Research Data Analysis

Prelab

Read this Data Analysis lab description and review the information about simple linear regression, *t*-tests, and chi-squared analysis from earlier labs; then do the Lab 7 Prelab linked to the course website. The next week's prelab link is posted each Thursday afternoon. See "Submitting Catalyst Exercises" in this course manual; prelabs are due by Tuesday at 8:00 AM. (2 points)

Note: Bring course manual Appendices A and B to lab.

Learning Objectives

By the end of this exercise, you will have analyzed research data provided by UW Biology department faculty, and gained additional experience in …

- Organizing and exploring large datasets,
- Using statistical tools and graphs to answer a question, and
- Presenting experimental results to your classmates.

The exercise also provides an introduction to the ecology portion of the course: most of the data is ecology-related.

Procedure

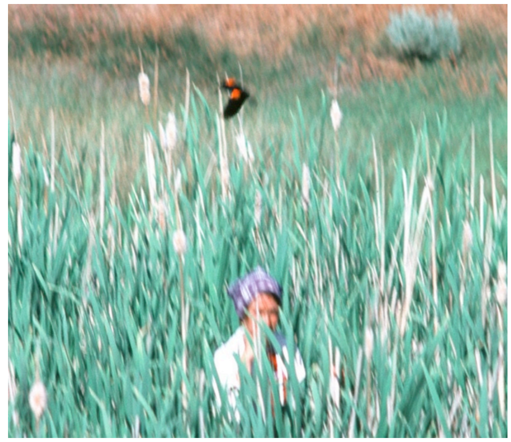
In lab you will …

- Choose or be assigned a dataset to investigate.
- Pose a question, suggest a hypothesis, and analyze the data using a t-test, simple linear regression, or chi-squared analysis.
- Write a report, with statistical results and graph.
- Present your findings to the class.

The Datasets

You will have access to the datasets described on the following pages.

Eileen O’Connor, UW Biology
Red-winged Blackbird Nesting and Fledging Success



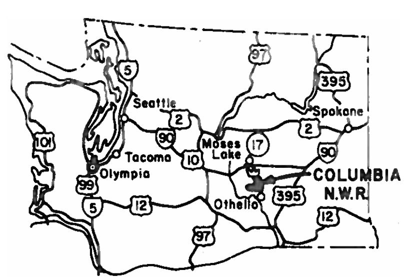
Eileen O’Connor worked with Red-winged Blackbirds *(Agelaius phoeniceus*) as a graduate student. She gave up fieldwork to be a lab coordinator for Biology 180 for many years, and also taught Bio 180 (and its predecessor, Bio 203) many times. She is a reformed climber, weaves and plays the concertina.

The Red-winged Blackbirds breed from Central America almost to the Arctic Circle, and from the Atlantic to the Pacific. They nest near water, especially marshes.

The birds are dimorphic (males and females look different) and polygynous (males control breeding access to more than one female). Males are territorial, with territory size varying with the size and productivity of the marshes. Harem size varies from one to six females, with an average of two or three.

Females build nests alone, over the course of three to six days. They lay three to six eggs and often start incubating the eggs the day before they lay the last one. Incubation lasts 11 to 12 days, and young are brooded and fed for about 11 days. The young are fed primarily insects, and almost exclusively by the females. Females sometimes raise two broods in a single season and are presumed to re-nest if a nest is destroyed early in the season.

These studies were conducted in the Columbia National Wildlife Refuge, in the Eastern Washington “Potholes” region, channeled scabland between Moses Lake and Othello. The Potholes consist of about 30 sq km of shallow lakes, ponds and marshes surrounded by sagebrush. The area receives only about 20 cm of precipitation a year, mostly as winter snow; the ponds and lakes are due to the rising water table caused by extensive irrigation.



The data provided here are nesting records from 3 marshes in one season. They should provide some insights into the reproductive success of these birds.

