Lab 1 –Making Scientific Observations And Using Dichotomous Keys

I. Central questions

- What kind of questions do ecologist study?
- How do ecologists do ecology?
- How do ecologists assess biodiversity?

II. Learning Objectives

At the end of this lab you will be able to:

- describe safety precaustions necessary for laboratory work
- distinguish between observations and interpretations
- explain sources of bias in scientific observations
- identify organisms using a dichotomous key.

III. Introduction and Background

"The San Francisco Bay Area is one of the world's great biological treasures. It is home to dozens of unique wildlife and plant species, many found nowhere else on Earth. Unfortunately many of these species are on the brink of extinction, and the precarious status of San Francisco's wildlife and plants has become a topic of global concern: the Nature Conservancy has determined that the San Francisco Bay Area is one of the six most important hotspots of biological diversity in the United States, and the United Nations Educational, Scientific, and Cultural Organization ("UNESCO") has recognized portions of the City as part of the Golden

> *Gate Biosphere Reserve—the same status granted to Brazil's Central Amazon rainforests. Yet while Brazil has preserved approximately 42% of its rainforests— which most scientists and conservationists consider a failure— San Francisco has preserved only 3-5% of its indigenous habitats, and since 1958 approximately 50% of the City's indigenous plants have gone extinct within the City's boundaries. " (*San Francisco Natural Areas Program Fact Sheet, xxdate)

Wing, Mei-Ling and Anthony were surprised when they read the above paragraph for their ecology class. "Did you know that San Francisco Bay Area is a **biodiversity hotspot**?" Wing asked the others. Everyone shook their heads. "And only 3-5% of its **indigenous habitat** remains" Anthony added "I wonder whether we can do anything ." – "Well, I remember that a previous ecology lab has proposed the **native** plant garden out there by the statue of the guns here on campus, and that they got the chancellor to pay for it. Couldn't we come up with a plan to make the whole campus a better place for biodiversity?" Mei-Ling suggested. "That seems like a pretty tall order" Wing was skeptical. "Also, I have heard that that native plant garden is a complete failure. They wanted to attract **endemic** insects and soil critters and birds and such, but I've heard it did not work at all". Mei-Ling did not give up: "What if we did a study to see whether that is true? If we can show that that little garden really increased biodiversity, then we have a good argument to try to change more of the campus greens".

Great idea, isn't it? And it fits right in with what ecologists commonly do: study the biological diversity on Earth, how organisms interact with each other and with the **abiotic** (physical, or non-living) environment, and which factors lead to the observed patterns of **distribution** and **abundance**.

IV. Lab instructions

Work in a group of three students.

Brainstorm

What are the issues in the above stories? List at least five issues.

How would you go about such a study?	What would you need to know//learn?

Where we are headed

Obviously, you would need some ecological skills, notably

- Make and record valid scientific observations
- Classify, identify, and name organisms (insects, soil critters, birds)
- Estimate the number of organisms (**abundance**) in a given area
- Set up a comparative study

In this and the following labs we will practice those skills.

2. Make Scientific Observations

An essential skill for any scientist is the ability to make detailed, reliable observations. Good observations lead us to ask the "how" and "why" questions of scientific investigation. In this brief activity, you will practice scientific observation by listing five different, detailed observations about the items shown to you by your instructor. Be careful not to make inferences or assumptions about these items that you have not directly observed.

Item 1:

1. _____

2. _____

3. _____

4. _____

5. _____

Item 2:

1. _____

2. _____

3. _____

4. _____

5. _____

In what other ways could you make observations of these items besides the methods you used above?

Based on your observations, can you come up with any hypotheses or make any inferences about these items? (Here is where you take the information you have observed directly and make logical connections to infer something you cannot directly observe.)

3. Use Dichotomous Keys to Identify Organisms

Source*:* B Hoffmann, Dichotomous keys @ http://captain.park.edu/bhoffman/courses/bi225/labs/Dichotomous%20Keys%202.htm, 11/03

In order to assess and compare the biodiversity of two sites, we have to learn to identify and name the organisms we have observed. In this activity, you will use one method that is commonly used to help identify uknown organisms.

The identification of biological organisms can be greatly simplified using tools such as dichotomous keys. A dichotomous key is an organized set of couplets of mutually exclusive characteristics of biological organisms. You simply compare the characteristics of an unknown organism against an appropriate dichotomous key. These keys will begin with general characteristics and lead to couplets indicating progressively specific characteristics. If the organism falls into one category, you go to the next indicated couplet. By following the key and making the correct choices, you should be able to identify your specimen to the indicated taxonomic level.

Couplets can be organized in several forms. The couplets can be presented using numbers (numeric) or using letters (alphabetical). The couplets can be presented together or grouped by relationships. There is no apparent uniformity in presentation for dichotomous keys.

Sample keys to some common beans used in the kitchen

Numeric key with couplets presented together. The major advantage of this method of presentation is that both characteristics in a couplet can be evaluated and compared very easily.

1.	Bean round	**Garbanzo bean**
1'.	Bean elliptical or oblong	Go to 2
2.	Bean white	**White northern**
2'.	Bean has dark pigments	Go to 3
3.	Bean evenly pigmented	Go to 4
3'.	Bean pigmentation mottled	**Pinto bean**
4.	Bean black	**Black bean**
4'.	Bean reddish-brown	**Kidney bean**

Alphabetical key with couplets grouped by relationship. This key uses the same couplet choices as the key above. The choices within the first and succeeding couplets are separated to preserve the relationships between the characteristics.

