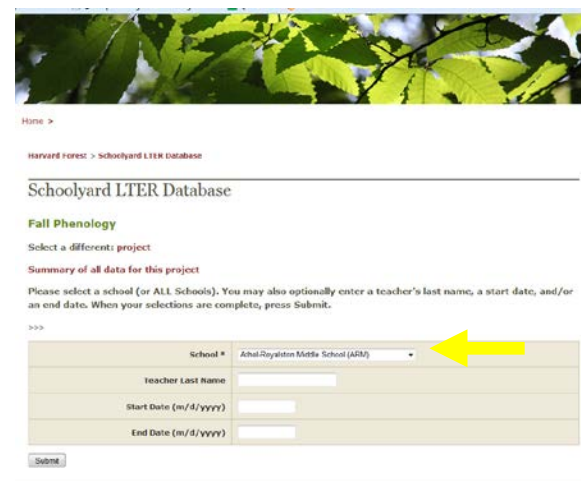
Download and work with data set

| School Code | Teacher | Date | Julian | Tree ID | Species Code | Total Leaves | Fallen Leaves | Tree Color |
|---|---|---|---|---|---|---|---|---|
| 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 |

1. Download ARM data set from Buds, Leaves, Global Warming part of Schoolyard Webpage
   - Go to the Harvard Forest website, and go to Schoolyard Program webpage (click on **K thru 12 Schoolyard LTER** in left column on Home page, and **Harvard Forest Schoolyard Program** on the next page)
   - Select the Buds, Leaves, and Global Warming, and click on Data, Protocols
   - Go down to the bottom of the page under Data, and double click on ARM to download it to your computer.
   - Save the Excel file as an xls file. You may want to name it "PracticeGraphs"
   - We will be making a variety of modifications to these data during the session
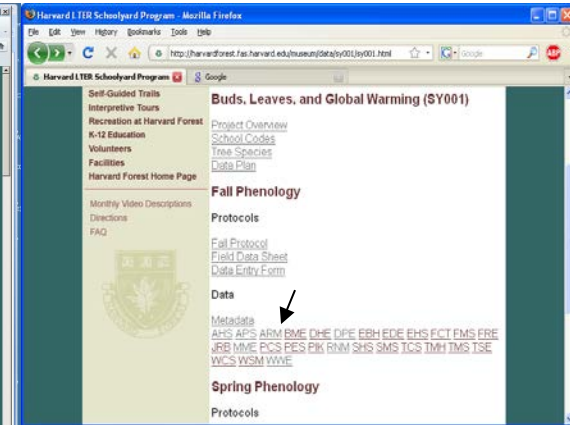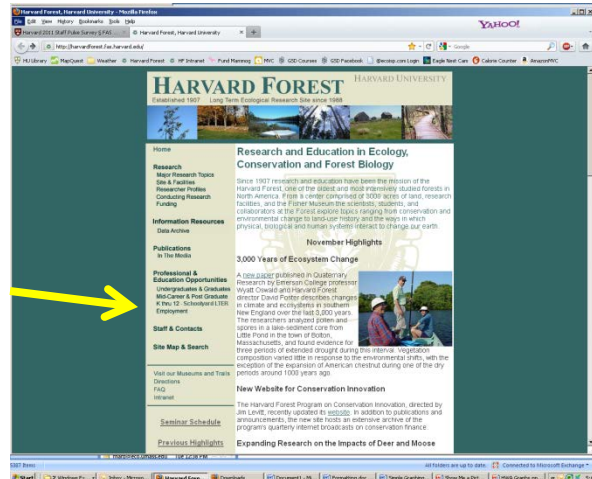
2. Become familiar with basic Excel graphing tools on your computer
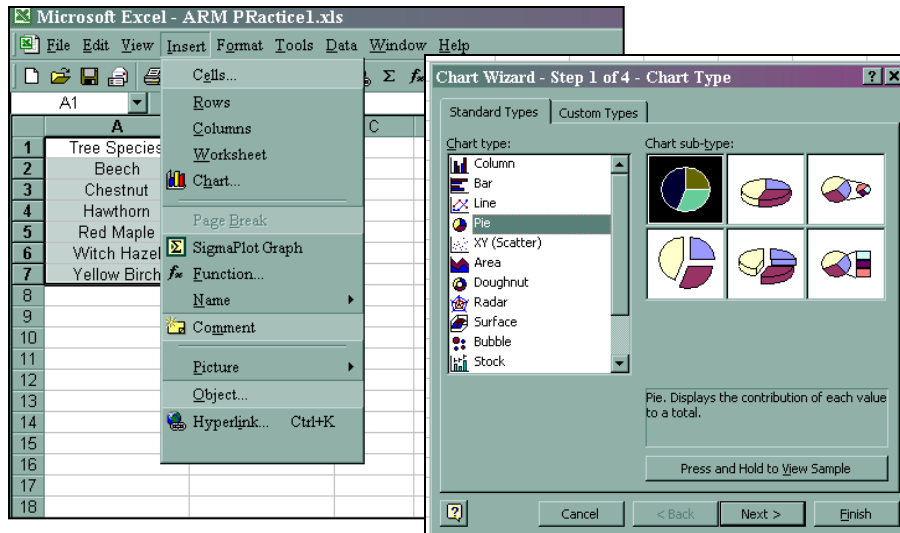
- Open Excel to a blank spreadsheet