Redwing Blackbird Data Codes

Column	Description
Nest#	Each nest has a unique number
Marsh#	There are 3 marshes, 1 is small, 2 is large and 3 is tiny
Territory#	Territory number: each number corresponds to one male
1st active date	Day when nest building started (Day 1 = April 13)
Last active date	Day when nest was destroyed or young fledged (Day 90 = July 11)
# eggs	Number of eggs laid
# young fledge	Number of young fledged
Starvation/ predation loss code	1 = all eggs hatch, all fledge 2 = all eggs hatch, fewer fledge 3 = some eggs hatch, all fledge 4 = some eggs hatch, fewer fledge 5 = all eggs hatch, all present until destruction 6 = all eggs hatch, fewer present until destruction 7 = some eggs hatch, all present until destruction 8 = some eggs hatch, fewer present until destruction 9 = all eggs hatch, outcome unknown
Nest success code	1= nest abandoned or destroyed before or with eggs 2= nest destroyed with nestlings 3 = young fledge
Meters to edge of open water	Meters from nest to open water or land (whichever was closer)
Cm from water to top of nest	Centimeters from water to the top of the nest
Cm from nest to top of reeds	Centimeters from the top of the nest to the top of the reeds (cover)
Vegetation type	Support vegetation: 1= old reeds, 2=new reeds, 3= grass/sedge

Micah Horwith, UW Biology
Human Impacts and Introduced Species in Nearshore Marine Ecosystems

Micah Horwith studies community ecology in soft-sediment bays and coasts. He was a graduate student in UW Biology and received his PhD in 2011. He has taught Biology 180 at UW as well as upper division courses in ecology and on the biological impacts of climate change. In addition to the eelgrass work highlighted here, Micah has done research on the impact of geoduck clam harvesting. When he is not teaching or doing research, he hikes and kayaks.

Zostera marina (eelgrass) is a native plant that grows in marine environments with soft sediments. It forms expansive underwater meadows in many of the shallow-water coastal regions of Washington State. These “eelgrass beds” are of intense interest because juvenile salmon, Dungeness crab, and many other ecologically and commercially important species depend upon the meadows for shelter and as a rich place to forage for food. Eelgrass beds can also help hold sediments in place and minimize the impact of wind and wave erosion.

Zostera japonica (dwarf eelgrass) is a non-native plant that was accidentally introduced to Washington State in the first half of the 20^{th} century. Dwarf eelgrass originally arrived as packing material for imported Japanese oysters.

Shellfish farmers and natural resource managers want to understand how *Z. japonica* interacts with native species, including *Z. marina*. When a non-native species threatens the diversity or abundance of native species, it is labeled **invasive**, and removal efforts often follow.

The data that you will be considering are from an experiment exploring competition between *Z. japonica* and *Z. marina*. At the start of the experiment, 120 *Z. japonica* adult plants were transplanted into nine *Z. marina* beds that varied in terms of the density of *Z. marina* stems. Then, 25 days later, 20 *Z. japonica* seedlings were transplanted into different areas of the same nine *Z. marina* beds. By following both species’ density over time, it should be possible to test whether *Z. marina* is able to compete with *Z. japonica* at two different life stages (adult versus seedling). The goal is to evaluate whether *Z. japonica* should be labeled an invasive species. If competition from *Z. japonica* threatens the health of native eelgrass beds, expensive and often difficult removal programs may be recommended.

The data that you'll be working with were collected in Padilla Bay, Washington. The columns are:

- **Calendar date**, day on which the data were collected;
- **Date (days)**, days since the start of the experiment;
- **Study plot number**, which of the nine study beds the data come from;
- ***Z. marina* density**, the average number of native eelgrass stems, per square meter;
- ***Z. japonica* adult transplant**, the average number of dwarf eelgrass stems, per square meter, in beds where dwarf eelgrass **adult** plants were transplanted on 5/18/2010.
- ***Z. japonica* seedling transplant**, the average number of dwarf eelgrass stems, per square meter, in beds where dwarf eelgrass **seedlings** were transplanted on 6/12/2010.

Note: all of the study plots were at the same tidal line (same height, relative to the tides) and had the same substrate—mud.

Padilla Bay at high tide

Dungeness crab in *Z. marina*

Z. japonica transplanted into *Z. marina*

Z. japonica (above line) and *Z. marina* (below)

Bradshaw Lab, UW Biology
Speciation in Monkey Flowers

Toby Bradshaw was trained as a biochemist and now does research in evolutionary genetics. He has taught Biology 180, evolutionary biology, and graduate seminars in evolution and systematics. He is an accomplished falconer, rides a motorcycle to work every day, has a daughter who is a UW student, and is currently Chair of the Department of Biology.