A. Bean elliptical or oblong	Go to B
B. Bean has dark pigments	Go to C
C. Bean color is solid	Go to D
C. Bean color is mottled	**Pinto bean**
D. Bean is black	**Black bean**
D. Bean is reddish-brown	**Kidney bean**
B. Bean is white	**White northern**
A. Bean is round	**Garbanzo bean**

When you follow a dichotomous key, your task becomes simpler if you adhere to a few simple rules of thumb:

A. Read both choices in a couplet carefully. Although the first description may seem to fit your sample, the second may apply even better.

B. Keep notes telling what sequence of identification steps you took. This will allow you to double-check your work later and indicate sources of mistakes, if they have been made.

C. If you are unsure of which choice to make in a couplet, follow both forks (one at a time). After working through a couple of more couplets, it may become apparent that one fork does not fit your sample at all.

D. Work with more than one sample if at all possible. This will allow you to tell whether the one you are looking at is typical or atypical. This is especially true when working with plants – examine more than one leaf, branch, cone, seed, flower,…etc.

E. When you have keyed out an organism, do not take your effort as the final result. Double check your identification scheme, using your notes. Find a type specimen (if available) and compare your unknown to the type specimen. If a type specimen is unavailable, find a good description of the indicated taxonomic group and see if your unknown reflects this description.

F. When reading a couplet, make sure you understand all of the terms used. The best keys will have a glossary of technical terms used in the key. If a glossary is unavailable, find a good reference work for the field (textbook, biological dictionary,…etc.) to help you understand the term.

G. When a measurement is indicated, make sure that you take the measurement using a calibrated scale. Do not "eyeball" it or take a guess.

Exercise 3: Work in a group of four students. Introduce yourselves and write your four names on the index card provided. Chose a name for your group and add that name to the list of names. Turn index card with your names and your group's name in to your instructor. Given a container of beans, use one of the dichotomous keys above to identify the beans. Glue or tape the beans to the card provided and label them with their common name. Indicate what steps you followed to arrive at your answer. Turn the card in to your instructor. Compare your answers to the instructor's type specimens.

4. Construct You Own Dichotomous Key

When constructing a dichotomous key, you must be aware of the characteristics of the objects that you are separating. First, examine the objects closely. Write down some characteristics that are visible on the objects. Pay particular attention to those characteristics that seem to be different for groups of objects. For each named object, write down the value that the object has for each characteristic. Be aware that the more groups you try to distinguish, the more characteristics you have to note. Now you are ready to start constructing your key.

Group together objects that have similar values for each characteristic (similar size, shape, color). Determine which characteristic gives you the least number of subgroups. This is a good candidate starting point for the key. Then determine how to break down each subgroup into smaller subgroups, using couplets of characteristics. Keep working until you have separated all of your objects individually. It is often easy to follow your line of thought if you write your information (the characteristics and values you are using) on notecards and follow the cards until you have specified your object only.

Dichotomous keys will be easier to use if you follow some general rules of thumb.

A. Start with the most general characteristics and progress to increasingly more specific characteristics.

B. Indent each couplet or leave a space between each couplet to make the key easier to read.

C. Use constant measurements, not ones that are highly variable.

D. Use measurements when possible, avoiding descriptors like large or small if possible.

E. Try to use terms that are useable without complicated equipment, the simpler, the better. You may wish to develop a key that can be used in the field and one that can be used in the laboratory.

F. Use characteristics that are found year-round, not seasonal if at all possible (sometimes the point of a key is identifying organisms based on seasonal characteristics, such as flowers). If your key is seasonal, indicate it in the title of the key.

G. Choices are more effective if they are positive ("this characteristic is"…. rather than "this characteristic is not"). This is not always possible.

H. Precede the description with the part that is being described (leaves are red…instead of red leaves present).

I. Start the choices in a couplet with the same word, if possible.

J. Start each couplet with different words, if possible.

Exercise 4a: In a group of four, write a key to the four of you. Use this time to find something interesting out about each other. What are your interests, majors, career goals, etc. Once you have done the key, discuss how you could expand the key to include another group of four. Interview that group and write a key for the eight of you. At the end, each one of you should have a key written out. It does not need to be the same key. Exchange your key with someone from a different group and key out your classmates.

Exercise 4b: With your group, take one of the tree guides available and key out three trees on campus. In your ziploc bags, bring back small parts of the tree that were crucial in identifying the species and label the bags with your group name and the name of the tree. Note that many guides only include trees **native** to the Pacific region, so you might not find horticultural species. Go with the **conifers**, they usually are in the guides.

When you return to class, turn in the labeled bags to your instructor.

Use this space to jot down unfamiliar words from this lab and the tree guide. Make sure to ask your instructor or another student for definitions.

Term	Definition/drawing

V. Review questions

Please answer the following questions before leaving lab today.

1. What are the three main precautions you have to observe for making lab work safe?

2. Where in this lab are the first aid kit and eye wash stations?

3. Describe the location of the native plant garden on campus.

4. Explain goals of native plant gardens.

5. Explain why two people looking at the same object will see different things.

6. Give an example that illustrates the difference between observation and interpretation.

7. Know how to construct and use a dichotomous key.

8. Describe a situation in which you and a person with a different background from yours confront the same situation, but make very different observations. Develop a background for yourself and the other person that explains why

the two of you would make different observations. Be sure to distinguish between observation and interpretation.

VI. Homework assignment

Please complete this homework assignment before coming to lab next week.

- Review lab safety rules in appendix 1.
- Read Lab 2 – Classification and Soil Ecology
- Buy a field notebook according to the instructions on field notebooks (appendix 2)
- Take a walk on campus. Make one observation about a pattern of species distribution you see (e.g., a particular plant is found only in the shade). Record your observation as your first entry in the field notebook following the instructions field notebooks (appendix 2).

Note: All handuts and lab exercises are available on my website at: http://fog.ccsf.edu/~cpogge. Remember that I subtract 10 points if you come to lab without the exercise of the day or the pre-laboratory preparation.