- Find the Insert Tab and go to Insert Chart

- Look at the different options for (1) Pie Charts
  (2) Bar (Column) Graphs
  (3) Scatter Plots

# Creating a Graph: (1) Click a blank cell, select Insert Chart, choose the type of graph
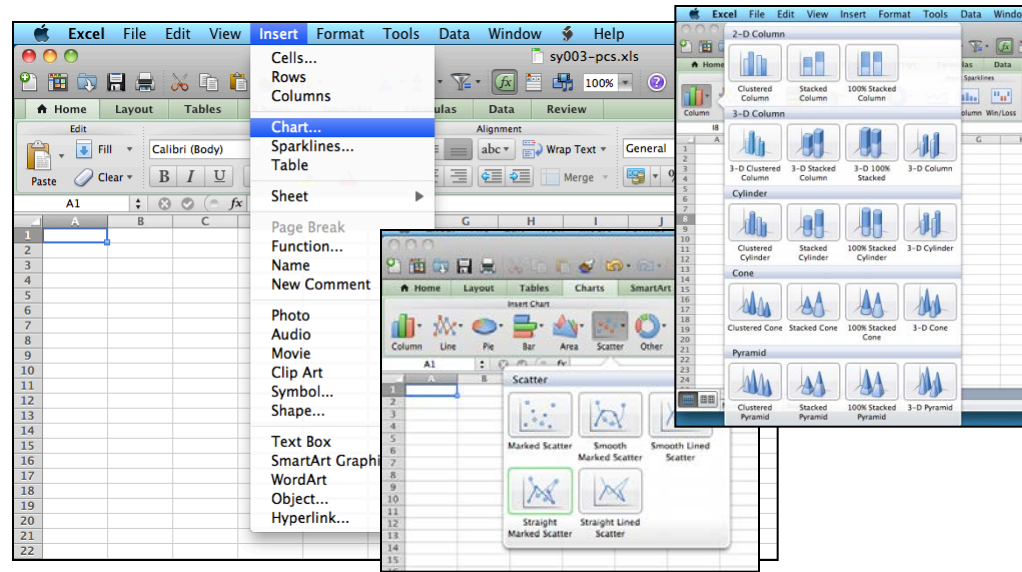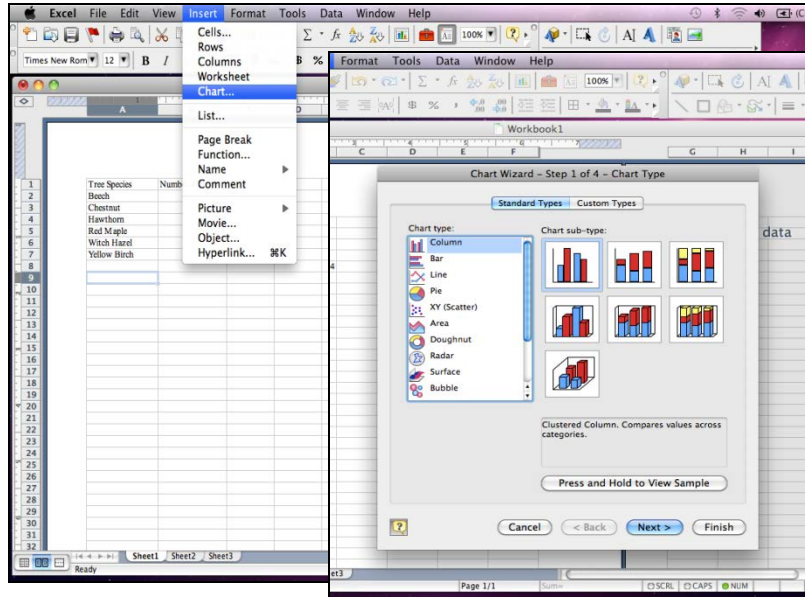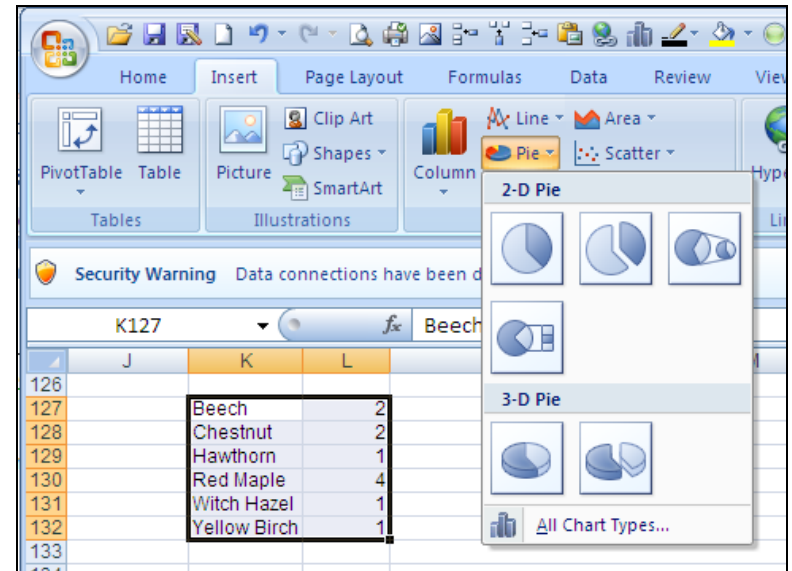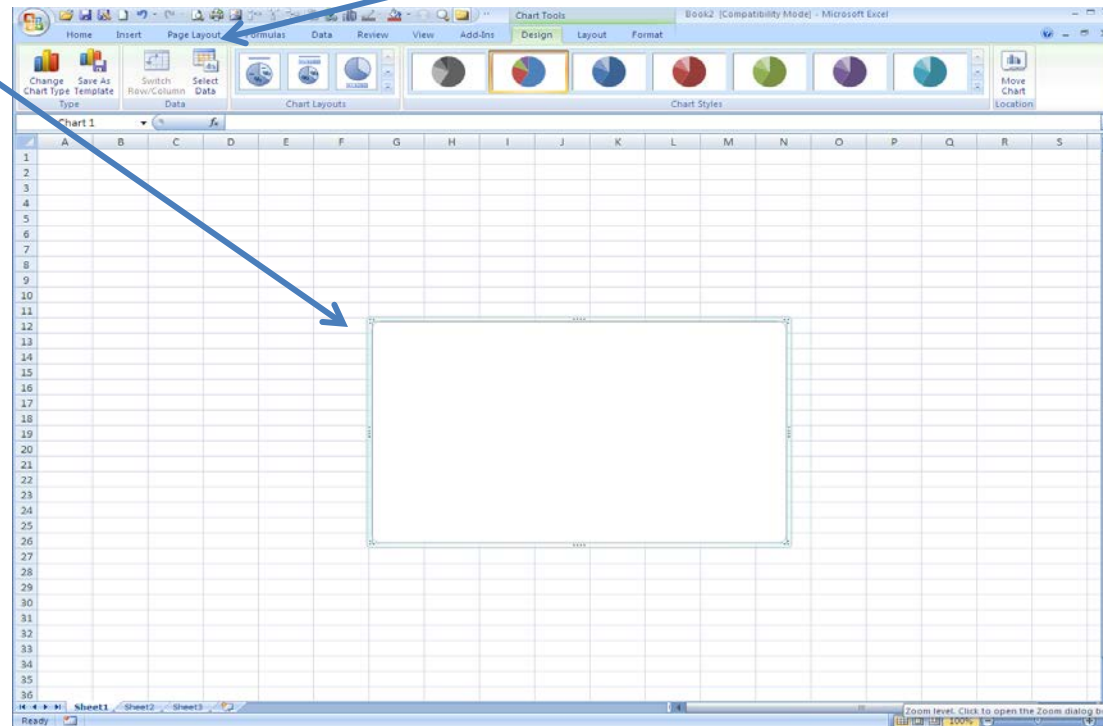