Mimulus lewisii and *M. cardinalis* are sister species, and are reproductively isolated because they are pollinated by different animals—*M. lewisii* by bumblebees and *M. cardinalis* by hummingbirds. *M. lewisii* and *M. cardinalis* differ markedly in flower color, shape, scent, and nectar volume and in the placement of anthers and stigma, as well as many other morphological and biochemical traits. (The anthers are structures inside a flower that produce pollen grains; stigmas are structures that receive pollen grains.)

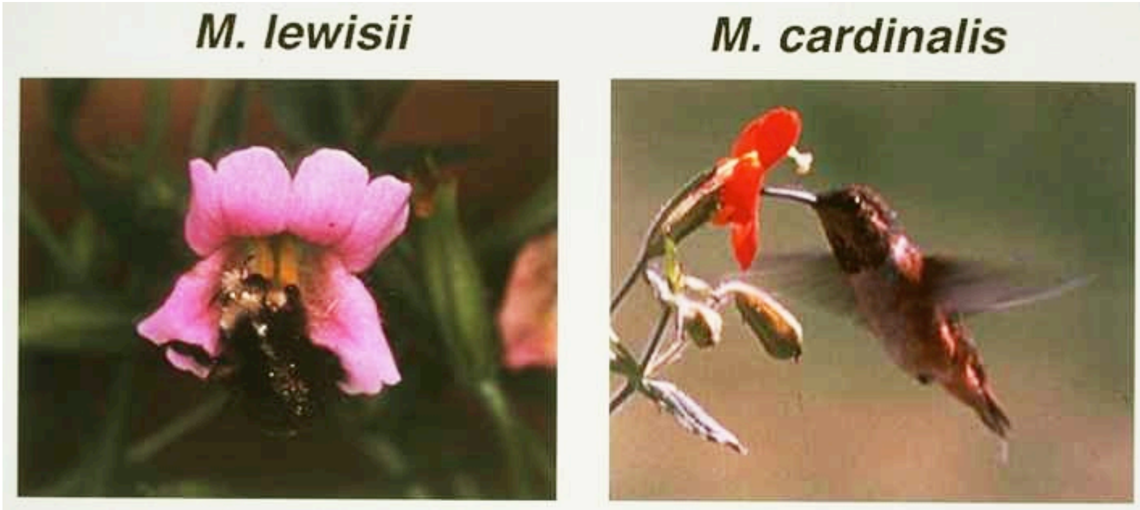
M. lewisii and *M. cardinalis* represent a model system for the study of speciation genetics. For example, *M. lewisii* and *M. cardinalis* are easily crossed by hand and produce fertile F_1 hybrids.

The dataset that you will be working with is from a backcross of an F_1 hybrid to *M. cardinalis*. The first three rows in the spreadsheet provide data on phenotypic traits measured in the two parents (*M. lewisii* and *M. cardinalis*) and in the F_1. The numbers are the means of measurements from multiple flowers on each parent. The *M. lewisii* and *M. cardinalis* parents used in the experiment are from inbred lines, so each of the individuals is homozygous at essentially every gene in the genome. The remaining 192 rows in the dataset each represent a different offspring from the backcross.

All of the backcross seeds were planted at the same time and the date of their first flower recorded. We have no data on flowering date for the parents and F_1, but experience shows that *M. lewisii* flowers earlier than *M. cardinalis*.

Anthocyanins are the magenta pigments in the flowers. Carotenoids are the yellow pigments.

The other data columns are self-explanatory (if you know some angiosperm anatomy!).



F_1 hybrid: *M. lewisii* x *M. cardinalis*

Ruesink Lab, UW Biology

Species Interactions and Community Ecology in Rocky Intertidal Habitats

Jennifer Ruesink studies ecological issues in nearshore environments and has established a long-term study site on Willapa Bay, on Washington's coast. She has taught Biology 180, and both undergraduate and graduate courses in ecology. She gardens, is a mom, and *loves* to analyze data.