Excel 2004, Mac
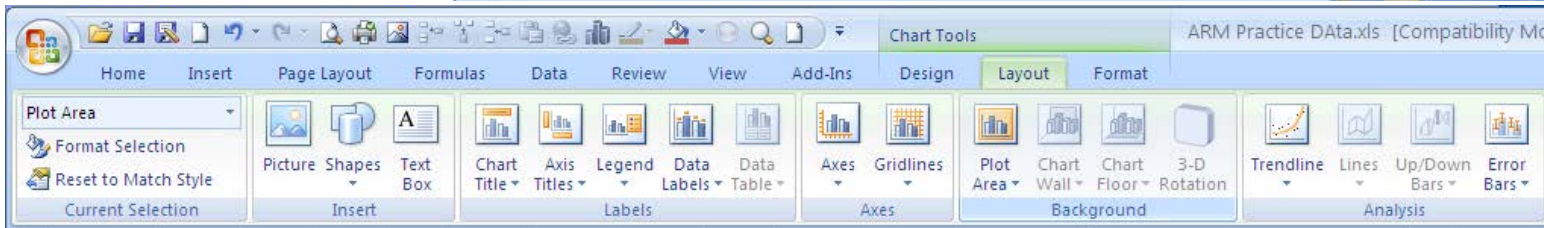
Excel 2011, Mac

Excel 2000, PC

Excel 12 (2007), PC

Example: Insert a Pie Chart onto your blank Excel Worksheet – what will appear is a blank template that you can fill in with the data of your choice.
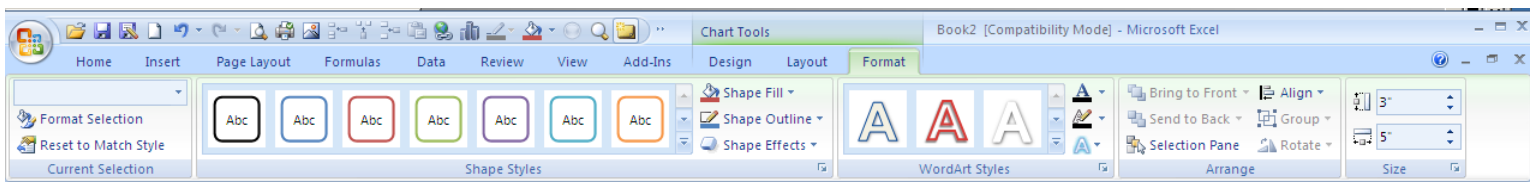
In Excel 12 (2007 PC, 2008 Mac), there are three tabs under "Chart Tools" for formatting graphs: Design, Layout, and Format
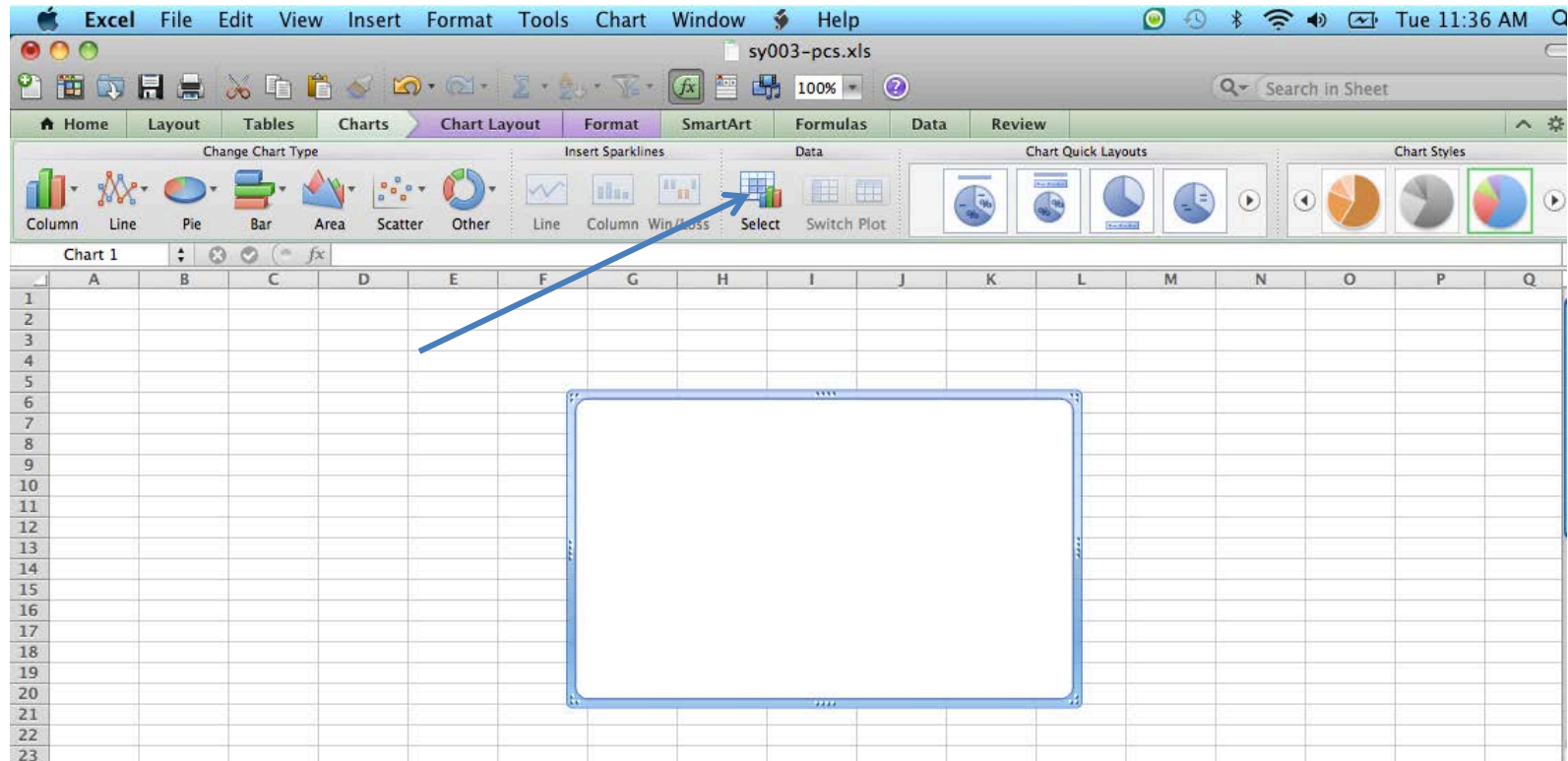
Design

Layout

Format

In Excel 2011 (Mac), the top of the screen looks different. Choosing the type of graph and selecting data are done under the Charts tab. Formatting is done under the Charts Layout and Format tabs, as in Excel 2007/2008.

# Formatting Command Choices in Pre-2007 Versions of Excel.

Top: Chart menu options change the type of graph; the data being graphed; the appearance of axes, gridlines, data labels, and a separate data legend; and axis and graph titles.

Bottom: Format menu options for selected parts of graphs change the color and patterns of the graph background and border, fonts, and the shape of the graph.