Ostrea conchaphila is the native oyster in Washington state, but remains extremely rare after it was almost fished to extinction in the late 1800s. The mainstay of Washington's oyster industry is now the Pacific oyster (*Crassostrea gigas*) which was introduced about 1920.

Here are the basic steps for oyster farming in Willapa Bay, which produces more oysters than any other estuary in the United States:

1. **Prepare shell**: Oyster larvae settle on old oyster shell. Oyster farmers either spread shell directly on the tideflat or place mesh bags filled with shell in the bay or hatchery tanks.
2. **Find larvae**: When abundant oyster larvae are found in water samples from the bay, oyster growers work day and night to put out shell. If they're too early, the shells become silty and larvae are less likely to choose them. If they're too late, they miss peak settlement.
3. **Toughen up the spat** (newly settled babies): Pacific oysters develop thick shells and strong muscles when they are periodically exposed to air. So spat are held intertidally overwinter.
4. **Plant**: Seed oysters are spread out in preferred habitat and left for 2-3 years.
5. **Transfer**: Mature oysters are collected and moved to a fattening bed.
6. **Harvest**: Oysters are collected from fattening beds by dredge or by hand.

The whole process of producing one crop of oysters takes 3-5 years.

The data that you'll be working with were collected in Willapa Bay. The columns are:

- **Year**, 1947-2011;
- **Late July Temperature**, the average temperature from July 16-30 each year;
- **Seasonal Pacific**, the average number of newly settled Pacific oysters per shell.
- **Setday**, the day of the year when a cohort of larvae first appears on shells.

The file also has a spreadsheet with data on average air temperatures over two-week periods at Willapa Bay during the oyster breeding season.

Strömberg Lab, UW Biology
Evolution in Grasslands

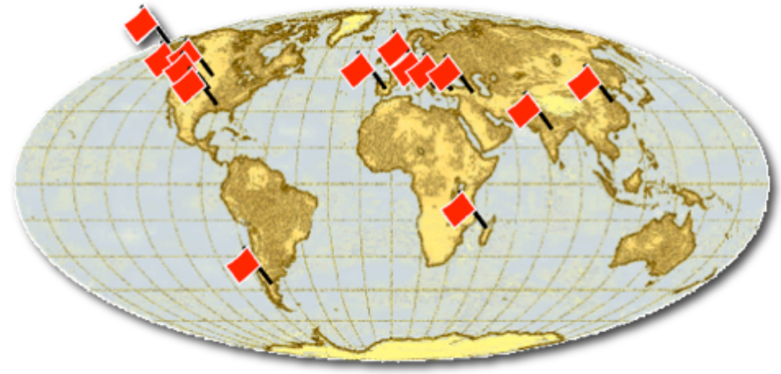
Caroline Strömberg is a paleobotanist—someone who studies fossil plants. Specifically, her work is focused on the evolution of grassland habitats. She pioneered the analysis of silica-rich structures called phytoliths (literally, “plant stones”) to study which plant species are present in rock formations of various ages. She is Swedish by birth, did post-doctoral fellowships at the Swedish Museum of Natural History and the Smithsonian’s National Museum of Natural History, is a curator at the Burke Museum, teaches Biology 180, and is a mom.

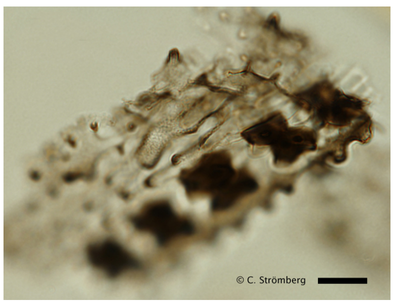
The evolution of grasslands in east Africa, central Asia, and the middle of North America was one of the great events of the past 30-40 million years. Humans, for example, can be considered creatures of grasslands. Most of our food comes from grasses or animals that eat grasses, and most hominin ancestors lived in grasslands or savannahs dominated by grasses. The evolution of grasslands was also associated with the evolution of other large, grass-eating animals such as horses, bison, antelope, and gazelles.

The dataset that you will be working with is from three different sites in the northern Rocky Mountains and the Great Plains. Time data are given by geologic epoch as well as absolute time in millions of years ago (Ma). The other data are phytolith direct counts or estimates, from comparable samples at each location and age.

- Zingiberales: forest-dwelling herbs related to today’s ginger and banana
- Palms: forest trees
- "Other forest indicators": dicotyledonous trees and herbs, conifers, ferns, and other forest-dwelling species
- Closed habitat (forest) grasses: bamboos and other grasses found in forests
- Pooid grasses: today, species in this group dominate grasslands in cool, temperate climates
- PACMAD grasses are adapted to warm climates and are broken into three sub-categories. Panicoids and Chloridoids inhabit hot, dry habitats and do a specialized type of photosynthesis called C4; there is also an “other” category of PACMAD species.
- Wetland: sedges, horsetails, and other species that grow in wet soils.
- "Potential grasses" are phytolith counts that don’t reflect the actual abundance of different species, but rather vary with respect to conditions like soil moisture.
- Miscl.: These are species that don’t have distinctive phytolith types.

Places where Caroline has worked:





Hille Ris Lambers Lab, UW Biology
Plant Communities and their Responses to Climate Change

Janneke Hille Ris Lambers is an ecologist who has done extensive research on:

1) the factors that maintain species diversity, and
2) how climate change is affecting the composition of plant communities.

She also teaches Biology 180 and has done research on how active learning techniques can improve student performance.

The Hille Ris Lambers lab (including undergraduates!) is studying how climate and climate changes effect the vegetation in Mount Rainier National Park. The dataset that you'll be working with focuses on a tree called the Pacific silver fir (*Abies amabilis*), which grows at middle elevations on the mountain. More specifically, the dataset focuses on Pacific silver firs that are growing at elevations of 700m 1600m (the summit is ~4400m).

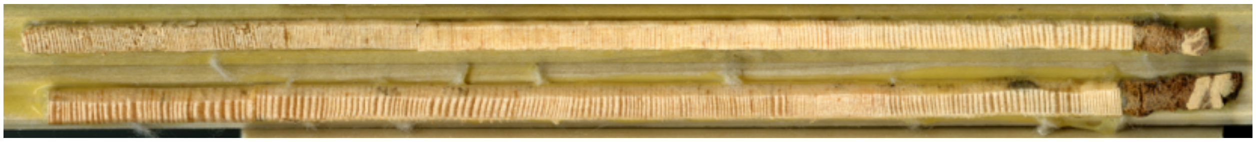
To study tree growth, Janneke and her students use an instrument called an increment borer to extract a cylinder of wood from the trunk and study the growth rings. (See the photos on the next page.) The space between the rings indicates the amount of growth in a year. Using these data, they can estimate the total amount of wood added to a tree each year. To make comparisons possible, Janneke standardizes the amount of growth reported from each tree for its size, and averages the values at a particular site over 20 trees. The data, you're using was collected by undergrads and graduate students in 2007-2009.

To track variation and trends in climate, researchers in the lab use data from weather stations in the Park. The data you have available include the total amount of snow that fell each year at 700m and 1600m, the number of days of snow cover at each elevation (essentially, this is how late spring was), and the number of hours each year where it was warm enough for photosynthesis to occur.

The Excel file that you'll be using has three worksheets:

- "Notes" explains what each variable means, including the units of measure;
- "Climate and growth" contains the climate data along with estimates of growth in Pacific silver firs;
- "Growth & elev" contains data on growth from 16 trees at low elevation and 20 trees at high elevation—specifically, the total amount of wood added between 2000 and 2009.

Using an increment borer (left and center) to get a record of tree rings (below).



Low elevation (700m; left) and high elevation (1600m; right) forests —note the impact of snow on trees.

Data Analysis Report

Student Names (4) ____

Dataset analyzed (circle one): Blackbirds Eelgrass Monkeyflowers Oysters Phytoliths Silver fir
Question that you explored and why it is interesting:
Hypothesis:
Prediction of your hypothesis:
Data used (which sheet/columns/rows):
Statistical test used (and why that test is appropriate):
Results: Describe your results and **attach** a copy of your **graph** and **statistical analysis**. Include p-values, R^2 values, and n (sample sizes) as appropriate.
Interpretation of results: