BIO/GEO 351: Biogeography

Lab Manual

Augustana Faculty
University of Alberta
Camrose, Alberta

September 2006

BIO/GEO 351 Lab Manual -- Table of Contents

Appendices

Lab Schedule

Lab	Date	Topic	Type	Location	Info about the lab
1	Jan 21	Environmental controls on species distribution	Ex	Lab	Map exercise examining tree distribution in North America.
2	Jan 28	Vegetation gradient	Ex	FW	Field-work in the Augustana ravine.
3	Feb 4	Disturbance effects	Ex	Lab	Fire and succession in the boreal forest.
4	Feb 11	Biogeography of a species	P	Lab	The biogeography of two sympatric species.
5	Mar 4	Dispersal and colonization	Ex	Lab	Mapping exercise regarding the large-scale movement of species.
6	Mar 11	Speciation	Ex	Lab	On-line exercise about the evolution of species.
7	Mar 18	Biodiversity and island biogeography	Ex	Lab	Graphical analysis of species richness.
8	April 1	Human effects on biogeography	P	FW	A research paper about an endangered species.

Type
Ex = exercise
P = written paper

Location
Lab = in lab only
FW = field work with lab component

Lab 1 - Environmental control on species distribution

Background
Investigating the range and distribution of a species at varying scales is one of the oldest and most important pursuits in biogeography. Simply trying to determine why a species is found in any particular location is fundamental to understanding the relationship of that species to its environment. It is also an important step towards a greater understanding in the sub-disciplines of population biology and community ecology.

There are many non-environmental factors which will influence the presence or absence of a species in a locality: food resources, competition, niche preferences, predation, etc. But the most fundamental determinant of presence of a species is the abiotic (environmental) conditions of a site. And a good starting point is to consider two environmental factors which have had a very strong and long-term influence on the distribution of plant species: climate and topography.

Objectives
In this lab you will be examining the range of 81 coniferous tree species in North America (Canada, USA and Mexico). These range maps represents virtually all conifer species on this continent.

The objectives of this lab are to:
~ determine which abiotic (environmental) factors are influencing the distribution of conifer trees in North America.
~ determine the strength of this influence.
~ to examine the spatial trends in conifer tree diversity in North America.

<u>Biogeographic concepts</u>
~ relationship between environmental variables and species distribution.
~ latitudinal and longitudinal diversity gradients.

<u>Technical skills</u>
~ collating data from a large on-line database.
~ basic analysis of spatial trends.

Relevance of this lab to the lectures
The first part of the textbook, and the material we have covered in the lectures, emphasizes the non-living features of the earth and the variable nature associated with these abiotic components. This is especially the case for the most basic variables such as temperature, insolation, climate and land surface.

Relevance of this lab to professional science
All conservation plans must take into consideration the relationship of a species, or group of species, to the landscape, and this is required at a variety of geographic scales. A regional plan will require that the characteristics of a species be understood at a larger scale, so that components of a conservation plan will best enhance the prospects of long-term viability of a species within its larger range.

Misc. notes
Maps of the ranges of tree species in North America were compiled by Elbert Little of the U.S. Department of Agriculture, based on the "Atlas of United States Trees" (by Elbert L. Little) and other publications, and obtained from the USDA website. (www.usda.gov).

Lab procedures
On the Augustana network is a folder for this course in which you will find the range maps for the coniferous trees of North America. (The instructor will show you where this folder is located). Each species is identified by its scientific name and all of the species belong to these six genera:
Abies - Fir
Juniperus - Juniper
Larix - Larch
Picea - Spruce
Pinus - Pine
Tsuga - Hemlock

Working in groups of two you will examine the range map for each tree species, which you will use to compile two sets of data.

1. Environmental data
There are five maps illustrating environmental variables of North America supplied with this lab manual:
~ mean annual temperature – January.
~ mean annual temperature – July.
~ mean annual precipitation.
~ Koppen climate classification.
~ shaded relief of the topography.

For each species, determine which environmental variable(s) appear to have an influence on the range of that species. Do this by holding each map of the environmental variable next to the species range map and doing a quick visual comparison. Looking for corresponding trends. If you feel a variable is influencing the range, place a check-mark in the appropriate space for that species in Table 1. Once you have examined all five variables, estimate whether you feel the association between range and the environmental variable(s) is weak or strong and write the appropriate letter (**w** or **s**) under the heading "Association".

For each environmental variable, total the number of species influenced by that variable and enter that number in the bottom row of Table 1.

2. Diversity gradient data
For each species, you will record its range on the 'blank' map of North America as follows. The map is divided into squares that are 5 degrees of latitude and longitude in size. For each 5 degree square in which a species is found, make a small tick-mark within that square (on the map). You can do this by a quick "eyeball estimate". Some species will require that you mark only a few squares; others will have ranges that span many squares.

Once you have examined all of the tree species, sum the total tick-marks for each 5 degrees of latitude and each 5 degrees of longitude and record these numbers on the side/bottom of the map. This number represents an estimate of the conifer tree diversity along a latitudinal and longitudinal gradient.

At the end of the lab period, please hand in to the instructor:

- Table 1
- Map 1
- Figure 1
- Figure 2
- answer sheets.

BIOGEO 351   Lab 1 - Environmental control on species distribution

Name: ___________________

Mark: _______ / 85

1. Filling the required species/environment data into Table 1. _______ / 15

2. Assembling the diversity gradient data onto the map of North America (Map 1). _______ / 15

3. Species-environment interactions.

a). How many species ranges were associated with the mean temperature in January? _______ / 1

b). How many species ranges were associated with the mean temperature in July? _______ / 1

c). How many species ranges were associated with the mean annual precipitation? _______ / 1

d). How many species ranges were associated with the Koppen climate? _______ / 1

e). How many species ranges were associated with topography? _______ / 1

f). For how many species did you find that there was a strong association between range and the environmental variables? _______ / 3

g). For how many species did you find that there was a weak association between range and the environmental variables? _______ / 3

h). From the information in the preceding seven questions, what do you believe are the main factors influencing the ranges of conifer trees in North America and why? _______ / 10

4. Conifer diversity gradients.

a). Latitude gradient - using the data assembled on Map 1, produce a graph of the number of conifer tree species by 5 degree square of latitude. Use the blank grid sheet labeled Figure 1. Include a figure title and label all units and axes. _______ / 5

b). Longitude gradient - using the data assembled on Map 1, produce a graph of the number of conifer tree species by 5 degree square of longitude. Use the blank grid sheet labeled Figure 2. Include a figure title and label all units and axes. _______ / 5

5. Describe the data trend illustrated in Figure 1. _______ / 4

6. Are the overall trends in Figure 1 related to any of the five environmental variables? If so, explain what they are and how you feel this variable has influenced conifer diversity according to latitude. _______ / 8

7. Describe the data trend illustrated in Figure 2. _______ / 4

8. Are the overall trends in Figure 2 related to any of the five environmental variables? If so, explain what they are and how you feel this variable has influenced conifer diversity according to longitude. _______ / 8

Table 1. Data table of environmental controls by species.

Species	**Jan. temp**	**July temp**	**Annual ppt**	**Koppen**	**Topography**	**Association (w/s)**
Abies amabilis						
A. balsamea						
A. concolor						
A. grandis						
A. lasiocarpa						
A. magnifica						
Juniperus ashei						
J. californica						
J. communis						
J. deppeana						
J. flaccida						
J. horizontalis						
J. monosperma						
J. occidentalis						
J. osteosperma						
J. pinchotii						
J. scopulorum						
J. silicicola						
J. virginiana						
Larix laricina						
L. lyallii						
L. occidentalis						
Picea englemannii						
P. glauca						
P. mariana						
P. pungens						
P. rubens						
P. sitchensis						
Pinus albicaulis						
P. aristata						
P. attenuata						
P. ayacahuite						
P. banksiana						
P. caribaea						
P. cembroides						
P. clausa						
P. contorta						
P. cooperi						
P. cubensis						
P. douglasiana						
P. durangensis						

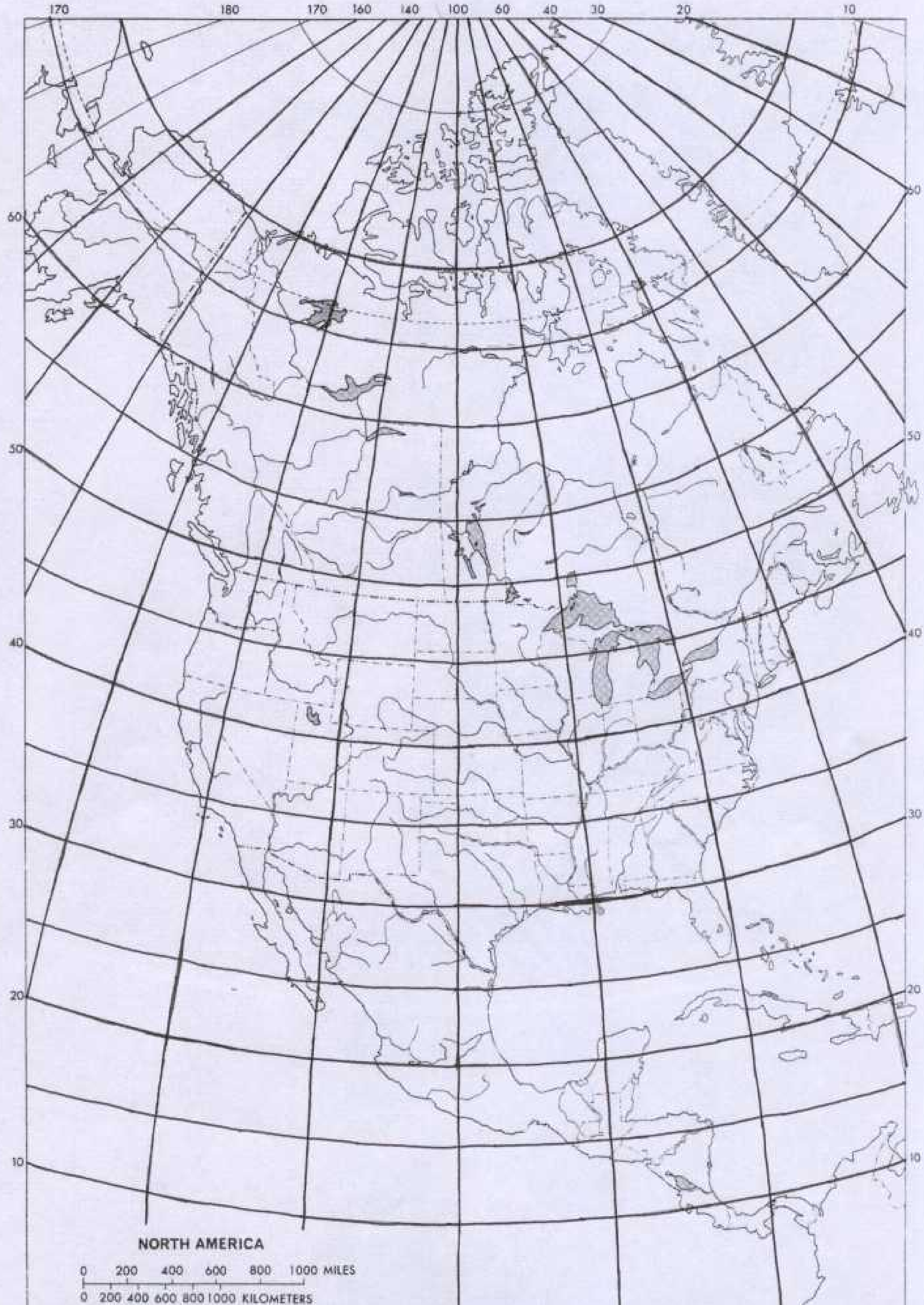
Species	Jan. temp	July temp	Annual ppt	Koppen	Topography	Association (w/s)
Pinus echinata						
P. edulis						
P. ellottii						
P. engelmannii						
P. flexilis						
P. glabra						
P. greggii						
P. hartwegii						
P. jeffryi						
P. lambertiani						
P. lawsonii						
P. leiophylla						
P. longaeva						
P. lumholtzii						
P. michoacana						
P. monophylla						
P. monticola						
P. montezumae						
P. nelsonii						
P. oocarpa						
P. palustris						
P. patula						
P. pinceana						
P. pondersa						
P. pringlei						
P. pseudostrobus						
P. pungens						
P. resinosa						
P. rigida						
P. sabiniana						
P. serotina						
P. strobes						
P. strobiformis						
P. taeda						
P. teocote						
P. virginiana						
Tsuga canadensis						
T. caroliniana						
T. heterophylla						
T. mertensiana						

Total						na

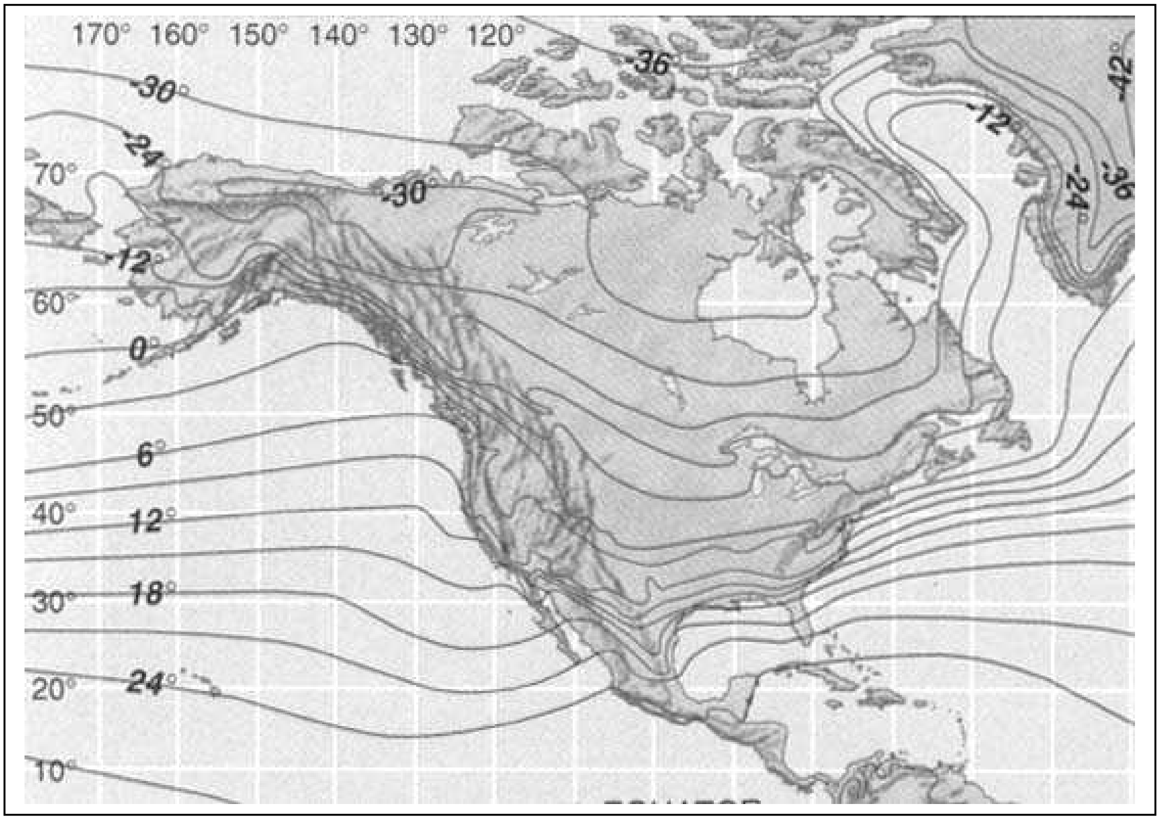
Figure 1. ____

Figure 2. ____

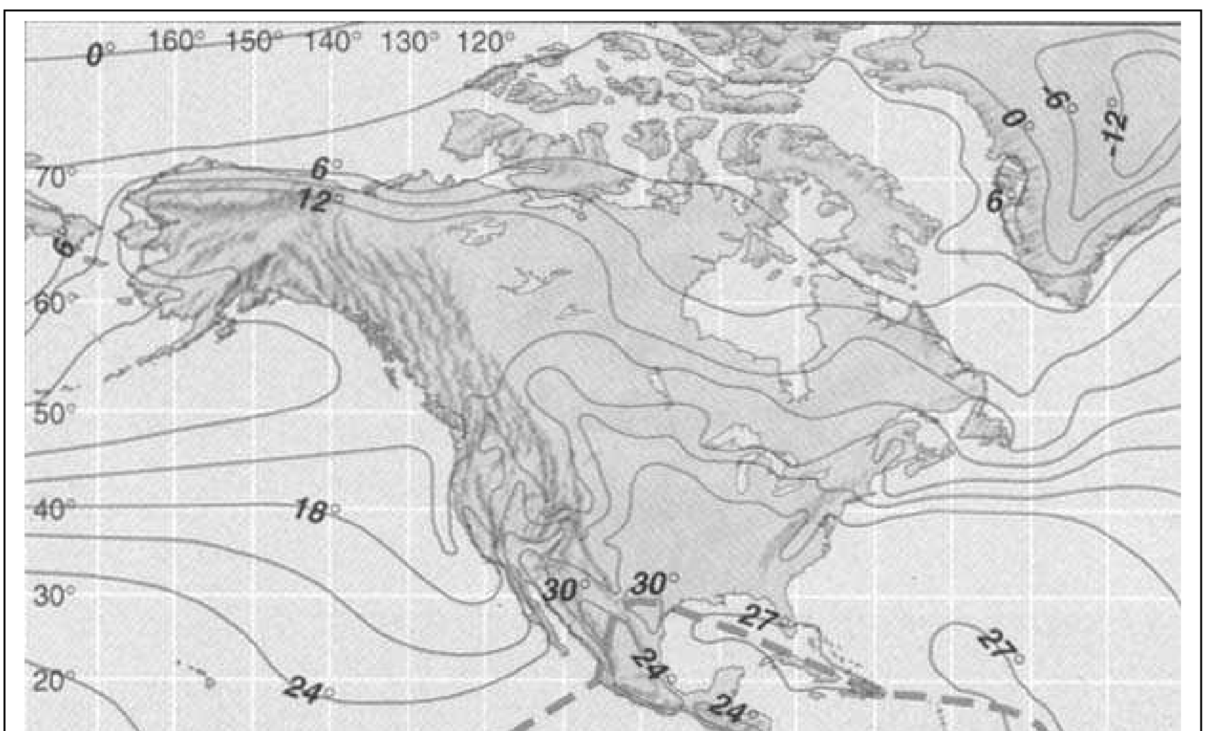
Map 1. Latitudes & longitudes of North America



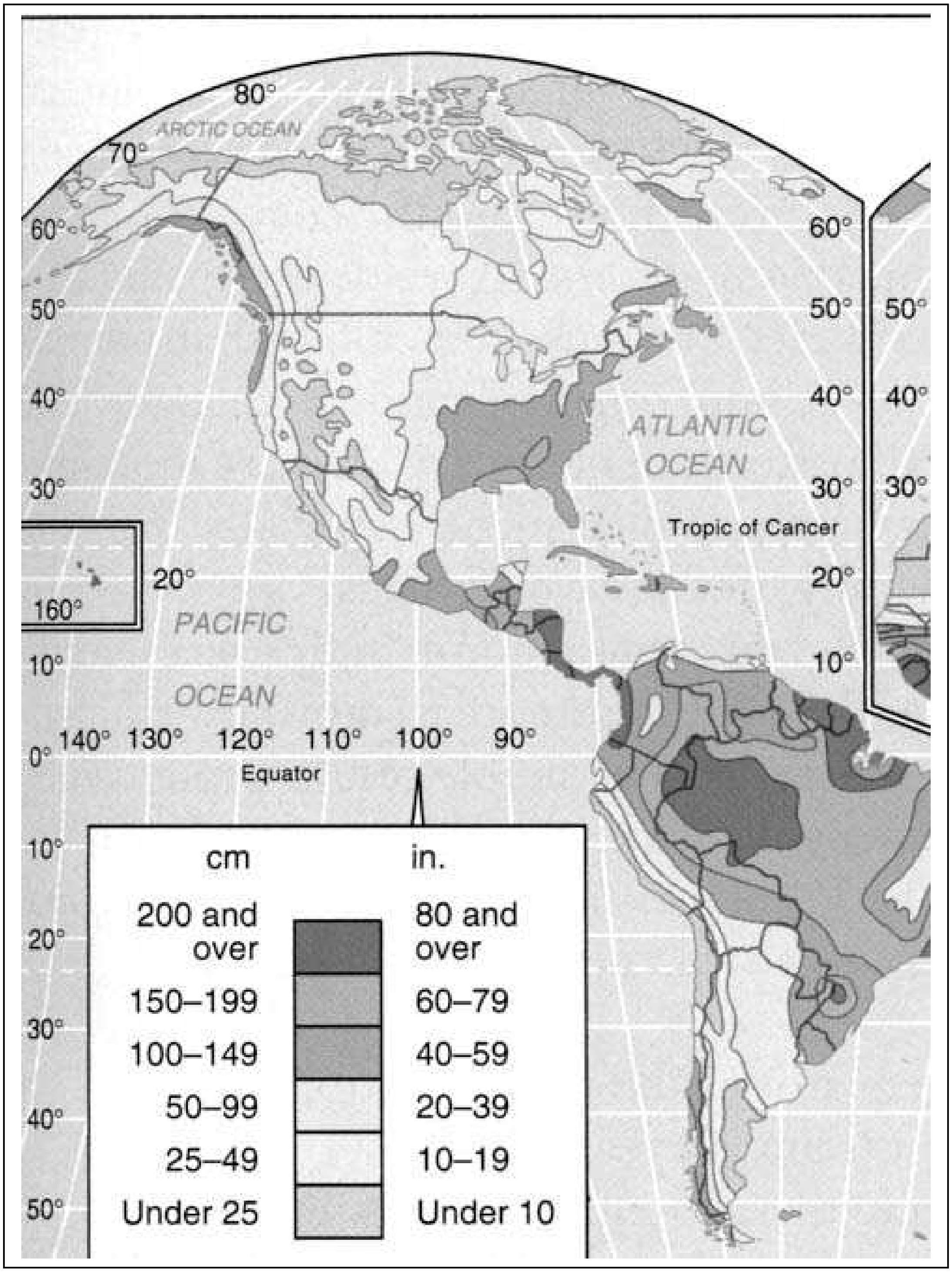
Mean annual temperature - January



Mean annual temperature - July



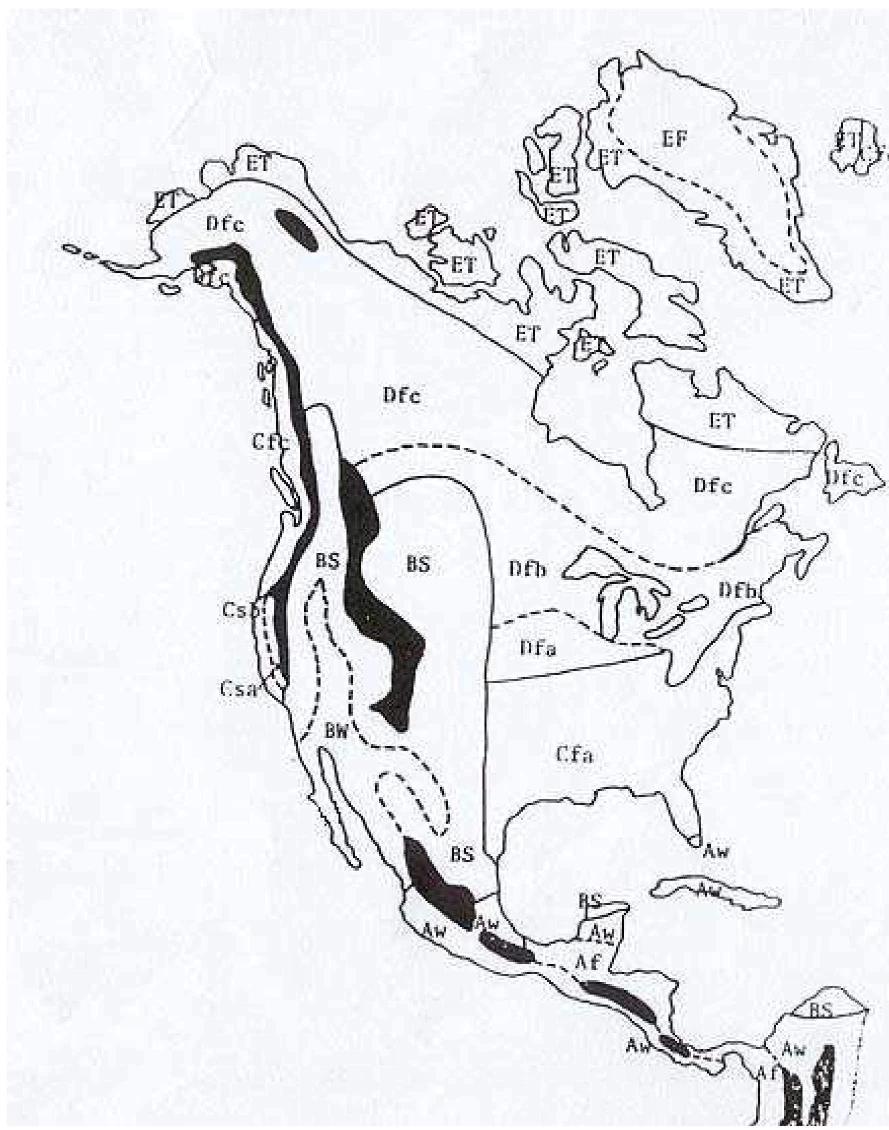
Mean annual precipitation



Koppen Climate Classification

A: tropical Moist Climates: all months have average temperatures above 18 ºC
B: Dry Climates: with deficient precipitation during most of the year
C: Moist Mid-latitude Climates with Mild Winters
D: Moist Mid-Latitude Climates with Cold Winters
E: Polar Climates: with extremely cold winters and summers

Af - Tropical Rainforest
Am - Tropical Monsoon
Aw - Tropical Wet/Dry
BS - Tropical Steppe
BW - Tropical Desert
Csa, Csb - Dry Summer Subtropical
Cfa - Humid Subtropical
Cfb, Cfc - Marine West Coast
Dfa,Dfb, Dwa, Dwb – Humid Continental
BWk - Midlatitude Desert
BSk - Midlatitude Steppe
Dfc, Dfd, Dwc, Dwd - Subarctic
ET - Tundra
EF - Ice Cap
H – Highland (dark areas)



Topography of North America

Lab 2 – Vegetation gradients

Background
The first lab (*Environmental controls on species distribution*) examined the variations in conifer tree diversity across North America and looked at correlations between these diversity patterns and climate and topographic variables. This lab aims to do the same thing however, instead of looking at continent-wide trends, we will be examining variations in species richness at a much smaller scale.

Vegetation communities are influenced by a number of environmental variables including climate, topography, slope, aspect and soil type. These variables control, among other things, the amount of sunlight and soil moisture accessible by plants within the community, which subsequently determines which plants are able to survive on a site. This resulting plant community will, in turn, influence the wildlife and insect species found at that site. The overall outcome is a direct (and often very strong) connection between climate, soils, plants and animals. And it is these relationships which produce the observed patterns of species distribution.

Objectives
The objectives of this lab are to describe the vegetation communities within the Augustana campus ravine and use this information to predict the distribution and diversity of wildlife and insect species.

<u>Biogeographic concepts</u>

- examine the influence of topography and slope aspect on a vegetation community at a micro scale.
- distinguish plant communities based on their physiognomic components.
- use plant community variables to estimate the diversity of the wildlife and insect community.

<u>Technical skills</u>

- hands-on experience in measuring environmental variables in the field.
- developing skills in vegetation science.

Relevance of this lab to the lectures
This lab should reinforce the concept that abiotic components of the environment have a profound influence on the distribution and diversity of biotic species.

Relevance of this lab to professional science
Landscape classification studies require the ability to identify and distinguish vegetation communities. This has been the backbone of almost all environmental studies done for projects such as creating national parks, determining the status of rare or unusual ecosystems and for use as baseline studies when looking at the effects of environmental disturbances.

Many environmental research projects require the ability to conduct transect surveys in order to collect data in an organized and systematic manner. For example, the Alberta Phase III Forest Inventory used transect survey methods to classify all of the forest community types within the Boreal Forest Region of Alberta.

The ability to make inferences about the wildlife community based on observed vegetation types is commonly used in preliminary biophysical resource assessment studies.

Misc. notes
Please ensure that you dress suitably for the weather as we will most likely encounter deep snow and chilly temperatures. A pair of thin gloves worn under a larger pair of mitts will allow you to takes notes and complete data sheets yet still keep your fingers relatively warm.

The biggest source of heat loss for humans in winter is through the head so you should bring a warm hat, even for balmy winter conditions. Field work of this type generally involves more standing around than you might think, and that's when people start to get cold if they are not prepared.

The best overall way to stay warm while doing winter fieldwork is to wear lots of layers.

If it is a sunny day with few clouds, the glare off the snow surface can be quite harsh; sunglasses will come in handy.

Field procedures
Working in groups of four, you will complete a survey transect through the Augustana campus ravine, recording vegetation information, using the following methods.

From a designated starting point near the creek in the bottom of the ravine, and using a compass with the declination set to zero (0°) degrees, take a straight line bearing of 80°. This will define your transect up the east slope of the ravine. It is best to have one person place a survey flag part-way up the slope which you can use to visually maintain a straight line transect.

Vegetation data will be collected at five metre intervals along this transect. Locate the centre of the survey plots using a 20m tape, running along the transect line. Each five metre point will be the centre point of a circular survey plot, within which you will collect the vegetation data. Place the plot pole on this centre point with one person holding the pole in place. (The soil is too frozen to stick the pole into the ground). Loop the plot cord over the pole and, while pulling the plot cord tightly away from the centre pole, one person will walk a complete circle; this circle defines the survey plot.

Within each survey plot, record the following data onto the field data sheet:
- number of trees.
- number of shrubs.
- the diameter of the three biggest trees.

To determine the number of trees/shrubs:
- each trunk/stem counts as one individual.
- in the case of multiple stems originating from a single point on the ground, this is considered a single shrub.

- the point at which a stem comes out of the ground must be within the plot circle in order to be included. Branches sticking into the circle from stems/trunks outside of the circle do not count.

When pulled straight, the plot cord is 2.5m in length, which will delineate a circular plot of $20m^2$ in size.

In order to determine accurate counts, you must ensure that:
- the centre pole is held upright and firmly at the very centre of the plot, and that it does not move once the plot data collection has started, and
- the plot cord is pulled tight so there is no slack, otherwise the plot circle will not be full-sized.

To determine tree diameter:
- the standard forest industry method of determining tree diameter is to measure it as the "diameter at breast height" (DBH).
- the standard DBH location is 1.35m above the ground adjacent to the trunk.
- DBH's will be measured using the calipers.

Be careful not to trample the area within the plot too much as in some areas of the ravine, there will be many shrubs just visible above the snowpack which are easily broken underfoot.

If there are no trees in a survey plot, the groundcover will be dominated by forbs and grasses.

Terms
DBH – diameter at breast height.
Forbs – non-woody plants, generally growing low on the ground.
Shrubs – plants with woody stems; in the Augustana ravine, these will vary in height from 0.3m to 1.5m.

Field equipment
Each group will need the following equipment, which will be supplied to you:
- compass
- 20m tape measure
- some survey flagging tape
- centre pole
- plot cord
- calipers

Be sure that you bring several pencils with you. Pens are OK as long as it's not cold outside, otherwise they tend to stop working.

Lab procedures
Once all transects have been surveyed, we will return to the lab room and compile the data so that everyone has access to all of the field data. This will be accomplished by having each group

input their data into an existing spreadsheet. The instructor will then compile the data from all transects and put a copy of this spreadsheet file (*Veg gradient data*) on to the course website. This is the field data you will use to complete the lab exercise. At this time you should also make a copy of the field data from your transect for your own records.

Classifying vegetation communities
There are several standard methods for classifying vegetation communities, most of which are based on more complex data than were collected during this lab. However, your data are adequate to make some basic classifications.

Distinct vegetation communities can be delineated on the basis of noticeable changes in:
- tree height.
- tree density.
- shrub density.
- tree size.

Often it is necessary to look at the combined effects of all four variables working together to make an accurate assessment.

The tree and shrub density data are, for the purposes of this lab, always given as the number of stems per $20m^2$. In other words, the number of stems counted within each survey plot circle.

Ecologists generally rely on the field data to classify vegetation communities. However, it is always useful to record general visual descriptions of the vegetation in what are obviously different communities along a transect, as well as where these communities appear to change. This is especially helpful since this will most likely be the first time you have closely examined the vegetation of this site and you will be collecting limited vegetation data.

NOTE: it is up to you to determine how many vegetation communities are present along the ravine transect. The tables and text which accompany this lab are designed to allow enough space to incorporate all of the data (either raw field data or analyzed data). Do not assume that just because there are a certain number of columns in a table that this indicates the correct number of vegetation communities; that determination is for you to make.

The lab report will be due in class, on Wednesday, February 2, 2005. Each student must complete and submit their own lab report (which should include) all tables and graphs.

BIOGEO 351 Lab 2 – Vegetation gradients

Name: ___________________

Mark: _______ / 50

Using the spreadsheet which contain all of the field data (*Veg gradient data,* which will be on the course website), complete the following.

1. Using the tree height data, draw basic tree shapes on the topographic profile of the ravine (Figure 1). Ensure the tree heights are accurate for the scale of the profile (i.e. using the elevation along the y-axis). _____ /3

2. Place the tree and shrub density data into Figure 2, using the left y-axis for the tree data and the right y-axis for the shrub data. Use line graphs of differing colours and include a legend. __ /3

3. Determine the mean DBH for each survey plot and enter this data into Table 1. Then place this mean DBH data into Figure 3, as a bar graph. _____ /4

Do not forget to label all parts of your graphs and provide titles for the figures.

4. Using figures 1, 2 & 3, estimate the boundaries between distinct vegetation communities along the Augustana ravine and indicate where you believe these boundaries occur on Figure 1. Do this by drawing a bold vertical line at each boundary point, transecting the topographic profile (from top to bottom of the entire figure). Number each vegetation community, starting from the beginning of the transect and place this number on Figure 1 above the corresponding community.

______ /2

5. Explain how you determined that the ravine and adjoining upland had this number of distinct vegetation communities and what distinguishes each community from the others.

_____ /5

6. Which physical environmental variables do you believe are responsible for the creation of each vegetation community, either through their direct influence or through their lack of influence.

_____ /5

The big disadvantage to doing this kind of field surveys during winter is that you cannot tell which non-woody plant species are present. Almost all vegetation surveys are done during the summer months so that ecologists can use data on forbs and graminoids to better classify a community as well as to determine levels of species richness (i.e., plant diversity).

Table 2 contains a list of all wildflower and graminoid species which are present in the Aspen Parkland ecoregion (in which Camrose is located) and their basic vegetation community associations. Use this plant information for the following questions.

7. Determine which plant species would occur within each of your designated vegetation communities in the Augustana ravine. To do this, you need to incorporate the wildflower and graminoid information provided in Table 2 into the Plant species presence-absence matrix (see Table 3). Bear in mind that some species could be found all along the transect while others may be found only in certain areas, depending on their habitat requirements. (Note: all species on the list will be found somewhere along the transect).

Simply put a checkmark into the appropriate box if you think that species would be found in that community. You must include the community number (from Figure 1) in the column headings for Table 3.

_____ /2

8. The total wildflower and graminoid species for each community represents that community's non-woody plant species diversity. Place that data into Figure 1 by using the blank right y-axis and for each community, draw a bar graph illustrating plant species diversity, placing one bar within the appropriate community space. (Don't forget to accurately label the axis and add the necessary wording to the figure title). Don't worry about covering over parts of the topographic profile or the tree figures; use the entire graph space so that the trend in plant species richness is clearly presented.

_____ /5

9. What is the trend in forb and graminoid diversity along the Augustana ravine?

_____ /5

10. What physical environmental variables do you think have influenced the variation in plant species diversity in the Augustana ravine? Why?

_____ /8

11. What biotic (i.e. vegetative) factors do you think have influenced the variation in plant species diversity in the Augustana ravine? Why?

_____ /8

Table 1. Mean Aspen size (DBH)

Plot Distance (m)	Mean DBH (cm)	Tree Ht (m)
5		
10		
15		
20		
25		
30		
35		
40		
45		
50		
55		
60		
65		
70		
75		

Plot Distance (m)	Mean DBH (cm)	Tree Ht (m)
80		
85		
90		
95		
100		
105		
110		
115		
120		
125		
130		
135		
140		
145		
150		

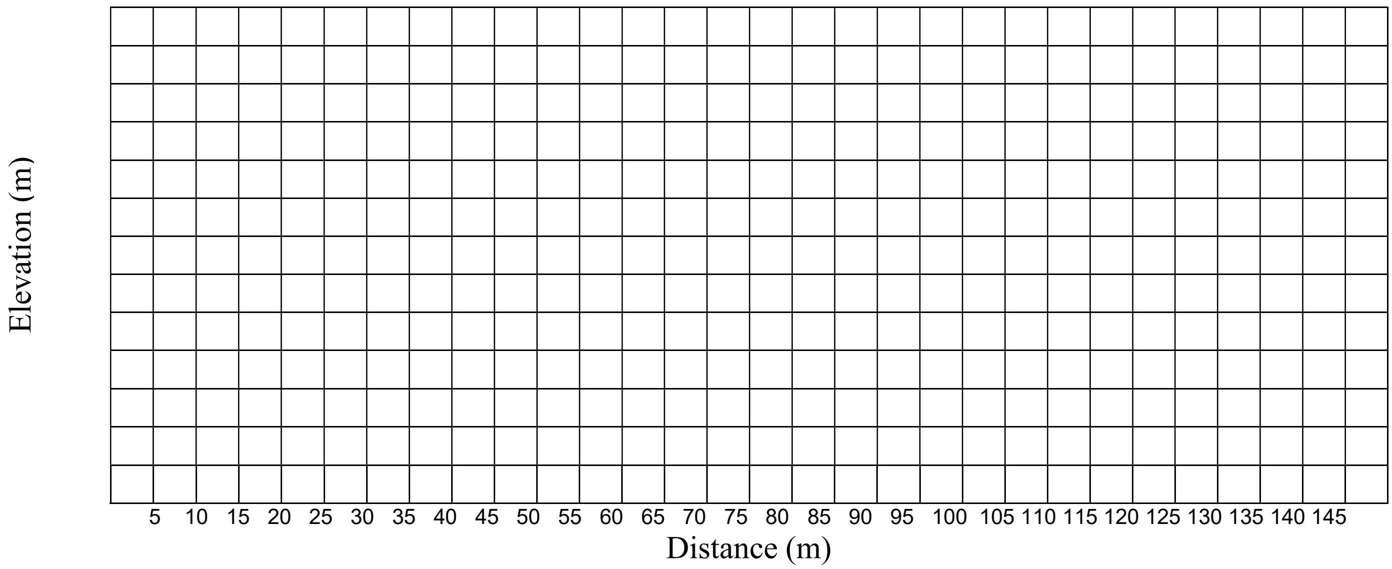


Figure 1. Topographic profile of the east slope of the Augustana Campus ravine.

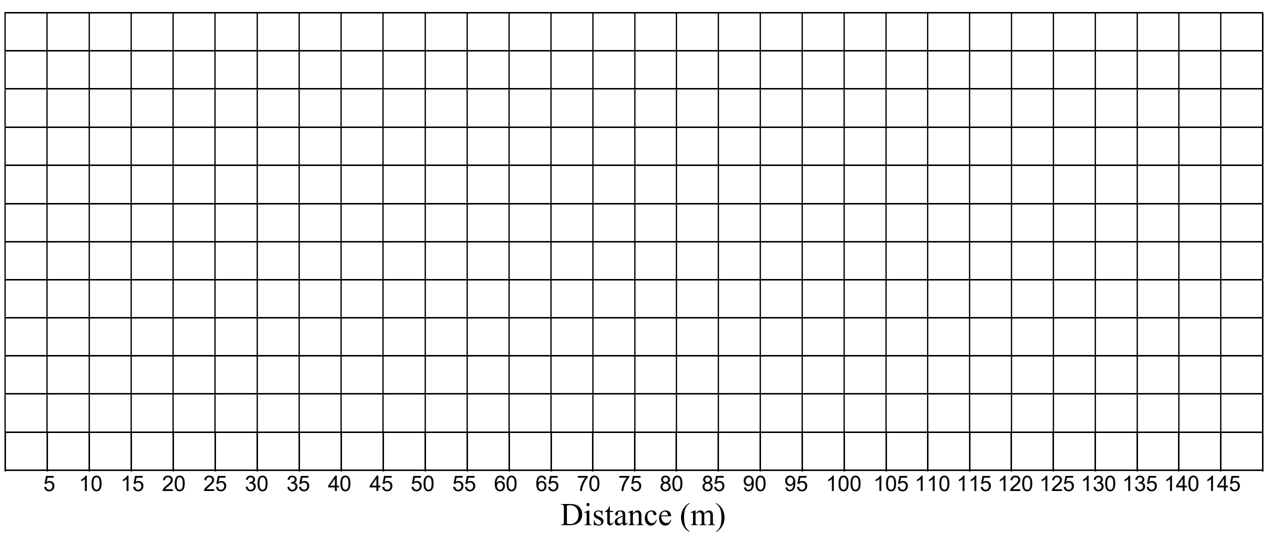


Figure 2. ____

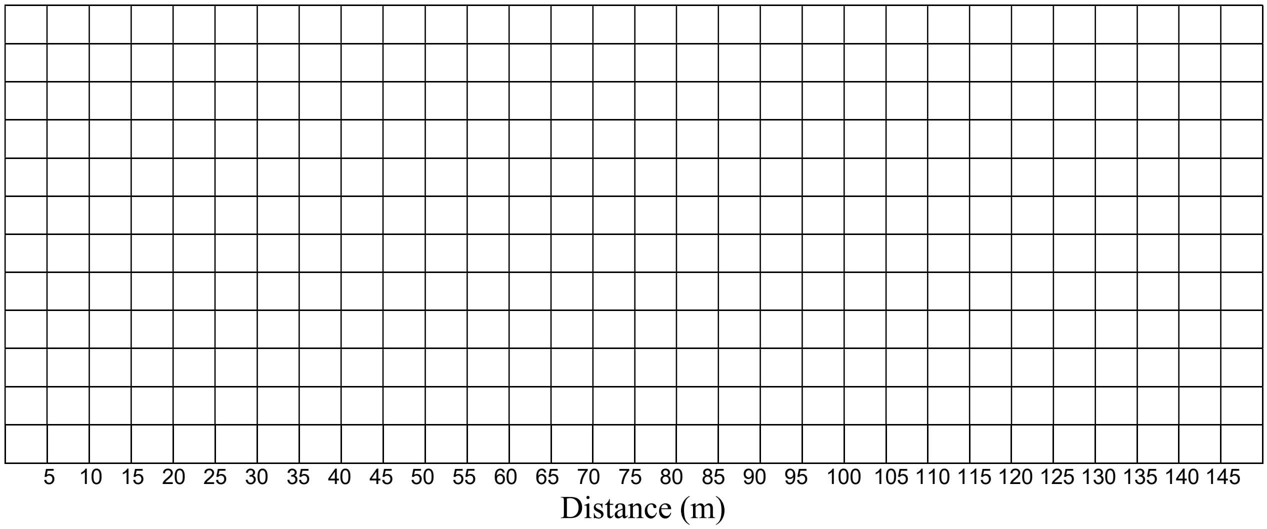

5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145
Distance (m)

Figure 3. ____

Table 2. Forb and grass species most likely to occur within the Augustana Ravine, along with their basic habitat requirements.

Wildflowers

Western Wood Lily – open deciduous woods.
Fairybells – moist woods.
Star-flowered Solomon's Seal – open woodlands.
Common Blue-eyed Grass – moist slopes.
Sparrow's-egg Lady's Slipper – streambanks.
Round-leaved Orchid – well-drained streambanks.
Lesser Rattlesnake Plantain – dry forests.
Spotted Coralroot – moist to dry forests.
Pale Coralroot – dry tomoist forests.
Blunt-leaved Sandwort – moist thickets and woods.
Long-stalked Chickweed – dry to moist open areas.
Hairy Rock Cress – open woods and fields.
Purple Rock Cress – dry slopes.
Common Pepper-grass – dry, open areas.
Richardson's Alumroot – open woods and meadows.
Bishop's Cap – moist forests.
Prairie Crocus – dry hillsides.
Cut-Leaved Anemone – dry to moist open woods and meadows.
Canada Anemone – damp meadows.
Wood Anemone – moist woods.
Red and White Baneberry – moist woods.
Tall Larkspur – moist open woods.
Blue Columbine – open woods.
Canada Columbine – open woods.
Veiny Meadow Rue – open woods.
Tall Meadow Rue – moist woods.
Dewberry – moist woods.
Woodland Strawberry – Dry to moist open woods and meadows.
Wild Strawberry – open woodlands and clearings.
Graceful Cinquefoil – open woods; grasslands.
Agrimony – edges of Aspen woods.
Wild Vetch – fields; open woods.
Purple Peavine – shrub thickets; deciduous woods.
Creamy Peavine – open woods and clearings.
American Milk Vetch – moist open woods.
Canadian Milk Vetch - moist open woods.
Alpine Milk Vetch – forest edges, meadows.
Purple Milk-Vetch – meadows and open slopes.
Showy Locoweed – open woods and clearings.
Reflexed Locoweed – open woods.
Early Blue Violet – meadows, open woods.
Western Canada Violet – moist to fairly dry woods.

Table 2 (cont'd).
Fireweed – open woods.
Purple-leaved Willowherb – moist woods; meadows.
Yellow Evening-primrose – dry open areas.
Spreading Sweet-Cicely – moist deciduous woods.
Cow Parsnip – moist woods.
One-Flowered Wintergreen – moist woods.
One-sided Wintergreen – woods and thickets.
Common Pink Wintergreen - moist woods.
Lesser Wintergreen – moist woods.
Green Wintergreen – moist woods.
Fringed Loosestrife – moist woods.
Northern Starflower – moist woods.
Hemp-nettle – clearings.
Giant Hyssop – open deciduous woods.
Yellow Rattle – meadows, open woods.
Common Red Paintbrush – open woods, meadows.
Narrow-leaved Hawkweed – open forests, meadows.
Common Blue Lettuce – moist woods.
Ox-eye Daisy – meadows.
Canada Thistle – fields.
Common Yarrow – meadows, woods, clearings.
Small-leaved Pussytoes – dry, open areas.
Broad-leaved Pussytoes – open woods and grasslands.
Northern Daisy Fleabane – moist woods.
Smooth Fleabane – meadows; open woods.
Philadelphia Fleabane – moist woods.
Fringed Aster – forest fringes.
Showy Aster – open woods and clearings.
Palmate-leaved Coltsfoot – moist woods.
Cut-leaved Ragwort – open woods.
Balsam Groundsel – moist open woods, meadows.
Canada Goldenrod – moist woods, meadows.
Mountain Goldenrod – open woods, meadows.
Bastard Toadflax – grasslands.
Northern Bastard Toadflax – moist woods.
Stinging Nettle – moist woods, open grasslands.
Wild Sarsaparilla – moist woods
Northern Gentian – moist woods, meadows.
Spurred Gentian – moist woods.
Spreading Woodbane – open hillsides.
Bunchberry – moist woods.
Tall lungwort – moist woods, meadows.
Northern Bedstraw – open woods, clearings, meadows.
Common Harebell – meadows.

Table 2 (cont'd).

Graminoids
Foxtail Barley – meadows.
Slender Wheat Grass – open woods, meadows.
Hairy Wild Rye – open woods, slopes, meadows.
Timber Oat Grass – grasslands, meadows.
Rocky Mountain Fescue – open woods, clearings, grasslands.
June Grass - grasslands.
Purple Reed Grass – clearings, hillsides.
Bluejoint – moist woods, meadows.
Rough-leaved Rice Grass – moist open woods and clearings.
Kentucky Bluegrass – open woods, grasslands.
Fringed Brome – open woods, meadows.
Northern Brome – meadows, open woods.
False Melic – open woods, grasslands.

Definitions of terms used in plant habitats
Open woods – tree canopy is not closed; open space between trees.
Closed woods – tree canopy continuous; trees close together.
Moist woods – moist upper soil layers because they are not subjected to direct sunlight.
Dry woods – drier soils because the ground surface is subject to direct sunlight.
Meadows – no trees and few shrubs; dominated by grasses. Generally found on level or near-level ground.
Thickets – stands of dense shrubs or small trees separate from continuous woods.
Clearings – open areas within a forest.

Source
This vegetation information was taken from:
Johnson, D., L. Kershaw, A. MacKinnon and J. Pojar. 1995. Plants of the western boreal forest and aspen parkland. Lone Pine Press, Edmonton. 392p.

Table 3. Plant species presence-absence matrix

Species	**Comm ____**	**Comm ____**	**Comm ____**	**Comm ____**	**Comm ____**
Western Wood Lily					
Fairybells					
Star-flowered Solomon's Seal					
Common Blue-eyed Grass					
Sparrow's-egg Lady's Slipper					
Round-leaved Orchid					
Lesser Rattlesnake Plantain					
Spotted Coralroot					
Pale Coralroot					
Blunt-leaved Sandwort					
Long-stalked Chickweed					
Hairy Rock Cress					
Purple Rock Cress					
Common Pepper-grass					
Richardson's Alumroot					
Bishop's Cap					
Prairie Crocus					
Cut-Leaved Anemone					
Canada Anemone					
Wood Anemone					
Red and White Baneberry					
Tall Larkspur					
Blue Columbine					
Canada Columbine					
Veiny Meadow Rue					
Tall Meadow Rue					
Dewberry					
Woodland Strawberry					
Wild Strawberry					
Graceful Cinquefoil					
Agrimony					
Wild Vetch					
Purple Peavine					
Creamy Peavine					
American Milk Vetch					
Canadian Milk Vetch					
Alpine Milk Vetch					
Purple Milk-Vetch					
Showy Locoweed					
Reflexed Locoweed					
Early Blue Violet					

Species	Comm ____	Comm ____	Comm ____	Comm ____	Comm ____
Western Canada Violet					
Fireweed					
Purple-leaved Willowherb					
Yellow Evening-primrose					
Spreading Sweet-Cicely					
Cow Parsnip					
One-Flowered Wintergreen					
One-sided Wintergreen					
Common Pink Wintergreen					
Lesser Wintergreen					
Green Wintergreen					
Fringed Loosestrife					
Northern Starflower					
Hemp-nettle					
Giant Hyssop					
Yellow Rattle					
Common Red Paintbrush					
Narrow-leaved Hawkweed					
Common Blue Lettuce					
Ox-eye Daisy					
Canada Thistle					
Common Yarrow					
Small-leaved Pussytoes					
Broad-leaved Pussytoes					
Northern Daisy Fleabane					
Smooth Fleabane					
Philadelphia Fleabane					
Fringed Aster					
Showy Aster					
Palmate-leaved Coltsfoot					
Cut-leaved Ragwort					
Balsam Groundsel					
Canada Goldenrod					
Mountain Goldenrod					
Bastard Toadflax					
Northern Bastard Toadflax					
Stinging Nettle					
Wild Sarsaparilla					
Northern Gentian					
Spurred Gentian					
Spreading Woodbane					
Bunchberry					
Tall lungwort					

Species	Comm ____	Comm ____	Comm ____	Comm ____	Comm ____
Northern Bedstraw					
Common Harebell					
Foxtail Barley					
Slender Wheat Grass					
Hairy Wild Rye					
Timber Oat Grass					
Rocky Mountain Fescue					
June Grass					
Purple Reed Grass					
Bluejoint					
Rough-leaved Rice Grass					
Kentucky Bluegrass					
Fringed Brome					
Northern Brome					
False Melic					
Total					

Vegetation Gradient -- Field Data Sheet

This sheet will contain the mean data from all five transects.

Distance (m)	**No trees**	**No shrubs**	**DBH 1***	**DBH 2**	**DBH 3**
5					
10					
15					
20					
25					
30					
35					
40					
45					
50					
55					
60					
65					
70					
75					

Distance (m)	**No trees**	**No shrubs**	**DBH 1**	**DBH 2**	**DBH 3**
80					
85					
90					
95					
100					
105					
110					
115					
120					
125					
130					
135					
140					
145					
150					

***- DBH is measured in cm**

Visual descriptions of vegetation types and vegetation changes along the transect:

Lab 3 – Disturbance effects

Background
A major component of the natural disturbance regime in the boreal forest of North America is wildfire (Johnson 1992). Fires serve a number of functions in forest ecosystems, including the elimination of downed woody material, incorporation of surface vegetation material into the humus soil layer and creation of a wide diversity of forest ecosystem types. The result is a patchwork mosaic of different-aged forest stands scattered throughout the northern coniferous forests of North America (Stelfox 1995).

The boreal forests have very high levels of biodiversity, which are directly related to vegetative composition and structural composition, which themselves vary according to the forest successional stage. Natural forest succession generally follows a distinct pattern, with older stages becoming more structurally complex along with increasing levels of plant and animal diversity.

Since wildfire is a natural disturbance, the boreal forest has evolved with this environmental constraint, as has the species diversity characteristic of each seral stage of the forest.

Objectives
The first two labs examined the variations in species diversity and distribution at very different scales:

- Lab 1 ((*Environmental controls on species distribution*) - North America
- Lab 2 (*Vegetation Gradients*) - 150 metre transect.

This lab will accomplish the same goal as the first two however, instead of concentrating solely on spatial distribution, it will examine the variation in species distribution and diversity over time.

The objectives of this lab are to:

- examine the effects of wildfire on the spatial heterogeneity of boreal forest types.
- determine how avian diversity and distribution varies according to changes in forest types.

This lab exercise is due at the end of the lab period.

<u>Biogeographic concepts</u>

- Forest succession.
- Temporal variation in species diversity.

<u>Technical skills</u>

- Map analysis.
- Critical evaluation of spatial and temporal trends.

Relevance of this lab to the lectures
This exercise continues the process of investigating the factors which influence the distribution of biotic species.

Relevance of this lab to professional science
Understanding the change in biodiversity in complex forest ecosystems over time and under the influence of natural disturbance regimes is crucial to determining the longterm effects of non-natural disturbances, such as large-scale logging.

Over the past decade in Canada, there have been many research projects aimed at determining how to change logging practices such that they will more closely emulate the effects of wildfire. In this way, the forest industry can continue to promote an important economic activity while maximizing the ability of the boreal forest to continue functioning as a natural system, with its constituent species and ecological processes intact.

Procedures
A field study was done by the Alberta Research Council (Vegreville Environment Centre) to compare bird species richness between young, mature, and old stands of aspen mixedwoods in the boreal forest of Alberta. Thirty-three species were detected during the two seasons that the surveys were run (1992 & 1993). Of those species, 24 were found to show a statistically significant preference for one or two of the forest stand types (as determined using a chi-squared approximation for the Kruskal-Wallis test). These 24 species are listed in Table 1, along with the number of times each species was recorded in the three forest types.

Using this species richness data, along with four hypothetical forest cover maps, you will determine how avian diversity and distribution vary over time due to the effects of wildfires.

Boreal forest information
The following information is a summary of the main vegetation characteristics which differ between young, mature and old aspen-dominated mixedwood forests in Alberta (copied directly from Stelfox 1995).

Old stands were structurally distinct from younger seral stages. Their uniqueness was related to a combination of canopy break-up and subsequent release of understory plants, emergence of secondary canopy species (white spruce and paper birch), the accumulation of deadwood, i.e., snags and down woody material (DWM), and the presence of nonvascular communities that develop on DWM. Relative to younger seral stages, old stands had trees of many ages and had more large-canopy trees, large snags, and advanced rot-class large DWM.

Old stands had a deeper organic soil layer and greater microtopographic relief than young and mature stands. The accumulation of organic material in the upper soil horizon may be related to greater input of deadwood materials from the canopy and subcanopy or to slower decomposition rates associated with cooler soils found in old stands.

Young stands had features associated with old stands because of residual materials from the previous stand cohort that escaped combustion during the fire or because of light conditions that were similar to old stands. Attributes that escaped combustion, or were created during fires, included large canopy trees, large snags, and coarse DWM.

Relative to young and old stands, mature stands were simple in structure with a closed canopy of aspen of relatively similar age, height, and diameter. In addition, mature stands had a more open understory with fewer shrubs and saplings.

Successional changes in stand heterogeneity were observed. For example, fires produced spatially heterogeneous patterns in the densities of trees and deadwood materials in young stands. The degree of spatial heterogeneity within and among stands was lowest in mature stands. In old stands, densities of trees and deadwood materials retained spatial homogeneity within stands; however, these structures became more heterogeneous among stands.

Terms

Species distribution patterns:

- Uniform – continuous cover throughout which, although it varies in shape, the range remains unbroken.
- Broken – areas of continuous cover remain but some large areas are separate from other large areas.
- Patchy – there are more numerous and smaller areas of cover, separated widely from other areas of cover.
- Scattered – many small areas of cover, widely spaced.

Species habitat utilization ability:

- Specialist – a species with a narrow range of resource tolerances and a small niche.
- Generalist - a species with a wide range of resource tolerances and a large niche.

Keep in mind during this lab exercise that changes to forest structure are directly due to the effects of wildfire.

References

Johnson, E. A. 1992. Fire and vegetation dynamics: studies from the North American boreal forest. Cambridge Univ. Press, NY.

Schieck, J. and M. Nietfeld. 1995. Bird species richness and abundance in relation to stand age and structure in aspen mixedwoods forests in Alberta. Pp. 107-152 in Stelfox (1995) (see below).

Stelfox, J. B. (ed.) 1995. Relationships between stand age, stand structure, and biodiversity in aspen mixedwood forests in Alberta. – Jointly published by Alberta Environmental Centre (AECV95-R1), Vegreville, Alberta, and Canadian Forest Service (Project No. 0001A), Edmonton, Alberta. 308 pp.

BIOGEO 351 Lab 3 – Disturbance Effects

Name: ___________________

Mark: _______ / 63

1. Using the information on bird species richness in Table 1, make a determination about which forest stand type (young, mature, old) you would expect to find each species. Keep in mind that bird species are very mobile and will sometimes be found in habitats outside of their normal ranges (due to flying through an area, predator avoidance, opportunistic foraging, etc). Put a check mark into the appropriate box(es) for each species, then total each column to determine the level of avian diversity within each forest type.

_____ /5

Using the avian diversity levels determined in Step 1, apply this information to the four Forest Cover Maps. These hypothetical maps show the distribution and extent of young, mature and old forest stands within one region of the boreal forest. The change in the age of each square is due to one of two factors:

- increase in age: vegetative succession.
- decrease in age: wildfire.

Each square is 1 km^2 in size, which means that each map covers an area of 150 km^2.

2. For each forest cover map time period, determine the species diversity along the transect (A-B) which runs through each forest region. Illustrate how the species diversity varies spatially for each time period by graphing this information into Figure 1. Note: this figure should have four lines, one for each time period. Be sure to include a figure title, axis titles, units and a legend.

_____ /5

3. How does avian diversity vary across the landscape for each time period?

_____/4

0 years:

10 years:

60 years:

100 years:

4. Considering all four of these avian diversity transects, what does the change in the pattern of avian diversity across the landscape over time indicate about the temporal variations of stand types within the boreal forest (eg., what is the relationship between stand type and bird community, and how does it change?)

____/5

5. For each forest map, determine the extent of the forest cover according to stand type and enter this data into the two tables below.

_____ /4

Table 2. Extent of forest cover by stand type for different aged forests (by km^2).

	0 years	**10 years**	**60 years**	**100 years**
Young				
Mature				
Old				

Table 3. Extent of forest cover by stand type for different aged forests (by percent of land area).

	0 years	**10 years**	**60 years**	**100 years**
Young				
Mature				
Old				

6. Using the data from Table 3, produce a bar graph which illustrates the change in forest cover type over the four time periods. Use Figure 2 for this graph. (Easiest if you put the age classes along the x-axis)

_____/5

7. How have wildfires affected the extent and distribution of the three forest stand types over the 100 year time period? Use the terminology provided on page 3 and discuss how this distribution pattern is manifest across the forest entire region.

_____/5

8. Using the forest cover maps, briefly describe the distribution of the forest stand types for each time period. (Use the terminology already defined for species distribution types and how trhis pattern is manifest across the entire forest map).

_____/4

0 years:

10 years:

60 years:

100 years:

9. Using the information in Table 4, make a determination about the niche size of each species based on the occurrence of each species within the various stand types. (You need only place a checkmark into the appropriate box for each species)

_____/4

10. What kind of species (based on niche size) are more common in the boreal forest: specialists or generalists? Speculate as to why. (Hint: use the information provided in the introduction).

____/5

11. What do you believe will be the effect that the variation in the size and distribution of forest stand types would have on interspecific competition between generalist and specialist species? (Hint: how does the species distribution and diversity change over time in relation to functional vs. realized niche?).

_____/4

12. Yellow-rumped Warblers and American Redstarts are both wood warblers and both forage by gleaning insects from branches in dense woods and shrubbery. How do you think their respective realized niche size will vary within each of the three forest stand types? Speculate on a few environmental factors which may permit them to co-exist in stands where they both occur.

_____/4

13. In five words or less, explain the relationship between Tree Swallows and Canada Warblers.
_____ /2

14. Overall, how has the presence of wildfire influenced the distribution of bird species throughout the boreal forest?

_____/8

Table 1. Avian species abundance in different-aged aspen-dominated mixedwood forests.

Species	Abundance			Habitat preference		
	Young	Mature	Old	Young	Mature	Old
Ruffed Grouse	24	3	1			
Yellow-bellied Sapsucker	25	7	50			
Least Flycatcher	5	44	141			
Tree Swallow	24	1	0			
Red-breasted Nuthatch	0	2	17			
Brown Creeper	0	0	42			
Winter Wren	1	0	10			
Swainson's Thrush	17	12	38			
Hermit Thrush	88	27	14			
Cedar Waxwing	16	1	5			
Philadelphia Vireo	6	8	16			
Yellow-rumped Warbler	2	22	116			
Black-throated Green Warbler	0	2	94			
Black-and-white Warbler	27	1	2			
American Redstart	1	2	24			
Ovenbird	307	401	246			
Connecticut Warbler	110	61	42			
Mourning Warbler	23	25	87			
Canada Warbler	0	1	12			
Western Tanager	0	3	15			
Rose-breasted Grosbeak	92	6	35			
White-throated Sparrow	217	106	323			
Brown-headed Cowbird	8	1	13			
Pine Siskin	8	31	41			

Species richness			

Note: species richness refers to the number of species within an area or habitat type.

Figure 1. ____

____

Note: A-B transect distance should be on the x-axis.

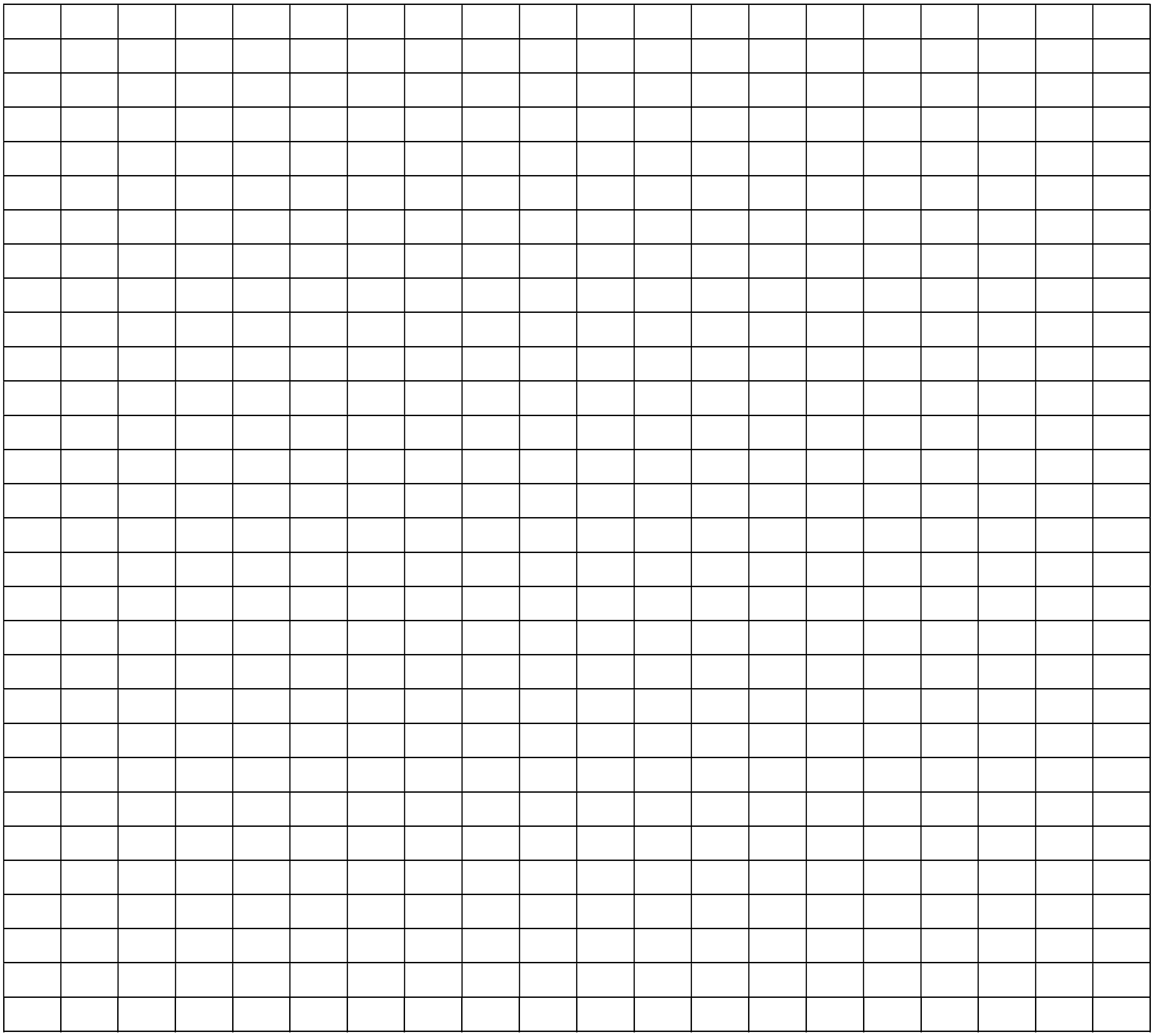


Fig. 2 ____

____

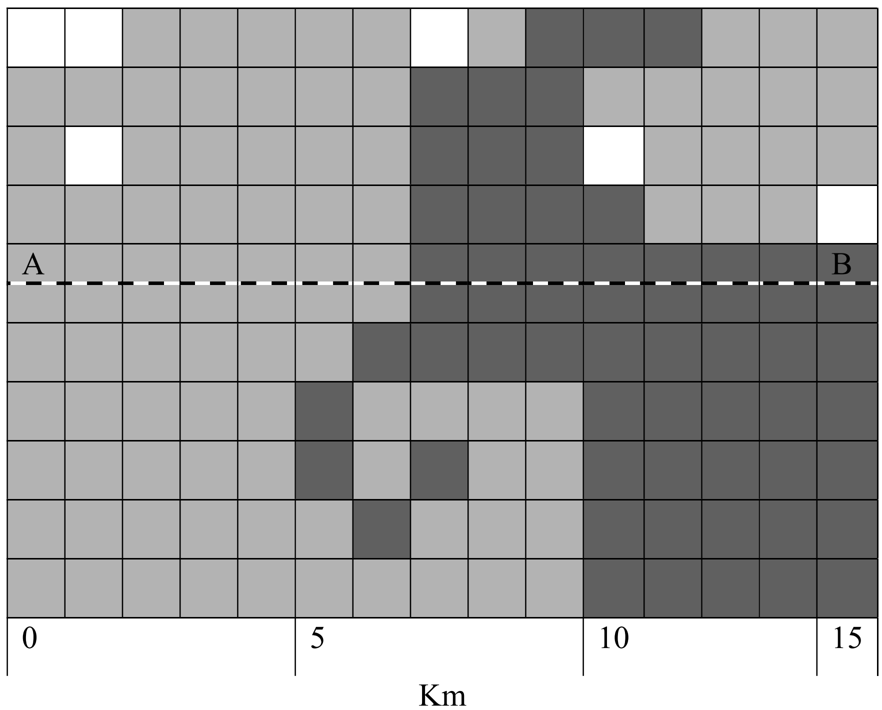
Table 4. Avian species designations according to habitat tolerance and niche use.

Species	Abundance				
	Young	Mature	Old	Generalist	Specialist
Ruffed Grouse	24	3	1		
Yellow-bellied Sapsucker	25	7	50		
Least Flycatcher	5	44	141		
Tree Swallow	24	1	0		
Red-breasted Nuthatch	0	2	17		
Brown Creeper	0	0	42		
Winter Wren	1	0	10		
Swainson's Thrush	17	12	38		
Hermit Thrush	88	27	14		
Cedar Waxwing	16	1	5		
Philadelphia Vireo	6	8	16		
Yellow-rumped Warbler	2	22	116		
Black-throated Green Warbler	0	2	94		
Black-and-white Warbler	27	1	2		
American Redstart	1	2	24		
Ovenbird	307	401	246		
Connecticut Warbler	110	61	42		
Mourning Warbler	23	25	87		
Canada Warbler	0	1	12		
Western Tanager	0	3	15		
Rose-breasted Grosbeak	92	6	35		
White-throated Sparrow	217	106	323		
Brown-headed Cowbird	8	1	13		
Pine Siskin	8	31	41		
		Total			

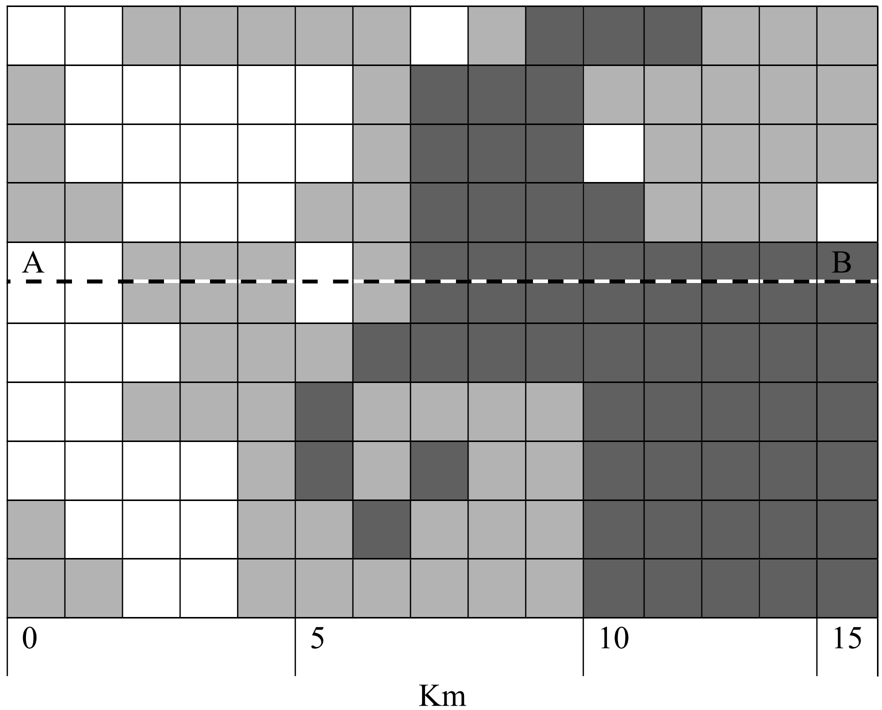
Forest cover maps

Forest age
Young
Mature
Old

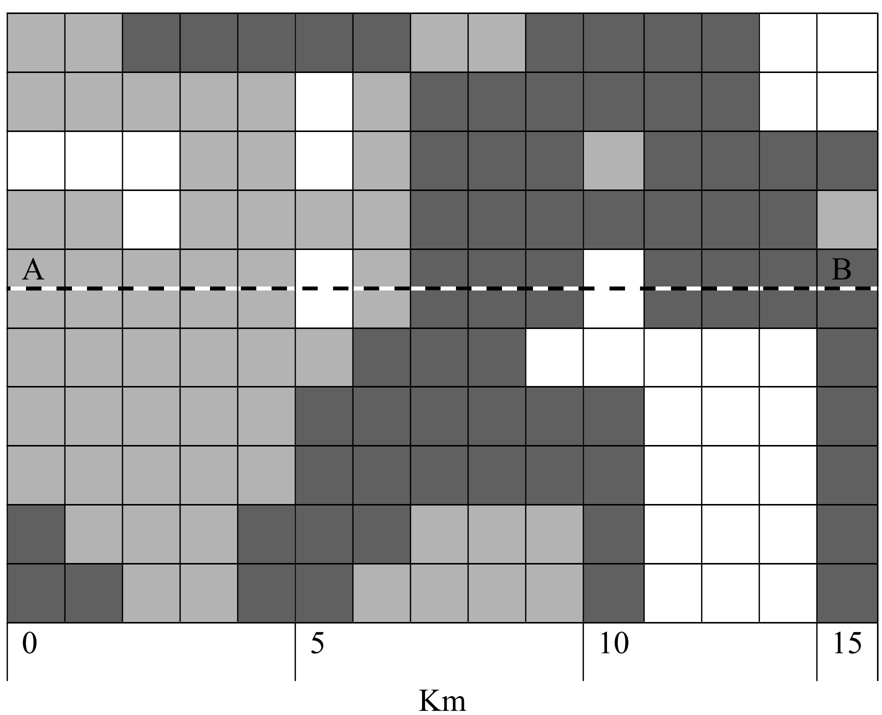
<u>Time 1: 0 years</u>



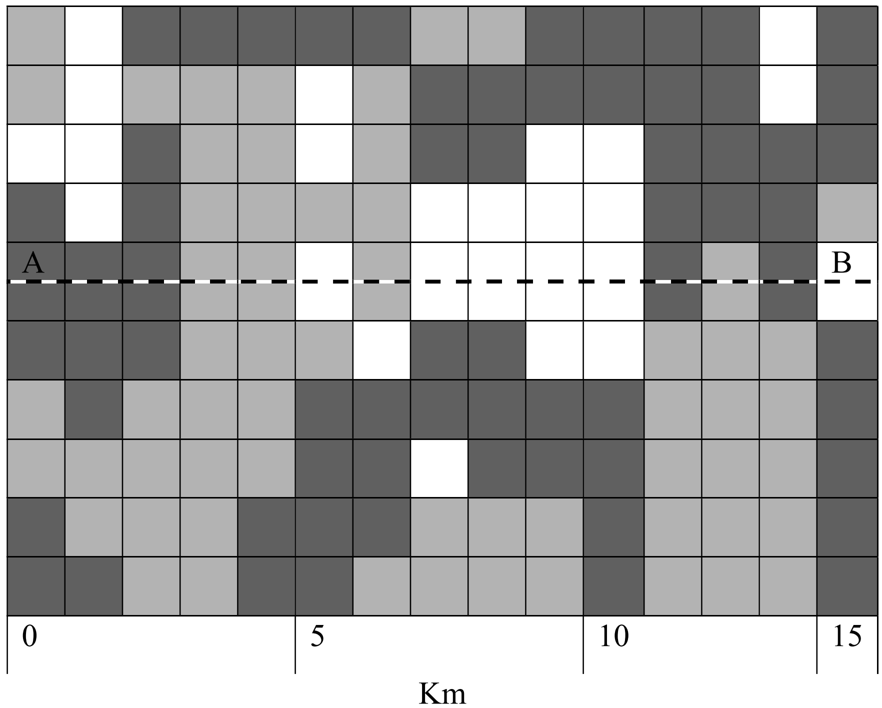
Time 2: time 1 + 10 years



Time 3: time 1 + 60 years



Time 4: time 1 + 100 years



Lab 4 – Biogeography of a species

Background
In order to understand the factors which influence the distribution of organisms, you need to understand the natural history of a species. This means assembling information about the biotic and abiotic factors which would affect a species, and how that species responds to both its environment and to other species.

For this assignment you will produce a biogeographic analysis of two species which are found in Alberta.

You will be writing a complete relatively biogeographic sketch of a species based on what is known in the current scientific literature and what is available from specific organizations which compile information about wildlife species of the western hemisphere.

Once you have completed the biogeographical sketch, you will be able to determine the realized niche of a species and can then speculate as to exactly why that species can co-exist with many other species in the same habitat.

Objective
To determine how two sympatric species, which are closely related on a taxonomic, morphological and distribution basis, can co-exist in the same basic habitat.

Relevance of this lab to the lectures
Examining the complete natural history of a species requires consideration of the two main determinants of distribution:

- environmental conditions.
- biotic interactions.

Both of these determinants have been covered in the lectures and they form a significant part of the foundational knowledge for the field of biogeography.

Relevance of this lab to professional science
Many researchers will spend a significant portion, if not the entirety, of their careers trying to understand what it is that makes a particular species, or group of species, "tick". This was more common in the middle to late part of the 20th century, as ecology and biogeography really became scientific disciplines in their own right. Much of the ecological research conducted today emphasizes ecosystem processes and cumulative disturbance effects, which means that entire groups of species are incorporated into a bigger research paradigm, rather than being the focus of the research in and of themselves.

However, before scientists can "paint a bigger picture", they need to know how each part of the landscape functions. Which means that detailed information about each species is of paramount importance, especially when examining such questions as ecosystem restoration following a disturbance or the effect of global climate change on species distribution.

Lab procedures
This project will be done with students working in pairs to produce a single report. Each student will assemble the information on their species and will then co-operate to answer questions about the two species and write the report.

Your research paper will be due in class, on Wednesday, February 2, 2005. Each student pair must complete and submit one jointly-produced lab report.

During the lab period, use the laptop computer to search the internet for information about your particular species. (See Appendix III - *Evaluating Information on the Internet*). Although much of what is found on-line is not peer reviewed information, some of what you find will be acceptable. The reason for this is that the websites you should check during the lab period (a list of them is provided below) belong to organizations whose purpose is to assemble information about the distribution and natural history of the species you will be researching.

Your assigned species is ____________________, and the sympatric species is _____________________.

Before you leave the lab today, you must have completed the following:
- determined the taxonomy of your species.
- produced a draft range map (using the provided map of the western hemisphere).

Research Paper
Your paper must include the following information.

1. Species name
Give your organism's complete scientific name.
- Kingdom, Phylum, Division or Class, Order, Family, Genus and Species.
- Names of all sub-species (both scientific and common, if the common name is generally accepted; if not, provide a short list of these common names.)

2. Natural history of the species
This is a detailed description of the species itself and includes the following headings:
- Morphology.
- Diet (include any seasonal differences).
- Reproduction: mating system, fecundity, mating rituals, etc.
- Habitat requirements:
  - Breeding, nesting, etc.
  - Feeding, foraging, etc.
  - Migration

The habitat requirements should be detailed enough to provide a clear indication of the realized niche of this species.

3. Distribution
On the map of North and South America, show the distribution of both species. Include its entire range and use colour to easily differentiate the various parts of the range (i.e. seasonal differences). Be sure to provide a legend.

A written description of the characteristics of its range:
- distribution type (i.e. continuous, disjunct, cosmopolitan).
- which abiotic factors are influencing the range.

4. Evolution of the species
Provide a dendrogram which illustrates the evolutionary relationship between the two species. Include at least the Order, Family, Genus and Species branches.

5. Other information
Any other useful or interesting information which would serve to provide a complete picture of this species, eg., population status (common, rare, endangered), interesting anecdotes, etc.

6. Sympatric species analysis
Once you have collected the above information for each species, you need to:
A. describe the realized niche of each species, highliting similarities and differences between the two species.
B. explain which factors you believe have allowed these two species to co-exist within the same range and habitat.

References
You must cite the sources of all information used in this report, using a standard citation format. In this course (as in all biology, geography and environmental science courses at the Augustana Faculty) citations will follow the Council of Biology Editors (CBE) style, as outlined in:

Pechenik, J.A. 2004. A short guide to writing about biology. Pearson-Longman, NY. 302p.

This short paper should describe all situations you will encounter regarding the wide variety of references in print (paper and digital). A copy of it is provided in Appendix II of this lab manual. References must be provided for both written literature and web references.

In addition to information that is found on the internet, you must include at least five (5) textbooks or scientific journals, although you will probably use more than that.

Some good websites with information about citations include:

Augustana Faculty Library
http://www.library.augustana.ca/citation.html

University of Wisconsin-Madison
http://www.wisc.edu/writing/Handbook/

San Francisco State University
http://www.library.sfsu.edu/instruction/guides/citref.html#ecite)

Plagiarism
Research work in academia and industry is based on previous work done by other people. Scientist A discovers something, which leads scientist B to discover something else, which in turn, allows scientists C through Z to advance their own work. In fact, this is the entire basis for advances in human endeavour in just about every field.

So, it is inevitable that you will have to incorporate the work of other people into your research paper. And it is perfectly acceptable to do so, **but only if you acknowledge their work**. Using someone else's ideas, words, data, research, etc., in your paper without providing the credit to this person is a form of literary theft known as **plagiarism**.

Plagiarism is a growing problem in universities, whether a student does it knowingly or by accident. Either way, the university has a very low tolerance towards plagiarism. For more information on this policy, please see the Code of Student Behaviour, which can be found at section 30.3.2(1) of the University of Alberta Calendar.

There is a very simple way to avoid any problems in this regard: simply provide a citation (in the Literature Cited section) for each reference, idea, data, etc., you use in your paper. If you are uncertain about whether you are straying into the dreaded plagiarism minefield, please feel free to talk to me about it. If you are unsure about how to cite articles, books, journals, etc., the instructor will be happy to show you how it's done.

Paper format
- Introduction – outline of the objectives of your paper; thesis statement.
- Natural history of species A.
- Natural history of species B.
- Discussion – the analysis of your topic.
- Conclusion – present your conclusions regarding the objectives you stated in the Introduction.
- Literature Cited – all information sources, references, etc., need to be included.

Format of the paper
- Length: 1500 words (3-4 pages max.).
- Paper is to be typed, double-spaced one side of the page, on letter-sized paper; one inch margins; paginated.
- Separate page for Literature Cited section.
- Title page with your names and student ID numbers.
- The maps and any other diagrams, figures, tables, etc., you choose to incorporate can be appended to the end of the paper.

How this paper will be graded

There are a number of things I will be looking for when grading this paper:

- Completeness – how thorough is your discussion of the topic.
- Information sources – authority of the source materials; the variety of sources.
- Clarity – is the paper well organized and the material clearly presented?
- Style – good grammar and syntax.
- Writing - clear, concise writing; no deadwood; sticks to the topic (is well focused).

Useful websites for avian species information

North American Breeding Bird Survey, Results and Analysis, 1966-2003
http://www.mbr-pwrc.usgs.gov/bbs/htm03/ra2003_red.html

Audubon Christmas Bird Count
http://www.mbr-pwrc.usgs.gov/bbs/cbc.html

BirdNet
www.nmnh.si.edu/BIRDNET/

Bird Studies Canada
http://www.bsc-eoc.org

NatureServe Explorer
http://www.natureserve.org/explorer/

The International Biogeography Society – Databases.
http://www.biogeography.org/databases.htm

California Academy of Sciences
Toolbox for conservation professionals and researchers: biodiversity and endangered species information resources.
http://www.calacademy.org/research/library/sla_02.html

Biogeography bibliographies and text archives
http://www.biogeography.org/bibliographies.htm

Biodiversity and biological collections web server
http://biodiversity.uno.edu/

Tree of life
http://tolweb.org/tree/home.pages/popular.html

World Resources Institute
http://www.wri.org/

Lab 5 – Dispersal ability of invasive species

Name ______________________________

Mark ________ /100

Background

Invasive species are those which are able to disperse widely and then successfully colonize new environments, often at the expense of native species. Because of their ability to exploit new habitats (or similar habitats in new areas but without the competition present in their former range), invasive species are a potent force of ecosystem change. In fact, the two most destructive forces altering ecosystems and causing biodiversity declines on a global scale are habitat destruction and invasive species.

Objectives

The objectives of this lab exercise are to assemble information about six invasive species and critically evaluate the characteristic of each species which makes them a successful invader.

<u>Biogeographic concepts</u>

- Species dispersal.
- Examination of species-specific life history traits.

<u>Technical skills</u>

- Ability to synthesize large amounts of on-line scientific information.
- Critical evaluation of morphological and physiological characteristics.

Relevance of this lab to the lectures

Since we have been examining the different ways in which organisms expand their range through various dispersal methods, it is instructive to delve more deeply into the dispersal ability of some specific species.

Relevance of this lab to professional science

There is a growing concern worldwide among scientists and conservation managers about the impact of non-native, invasive species. There are very few places on earth where invasive species are not found. Of course, this has always been the case, as demonstrated by historical and fossil records. However, the speed with which species are moving across the planet has been dramatically increased through either direct anthropogenic transport or indirect human effects.

If natural ecosystem components and processes are to be maintained, then scientists must understand:

- which species are the most successful at invading and colonizing new habitats.
- how the invasive species has become so successful in adapting to both the physical environment and the biotic components (i.e. despite the interspecific competition, predation, parasitism, etc).
- how to manage and/or eradicate the invading organisms.

Due date

This lab exercise is due at the end of the lab period.

Procedures
Working in groups of 2-3 students, use the laptop computers to search the internet for information about the following six invasive species:

- Africanized honey bee (*Apis mellifera scutellata*)
- American bullfrog (*Rana catesbeiana*)
- Cheatgrass (*Bromus tectorum*)
- Gypsy moth (*Lymantria dispar*)
- European starling (*Sturnus vulgaris*)
- Zebra mussel (*Dressena polymorpha*)

Use this information to answer a set of questions about each species, in order to determine how successful they are as invasive species.

Internet information
The internet is a good resource for this kind of information as there are many associations concerned about invasive species and they are helping to disseminate information about this problem to a wider audience. These groups include federal governments, state/provincial governments, academic researchers, non-governmental organizations and environmental advocacy groups.

As you go through the on-line information, try to stay with sites run by large organizations, as their information is generally the most reliable and current. You will be able to obtain all the required information from government sites, however there are a number of well-known non-governmental organizations which also have good data and you are certainly free to use their information.

As with all internet searches, you must be aware that not all of the web-based information is peer reviewed. There are a number of ways of determining if a website has legitimate information. If you are unsure of how to evaluate the information on websites, you can read the file "*Evaluating information on the internet*", located in Appendix III. This four page document provides a number of good ideas about how to quickly asses the relevance of a website and the accuracy of its data.

Species: Africanized honey bee (*Apis mellifera scutellata*)

1a. Briefly describe the native range of this species. /1

1b. Briefly describe the current range of this species. /1

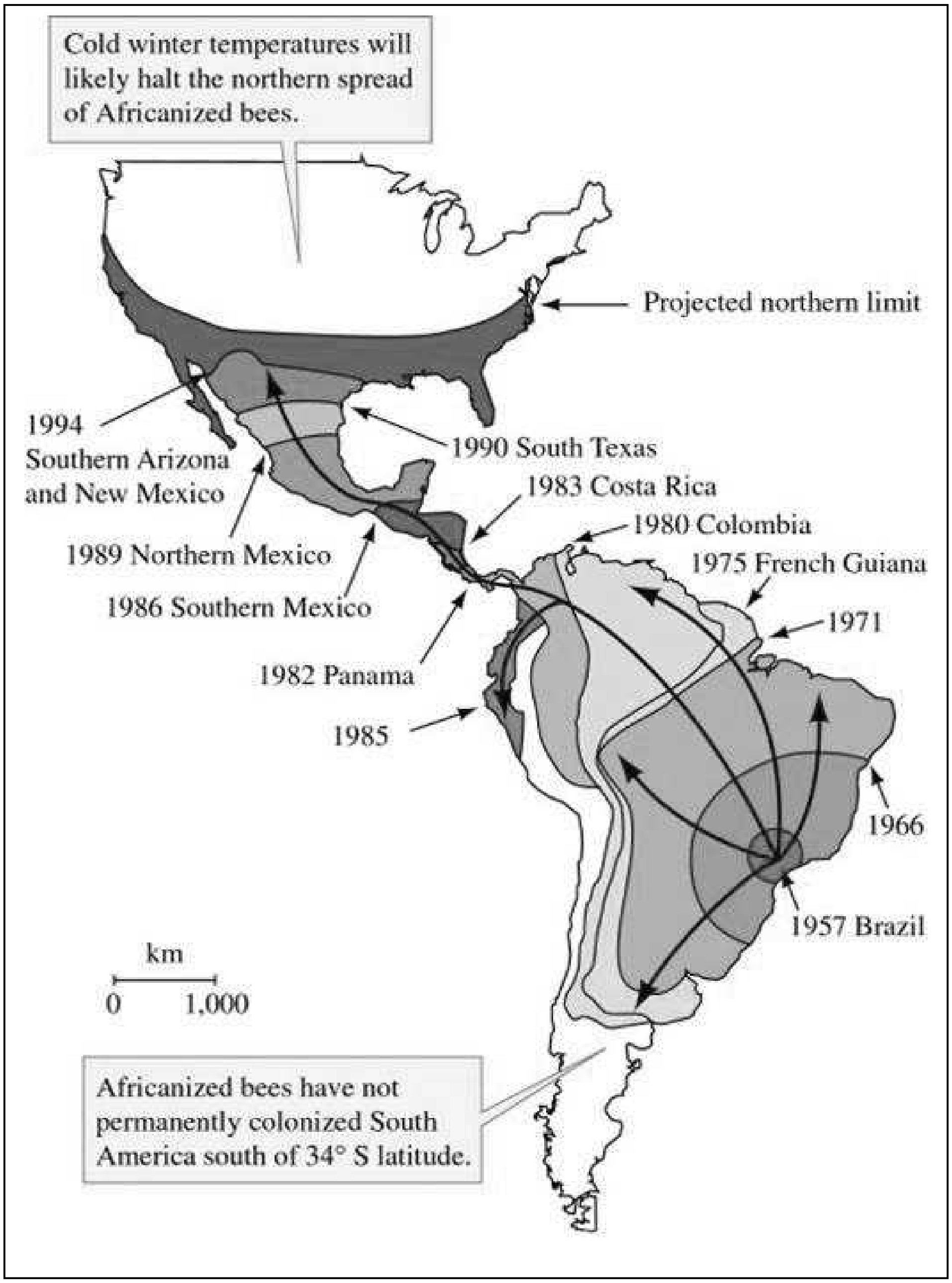
1c. How was this species initially introduced into its new range? /1

1d. Describe (in detail) how this species has managed to expand its range. You should consider such aspects as its physiology, reproductive capabilities, propagule dispersal, environmental adaptability, etc. /6

1e. What are the threats this species poses to integrity of the ecosystems it has invaded? /4

1f. Overall, why is this species so successful in its new range? /2

Africanized honey bee (*Apis mellifera scutellata*)



Species: American bullfrog (*Rana catesbeiana*)

2a. Briefly describe the native range of this species. /1

2b. Briefly describe the current range of this species. /1

2c. How was this species initially introduced into its new range? /1

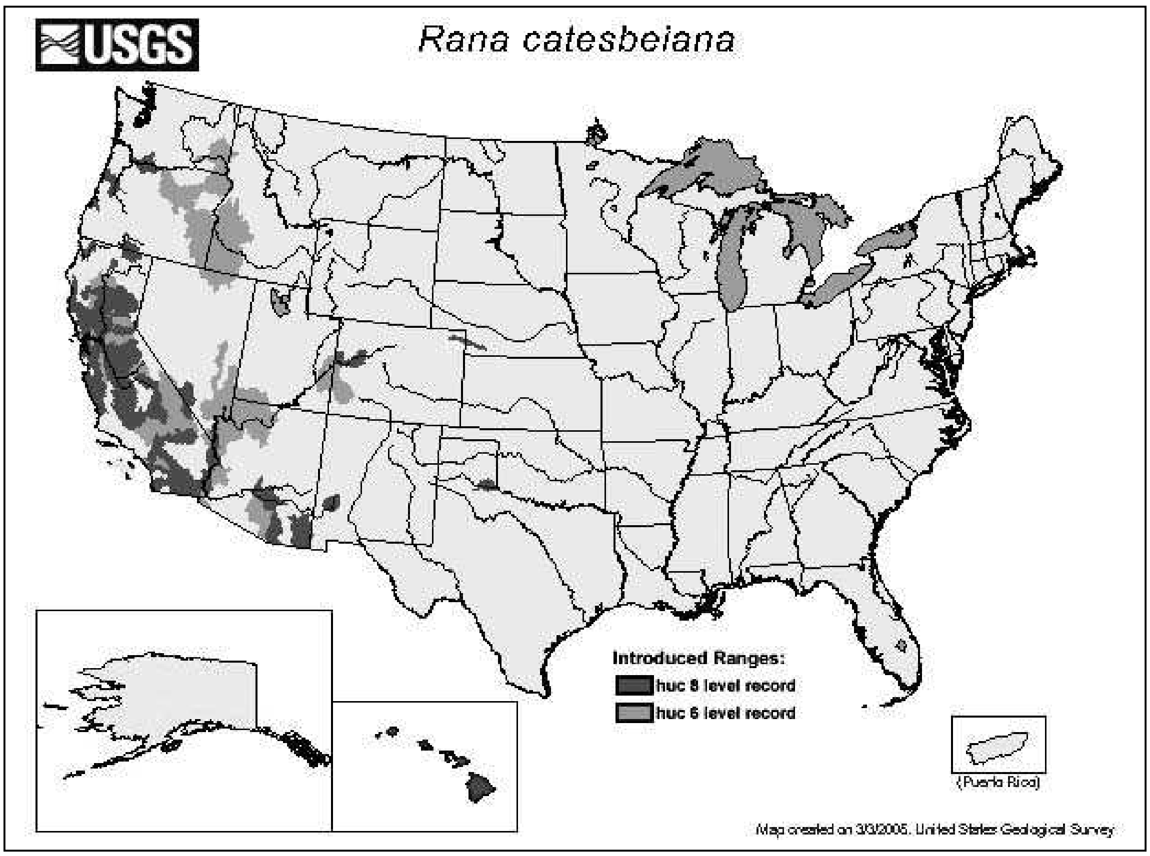
2d. Describe (in detail) how this species has managed to expand its range. You should consider such aspects as its physiology, reproductive capabilities, propagule dispersal, environmental adaptability, etc. /6

2e. What are the threats this species poses to integrity of the ecosystems it has invaded? /5

2f. Overall, why is this species so successful in its new range? /2

American bullfrog (*Rana catesbeiana*)

This map indicates areas in which the American bullfrog has been introduced and from which it has subsequently spread (by 2004).



Species: Cheatgrass (*Bromus tectorum*)

3a. Briefly describe the native range of this species.   /1

3b. Briefly describe the current range of this species.   /1

3c. How was this species initially introduced into its new range?   /1

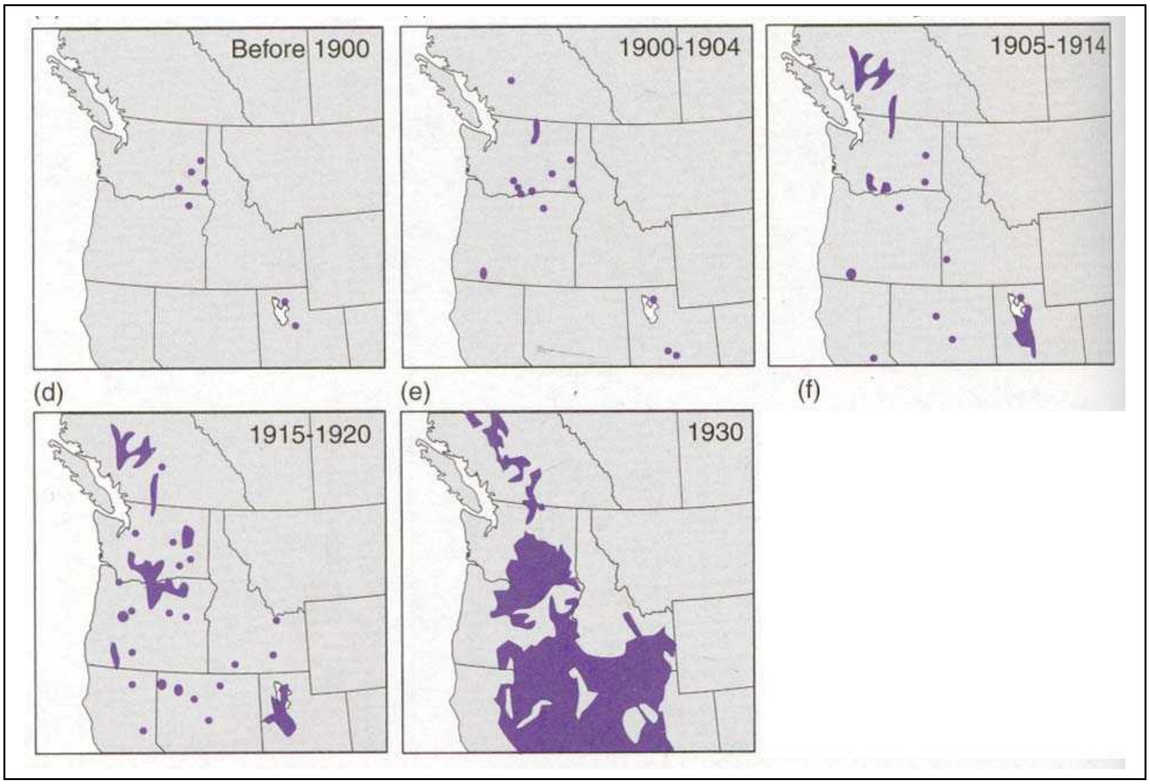
3d. Describe (in detail) how this species has managed to expand its range. You should consider such aspects as its physiology, reproductive capabilities, propagule dispersal, environmental adaptability, etc.   /6

3e. What are the threats this species poses to integrity of the ecosystems it has invaded?   /4

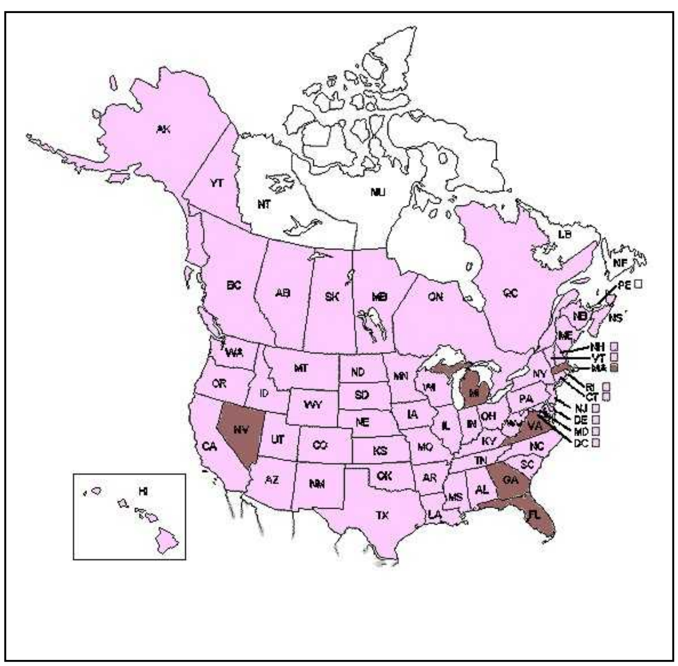
3f. Overall, why is this species so successful in its new range?   /2

Cheatgrass (*Bromus tectorum*)

Historical distribution



Current distribution



Species: Gypsy moth (*Lymantria dispar*)

4a. Briefly describe the native range of this species. /1

4b. Briefly describe the current range of this species. /1

4c. How was this species initially introduced into its new range? /1

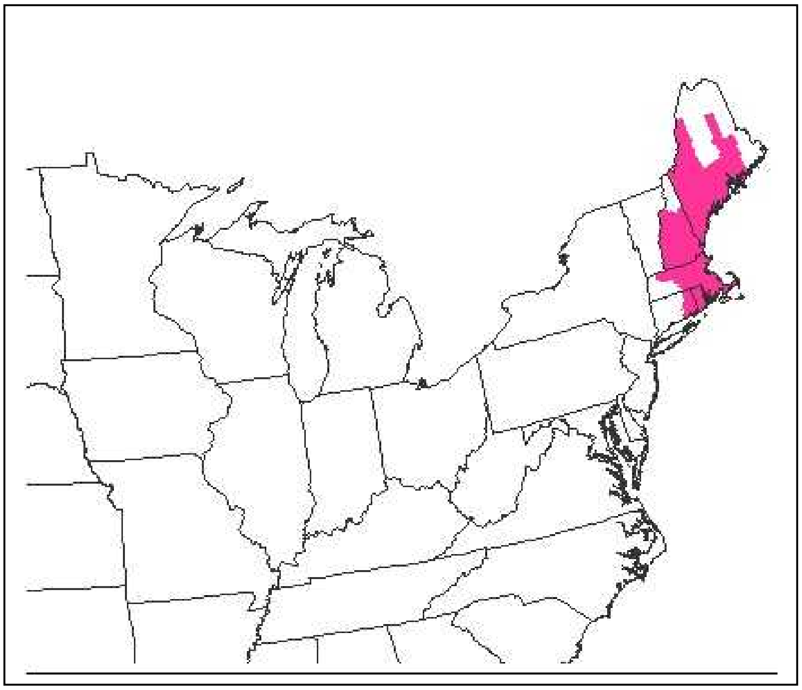
4d. Describe (in detail) how this species has managed to expand its range. You should consider such aspects as its physiology, reproductive capabilities, propagule dispersal, environmental adaptability, etc. /8

4e. What are the threats this species poses to integrity of the ecosystems it has invaded? /4

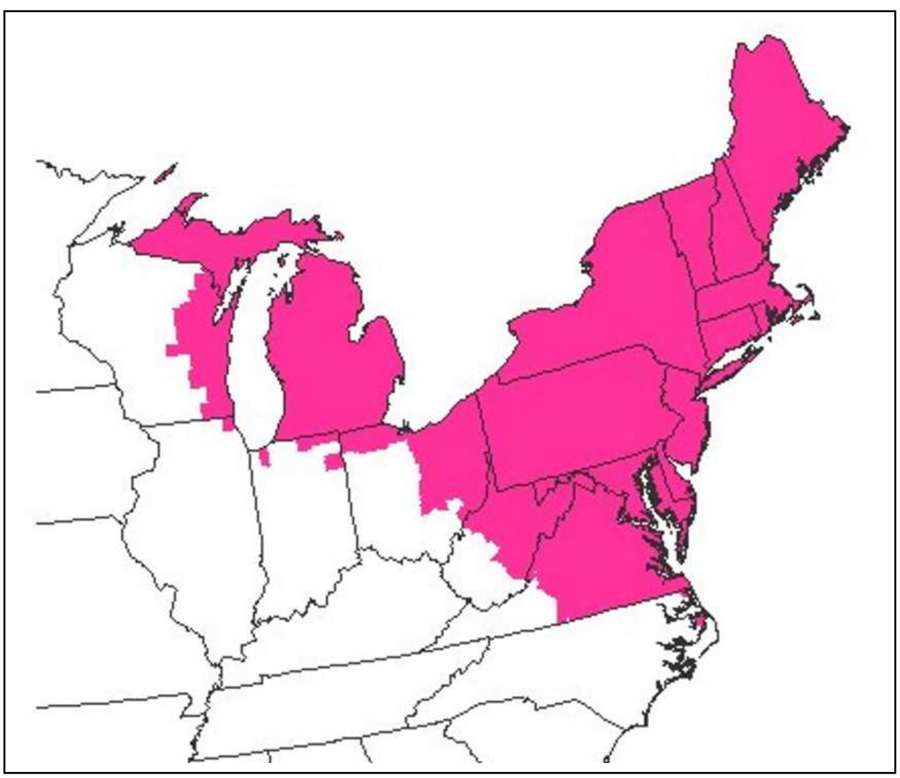
4f. Overall, why is this species so successful in its new range? /2

Gypsy moth (*Lymantria dispar*)

Range in 1914



Range in 2002



Species: European Starling (*Sturnus vulgaris*)

5a. Briefly describe the native range of this species. /1

5b. Briefly describe the current range of this species. /1

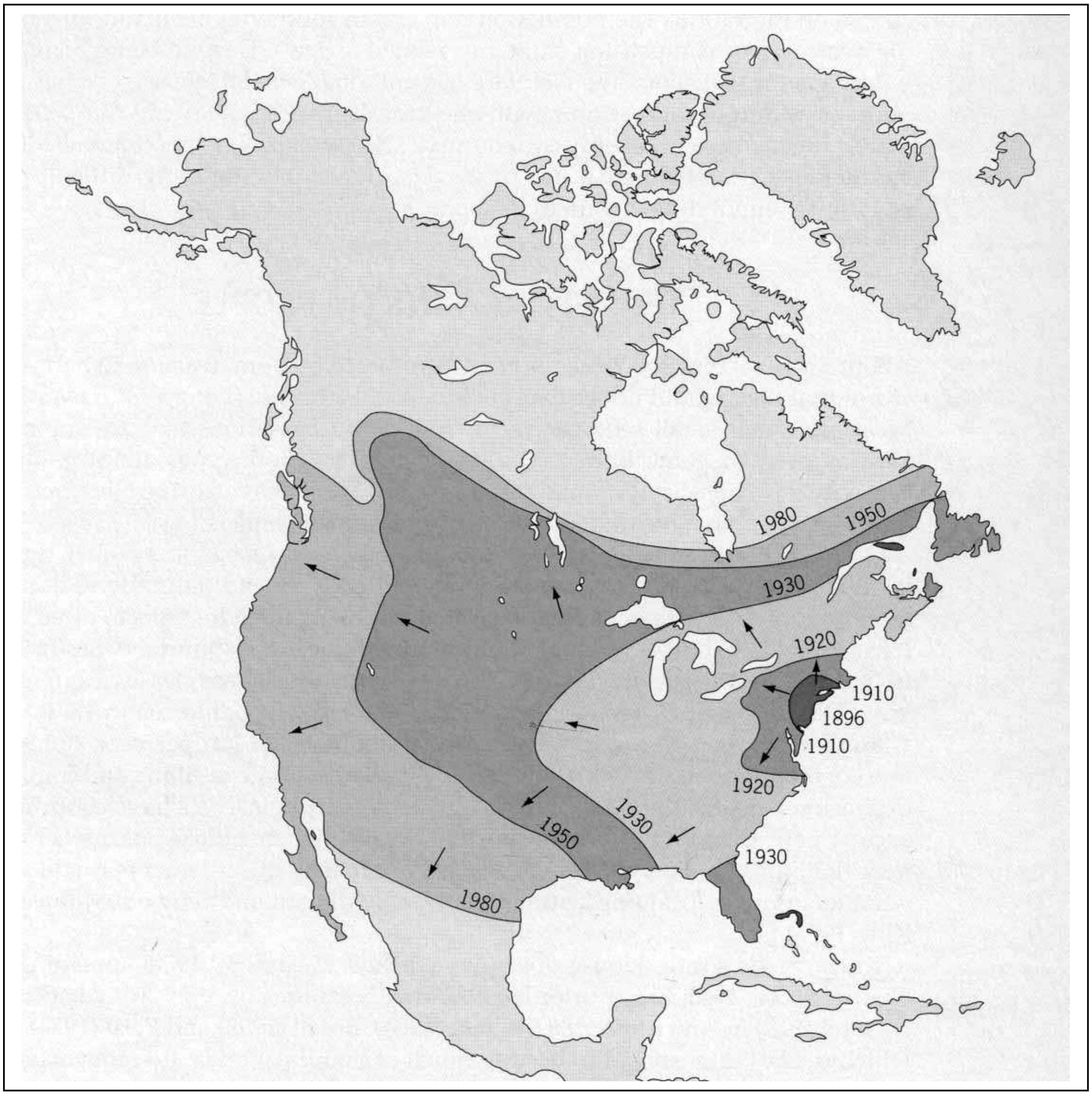
5c. How was this species initially introduced into its new range? /2

5d. Describe (in detail) how this species has managed to expand its range. You should consider such aspects as its physiology, reproductive capabilities, propagule dispersal, environmental adaptability, etc. /6

5e. What are the threats this species poses to integrity of the ecosystems it has invaded? /4

5f. Overall, why is this species so successful in its new range? /2

European Starling (*Sturnus vulgaris*)



Species: Zebra mussel (*Dressena polymorpha*)

6a. Briefly describe the native range of this species. /1

6b. Briefly describe the current range of this species. /1

6c. How was this species initially introduced into its new range? /1

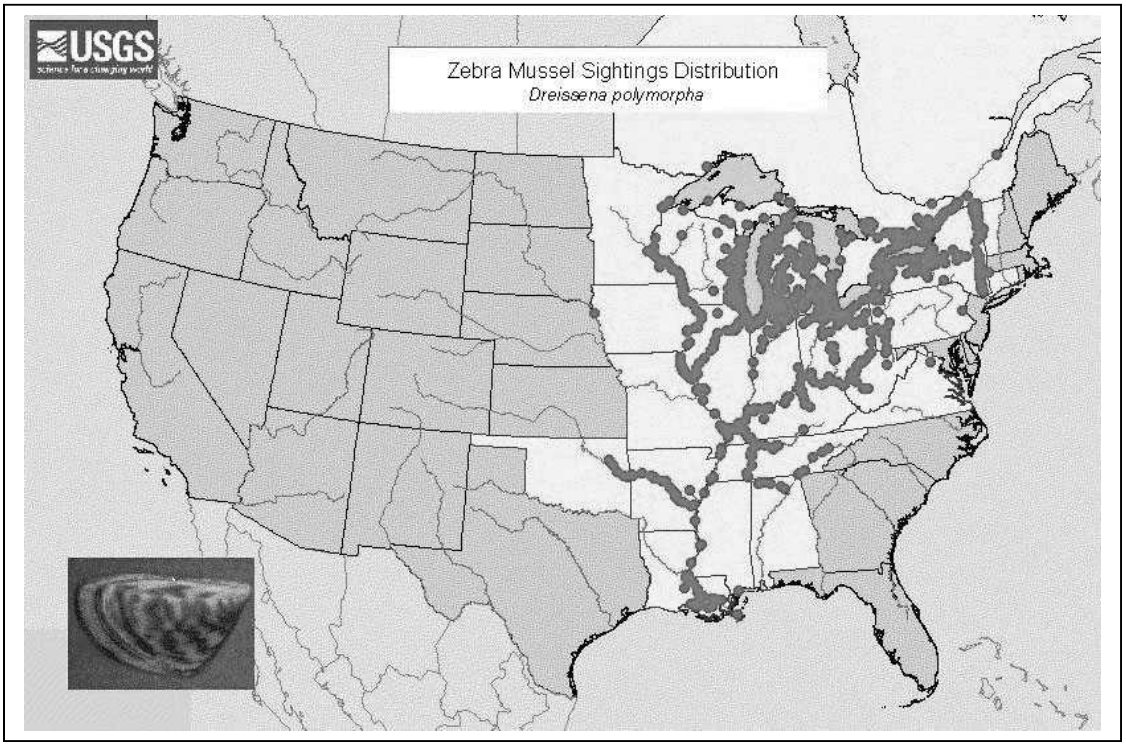
6d. Describe (in detail) how this species has managed to expand its range. You should consider such aspects as its physiology, reproductive capabilities, propagule dispersal, environmental adaptability, etc. /6

6e. What are the threats this species poses to integrity of the ecosystems it has invaded? /4

6f. Overall, why is this species so successful in its new range? /2

Zebra mussel (*Dressena polymorpha*)

Zebra mussel distribution in 2002.



7. Of these six species, explain which one(s) you believe is/are the best colonizers, and why they are more successful invasive species than the others. /10

Lab 6 – Speciation

Background
The principle method through which evolution of species occurs is natural selection, which works as follows: a population of a particular species contains at least some variation from one generation to the next and as long as this variation is at least partly heritable, and that variation results in higher levels of survival and subsequent reproduction, then those individuals with that variation will reproduce at higher rates than other members of the population who do not have that trait. The end result is that the population will evolve in a process of "descent through modification".

This heritable trait must have two characteristics:
- it must be passed through the generations, and
- it must be useful in that it increases the individual's chances of surviving long enough to successfully reproduce.

The longterm result of this process is a species which is increasingly successful at surviving given:
- the physical (abiotic) characteristics of its environment, and
- competition (both inter- and intraspecific) from other organisms.

The term "survival of the fittest" then refers not to the biggest and meanest animals, but to those individuals who are best able to adapt and survive, given the biotic and abiotic conditions during its lifespan.

The Snail and the Biologist
In the 1980's, a biologist named Robin Seeley was studying populations of the flat periwinkle, a small (~1cm long) marine snail which lives in the intertidal zone along the New England coast. One of this snail's main predators is the European green crab, an invasive species introduced to the eastern coastline of North America in the early 20th century. As the range of this crab expanded along the coastline over the 20th century, the flat periwinkles were suddenly faced with a new predator it had never dealt with before.

Robin Seeley found a museum collection of flat periwinkles which were collected at Appledore Island (near Cape Cod, Massachusetts) in 1871, prior to the introduction of the European green crab. She compared those museum shells to ones she collected at the same site during 1982-84. Using measurements of shell thickness and the height of the spire, she found that the 1980's population was significantly different in size than the population which was present one hundred years previously: the spire heights were shorter and the shells were thicker.

In this lab session you will run a digital experiment called EvoDots, a program which simulates the basic mechanism of evolution: descent with modification. This program demonstrates the basic procedure through which the evolutionary process occurs.

Objectives

The objectives of this lab are:

- to examine how hypothetical populations of organisms evolve through the process of descent with modification.
- to hypothesize how this process may occur in natural populations of organisms.

Biogeographic concepts

- evolution of specific traits through natural selection.
- range expansion through the evolution of traits which favour the ability to survive in more, or different, habitats.
- range contraction through the inability to compete with those species whose survival ability has increased through evolution.

Technical skills

- ability to critically evaluate how changes in the physiological and/or morphological traits of a species would aid in the longterm survival of that species.
- ability to click a computer mouse with hyperactive speed.

Relevance of this lab to the lectures

This exercise will provide a hands-on demonstration of the very simple ways in which species can change over generational time. Since biogeography is a "fluid field" in that the number and distribution of species is constantly changing, the subject of evolution is important as it illustrates how the 20^{th} century came to have its current number and types of different organisms.

Relevance of this lab to professional science

Scientists are constantly finding new species that have never been described or catalogued. Many of these new species can be taxonomically pigeon-holed into the existing Linnean classification system. However, every so often, some bug or beast is discovered which defies easy description and results in questions about its ancestry and how it evolved. Understanding how evolution works helps scientists understand why the earth has the species it does, how those species have changed over time and how they may change in the future. And understanding how these species came to exist is a basic step in determining their place within the overall functioning of the biosphere.

Due date

This lab exercise is due at the end of the lab period.

Procedures

Working in groups of 2-3 students, you will be using the laptops to run experiments using the EvoDots program. EvoDots lets you explore evolution by simulating natural selection in a population of dots.

The EvoDots program is located on the R Drive on the AUC network. Copy the EvoDots file onto the desktop of your laptop computer. (It will automatically be deleted from your machine the next time the computer is rebooted).

Open the program and click on the Welcome screen to get rid of it. Expand the program window to full screen size. The EvoDots window contains three white areas, three buttons, and three small square check boxes. Click on the small triangle in the upper right corner to open a fourth white area.

The four white areas show:

- the predation field (left side).
- the starting and current population numbers (middle).
- the generations (right side).

Make sure that all three square check boxes are checked and that the name in the title bar reads "Darwin's Theory". Under the *File* menu, select *Options*. Click to select size as the characteristic in which the dots vary, then click *Okay.*

Now click on the *New Population* button. This creates a new population of 50 dots, scattered at random across the predation field on the left. Note also that the white area on the upper middle right now contains a graph showing how many dots of each color (and size) are in your starting population.

In the EvoDots simulation, you will be a predator on the dots. Think of it as a situation in which you are a sandpiper on a sandy beach. The dots are insects which you are going to eat, as soon as you can catch them. The mouse pointer is your beak and you "eat" each bug (dot) by clicking on the dot.

Click on the *Run* button, which will set the dots in motion. As you use the mouse pointer to "eat" the dots, the counter just beneath the field will show how many dots are remaining.

To play your role correctly, you must act like a hungry predator. Don't just wait for the dots to come to you, go after them! However, keep in mind that you must act like a sandpiper. When sandpipers are trying to catch a bug, they will run up to it and stab at it with their beak, using as few stabs as possible to eat one bug. You may be tempted to just click the mouse as fast as possible, but this would mean the sandpiper's head would be moving up and down at the same rate as an industrial sewing machine. A rate of two clicks per second should be about right.

When you click on a dot successfully, it first turns red, then disappears. Eat 25 dots as fast as you can (note the display that tells you how many dots are left), then click on the *Stop* button.

When you click the *Stop* button, the dots stop moving and the white area on the lower right displays a histogram showing the distribution of colors representing the surviving dots. Compare this graph to that of the starting population (immediately above it).
The white area on the right will show a data matrix which corresponds to the data illustrated in the population graphs (g = generation). It will also show the numbers at the start of each generation and the number of each dot size remaining after you eat 25 of them, for all generations of the simulation run.

Now click on the *Reproduce* button. Each of the survivor dots splits into two daughter dots. Note that each mother dot splits to become two daughter dots that are identical in color and size to each other and to their mother (who now no longer exists). This is analogous to the asexual reproduction of organisms like bacteria and paramecia. Click on the *Run* button again, and eat 25 more dots as fast as you can. Click on the Stop button to compare this new crop of survivors to the starting generation.

Play around with the program for a few minutes to become familiar with it before you begin the experiment.

Information Sources

Herron, J.C. 2001. EvoDots 1.0. Evolution simulation software for evolutionary analysis. Location: http://faculty.washington.edu/~herronjc/SoftwareFolder/EvoDots.html. Accessed : March 9, 2005.

Seeley, R. H. 1986. Intense natural selection caused a rapid morphological transition in a living marine snail. *Proceedings of the National Academy of Sciences, USA* 83: 6897-6901.

Lab 6 – Speciation

Name ____________________________

Mark ________ **/70**

Using the EvoDots program, you will run several simulations and answer the accompanying questions.

Evolution with variation

EvoDots set-up: dots vary in size; size of dots is variable and heritable (boxes are checked). Procedure: run through 8 generations of this simulation, eating 25 dots before each reproductive cycle.

1. Before proceeding, make a prediction about how the population of dots will evolve in response to predation, and explain your reasoning. /2

2. After the first generation, compare the survivors to the starting population. Has the distribution of colors changed? How? /2

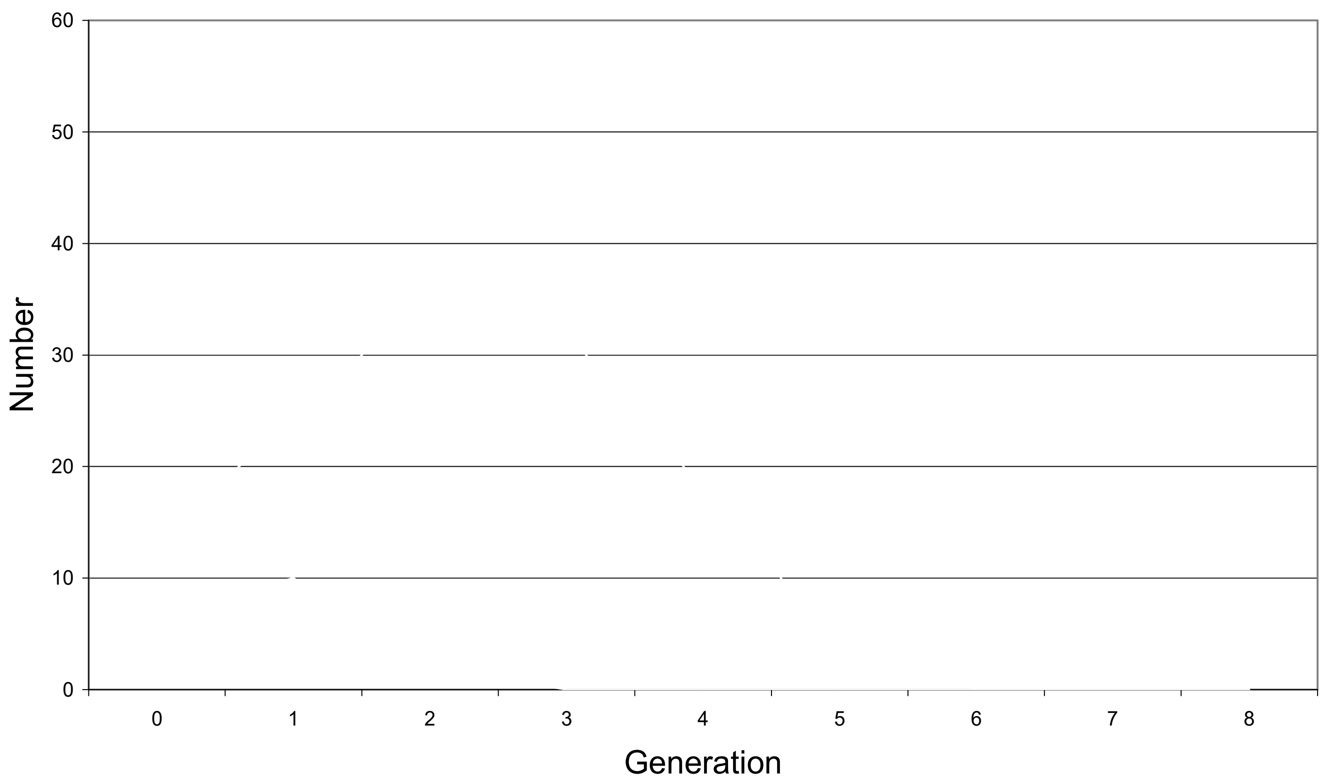
Complete 8 generations and record the data in Table 1. (Use the numbers after each reproductive cycle). Illustrate this data by making line graphs in Figure 1. (You don't need separate colours for each species). /5

3. What has happened to the population of the seven species? How has the distribution of the species within the ecosystem changed? /4

Table ____

Generation	Species 1	Species 2	Species 3	Species 4	Species 5	Species 6	Species 7
0							
1							
2							
3							
4							
5							
6							
7							
8							

Figure 1 ________________________________



4. Was the prediction you made in #1 above correct? Why or why not? /5

Now repeat the above procedure but this time without heritability. Make sure the check box "Size of dots is heritable" is not checked.

5. Do you think the population of dots would evolve if there were no variation in the starting population? Write down a prediction, and explain your reasoning. /2

6. After the first generation, compare the survivors to the starting population. Has the distribution of colors changed? How? /2

Complete 8 generations and record the data in Table 2. (Use the numbers after each reproductive cycle). Illustrate this data by making line graphs in Figure 2. (You don't need separate colours for each species). /5

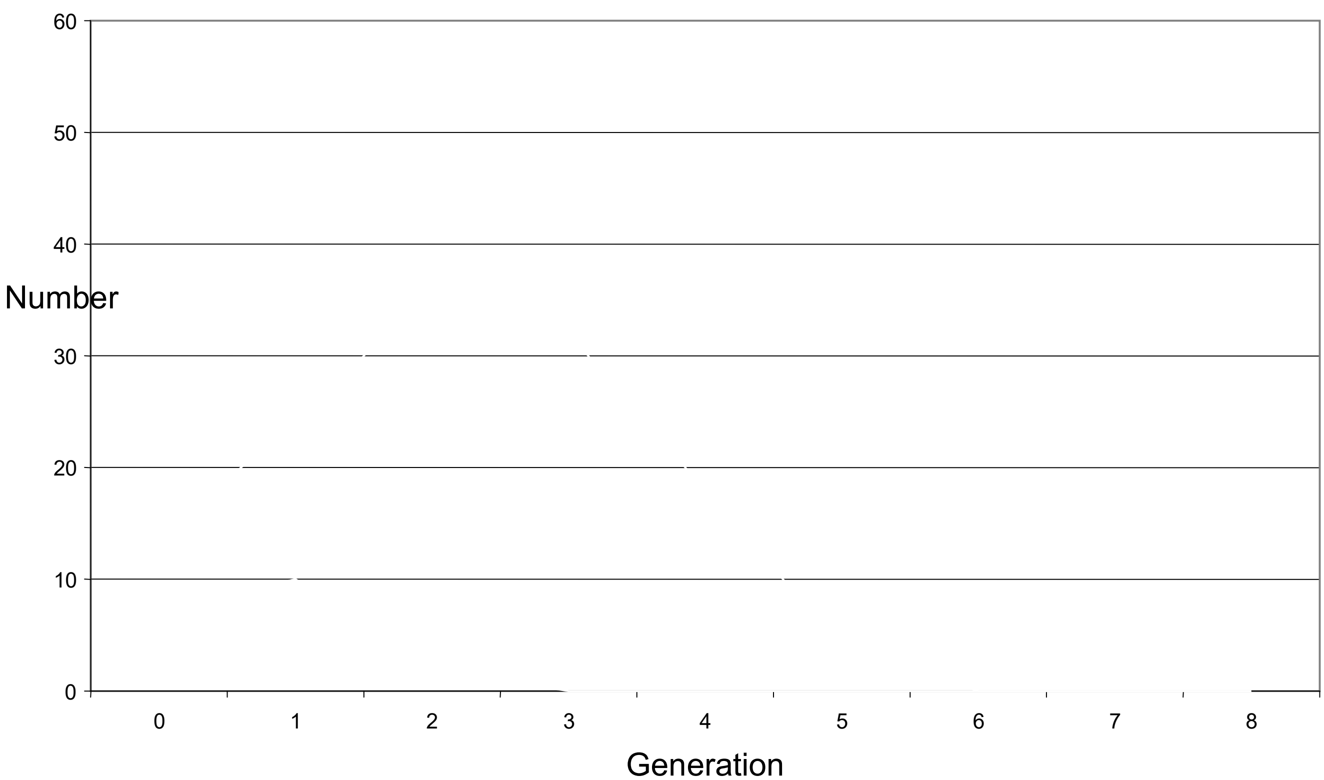
7. What has happened to the population of the seven species? How has the distribution of the species within the ecosystem changed? /5

8. What importance does the role of heritability play in the predation scenario? /5

Table 2 ____

Generation	Species 1	Species 2	Species 3	Species 4	Species 5	Species 6	Species 7
0							
1							
2							
3							
4							
5							
6							
7							
8							

Figure 2 ___________________________________



9. Which species best demonstrates "survival of the fittest"? What does this imply for the evolution of that species? /3

"Evolution" with no variation

EvoDots set-up: dots vary in speed; speed of dots is variable and heritable (boxes are checked). This will give you dots that have the same size but vary in speed.

10. Before proceeding, make a prediction about how the population of dots will evolve in response to predation, and explain your reasoning. /2

11. Complete 8 generations. How does the 8th generation population compare to the original population? What effect has predation had on this population? /4

12. Until now, when you have eaten dots you have done so selectively. Because faster dots are harder to catch, the slower dots are much less likely to survive than the faster dots. If you were to eat the dots at random, instead of selectively, do you think the population would still evolve? Write down a prediction and explain your reasoning. /4

Now start a new population but with the "Survival is selective" box <u>not</u> checked. Create a new population (in which size is variable and heritable). Click the *Run* button and eat 25 dots. Notice that when you click the mouse button, you don't kill the dot you are pointing at, but a dot selected at random. (In fact, clicking anywhere inside the EvoDots window will kill a randomly selected dot).

13. Complete 5 generations of random predation and reproduction. Does the population of dots evolve? If so, does it evolve in the same way it does when survival is selective? Was your prediction in Q.12 correct? /5

Back to the flat periwinkles

Robin Seeley hypothesized that the flat periwinkles of Appledore Island evolved by Darwin's mechanism of descent with modification.

When the European green crabs arrived on the east coast, they started eating most of the thin-shelled snails. This left almost nothing but the thick shelled ones to reproduce. And when the thick-shelled survivors reproduced, they had thick-shelled offspring. The end result is that the composition of the population changed.

Seeley performed a field experiment to test her hypothesis. She drilled small holes in the shells of a number of snails, and used fishing line to tether the snails to seaweeds in the intertidal zone. She then returned every few days to see which snails survived. This method allowed Seeley to distinguish between snails that were killed by crabs, part of whose crushed shells remained tied to their tethers, from the few snails that broke free of their tethers or died in their shells. She tethered the snails in pairs, with each pair including one thin-shelled snail and one thick-shelled snail. Seeley tethered snails in the following groupings:

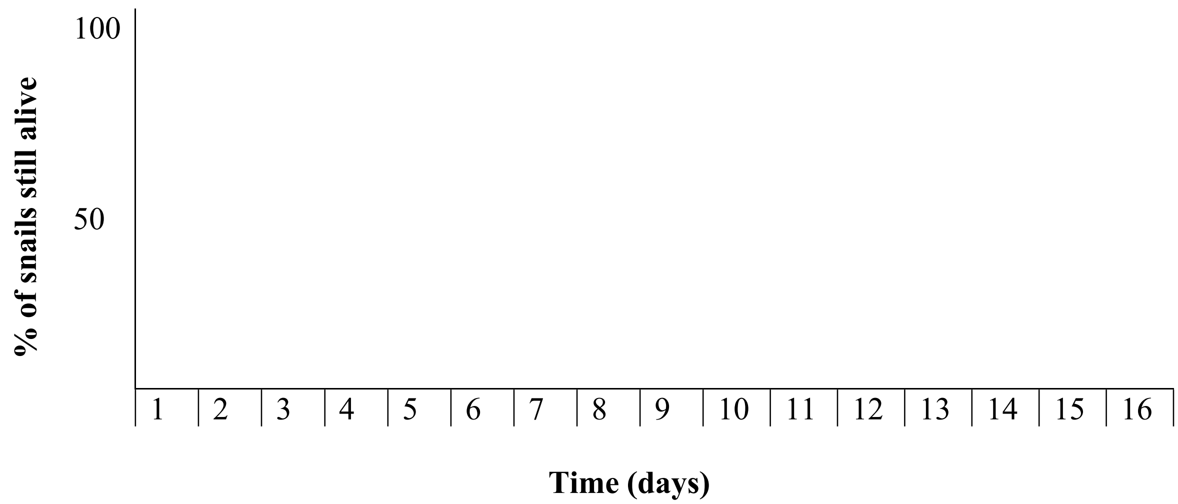
- 15 pairs at Timber Cove, where the crabs were absent.
- 15 pairs at Sipp Bay where the crabs were present but rare.
- 15 pairs of snails at Gleason Point, where the crabs were common.

She checked on the snails after 6, 9, and 16 days to determine predation rates on the snails.

Based on the lessons you have learned with the EvoDots simulations, fill in the three graphs below with hypothetical lines illustrating what you believe happened to each population of snails in each location of Robin Seeley's field experiment. Each graph should have two lines, one for each snail type.

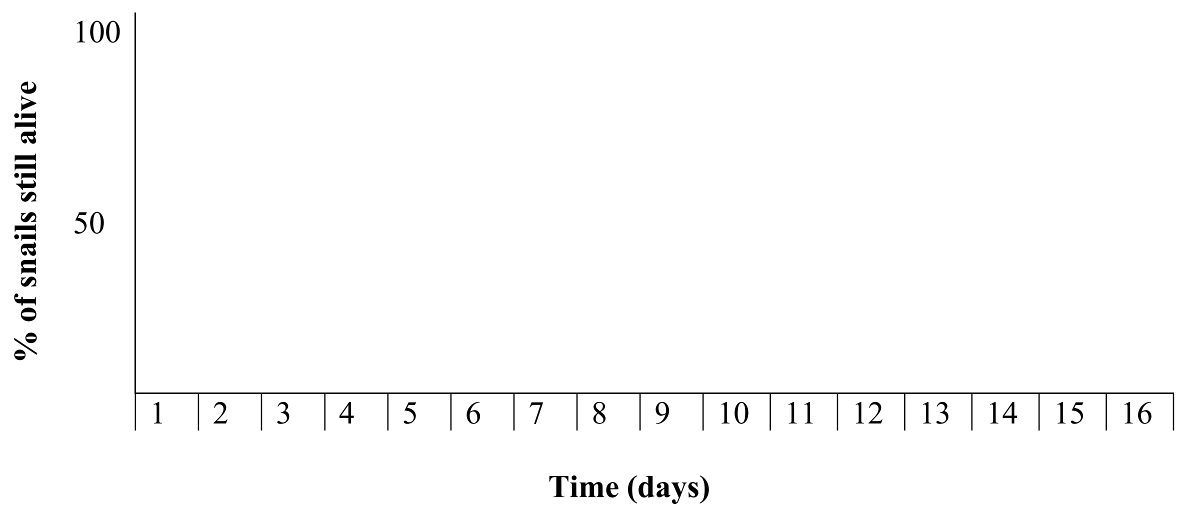
Timber Cove

/5



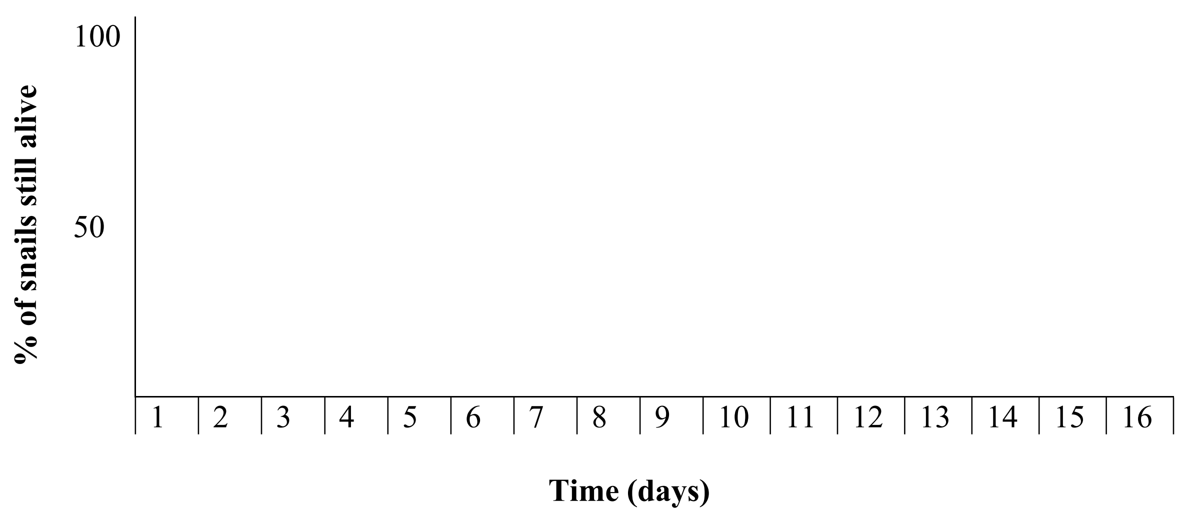
Sipp Bay

/5



Gleason Point

/5



Lab 7 – Biodiversity and Island Biogeography

Background
Biodiversity is the number and kinds of organisms in a given area. Although that may seem like a very simplistic definition, it is a very important one because much of biogeography can be directly associated with the concept of biodiversity.

Biodiversity is also the basis for the theory of island biogeography, which suggests that there is a strong relationship between the size of an area and the levels of biodiversity within that area. This theory, first proposed by Robert MacArthur and Edward Wilson in 1967, has received a great deal of attention over the past 30 years as scientists attempt to explain the patterns of biodiversity seen across the planet.

Objectives
The objectives of this lab exercise are to:
- examine variations of biodiversity according to geographic size of an area.
- examine the basics of island biogeography.

Biogeographic concepts
- species-area curves.
- island biogeography

Technical skills
- retrieving data from the internet
- interpretation of statistical analysis of biodiversity trends.

Relevance of this lab to the lectures
The first part of the course looked at many of the ecological and geographic processes which allow diverse species to co-exist or which drive them apart. The end result of this source of dynamic tension is that different ecosystems have different levels and kinds of biodiversity, and the biodiversity varies over time.

Relevance of this lab to professional science
Within the realm of academic research, biodiversity holds a pre-eminent position in that much of the ecological literature of the past two decades has been devoted to not only describing the biodiversity of various ecosystems but in trying to determine the biotic and abiotic factors which control biodiversity.

It is this search for answers to basic questions about biodiversity which lead scientists to conclude that, while nobody would dispute the importance of biodiversity in areas such as the Amazon rainforest or the Great Barrier Reef, scientists were missing a large part of the global biodiversity puzzle: the northern boreal forests.

The diversity of the boreal forest in North America and Eurasia is much higher than was first believed and research is being conducted to understand the reasons for this high biodiversity and the role it plays in the functioning of the global biosphere. This last point is especially important for two reasons:

- many species use two completely different biomes during their yearly cycle, i.e. neotropical migrants who breed in the boreal forest but winter in tropical and sub-tropical regions. Changes to the ecosystems in either of these two regions will impact biodiversity in the other.
- the impact of climate change. The current belief is that enhanced climate warming due to anthropogenic activities will have a detrimental effect on all ecosystems, and subsequently, their biodiversity levels.

Government scientists require detailed knowledge about biodiversity as it is the foundation for determining the political status of an area, i.e. ensuring that areas with high biodiversity are adequately protected.

Due date

This lab exercise is due at the end of the lab period.

Procedures

You will need the laptop computers for both acquiring data from internet sites and for doing some statistical analyses.

Procedures.

For this exercise we will make use of an extensive database on the flora and fauna on lands within the US National Park Service. These lands include National Parks (NP), National Recreation Areas (NRA), National Monuments (NM), and National Historic Sites and Places (NHS and NHP). You can use this database to test two fundamental aspects of island biogeographic theory:

a. Species richness should be a positive linear function of park size. In other words, if we plot the number of species in US Parks versus the area of the parks, we should be able to fit a straight line through the slope, and the line's slope should be positive.
b. If we compare data from mainland and island parks, the relationships between area and species richness as defined by a least squares regression analysis should be positive for both, but the intercept point for the regression line should be different.

The database is entitled NPFAUNA and can be accesses interactively through the Internet at http://ice.ucdavis.edu/nps/.

The title of this web page is "*Species in Parks - Flora and Fauna Databases*". At the bottom, you will find the link "Search database by park name". This link will take you to the complete list of parks.

When you first open the link for a specific park, you will see some cursory information on the park, including its area. There are also links for a series of taxon-oriented groups (amphibians, mammals, etc.). If you click on any of these buttons, you will generate a list of all the species in that taxonomic group that occur in the park. This is how you will obtain your two key data points: park area and species richness.

Regressions

One way to examine species-area curves is through the use of least-squares regression statistics. The basic method of a regression is that a "best fit" line is drawn through a set of data points, which indicates the type and strength of the relationship between two variables.

Regression lines can be used as a way of visually depicting the relationship between the independent (x) and dependent (y) variables in the graph. A straight line depicts a linear trend in the data, using the formula $y = ax + b$, where

y = dependent variable.
a = slope of the regression line
x = independent variable.
b = intercept.

In addition to visually depicting the trend in the data with a regression line, you can also calculate the equation of the regression line. How well this equation describes the data (the 'fit'), is expressed as a correlation coefficient, R^2 (R-squared). The closer R^2 is to 1.00, the better the fit.

Insert long-winded explanation of regression methods in Excel spreadsheets here, or just wait until the lab period and the instructor will demonstrate how it is done.

Lab 7 – Biodiversity and Island Biogeography

Name ____________________________

Mark ________ **/73**

1. Using the "*Species in Parks - Flora and Fauna Databases*", enter the data for Table 1, which is for mainland parks. Provide a complete title for the table. ___/5

2. Using the "*Species in Parks - Flora and Fauna Databases*", enter the data for Table 2, which is for island parks. Provide a complete title for the table. ___/5

3. Using Excel, enter your data from Tables 1 and 2 into separate spreadsheets. (Note: remember to save the files once you have the spreadsheets made, and before working on the data analysis part of the lab. Otherwise, you know what will happen…).

4. Perform a regression analysis on the three taxa for both the mainland and island populations and complete the three figures as follows:

- for each figure, include the regression line and the logarithmic trend-line for the mainland populations and the island populations.
- include a legend.
- include a title.
- include the complete regression equation for both mainland and island populations.

Figure 1: plants _____/10

Figure 2: Poaceae _____/10

Figure 3: mammals _____/10

Plants: includes all vascular plant species.
Poaceae: the family which includes many of the graminoid (grass) species.
Mammals: includes all mammal species.

Table 1 ____

		Number of species		
Park	**Area (ha)**	**Plants**	**Poaceae**	**Mammals**
George Washington Birthplace NM				
Valley Forge NHP				
Obed Wild & Scenic River				
Colonial NHP				
Mammoth Cave NP				
Big South Fork NR/NRA				
Shenandoah NP				
Great Smokey Mountains NP				
Everglades NP				

Table 2 ____

		Number of species		
Park	**Area (ha)**	**Plants**	**Poaceae**	**Mammals**
American Memorial NP				
NP of American Samoa				
Kalaupapa NHS				
Haleakala NP				
Hawaii Volcanoes NP				
Channel Islands NP				

Figure 1 ______________________________

Regression equations

Mainland

Island

Figure 2 ____

Regression equations

Mainland

Island

Figure 3 ____

Regression equations

Mainland

Island

The logarithmic line is the species-area curve.

5. What does the species-area curve indicate about the biodiversity of plant species on islands as compared to the mainland?   ____/3

6. What does the species-area curve indicate about the biodiversity of Poaceae species on islands as compared to the mainland?   ____/3

7. What does the species-area curve indicate about the biodiversity of mammal species on islands as compared to the mainland?   ____/3

8. Overall, what does the species-area curve indicate about the biodiversity of islands vs. mainland areas?   ____/6

9. Using the information from the regression equations, which area has a stronger influence on the diversity of plants: islands or the mainland? Explain why you think this? ____/3

10. Using the information from the regression equations, which area has a stronger influence on the diversity of the Poaceae: islands or the mainland? Explain why you think this? ____/3

11. Using the information from the regression equations, which area has a stronger influence on the diversity of mammals: islands or the mainland? Explain why you think this? ____/3

12. What does the y-intercept indicate about the differences in biodiversity between island and mainland sites? ____/3

13. From all of the above information, what conclusion can you draw about the effect that islands (whether actual islands surrounded by water) or discrete islands of habitat on a mainland (such as a park or natural area) have on how humans should protect biodiversity? ____/6

Lab 8 – Human effects on biogeography

Background
It is a commonly accepted fact within the academic community that we are now living in a period that can be accurately characterized as a mass extinction event. As with similar events in past earth history, it is a time when large numbers of species, representing the entire breadth of global biodiversity, are in danger of becoming extinct. The difference this time is that the cause is not global climate change or some large-scale cataclysmic event; it is due directly to the effects of human activity.

Intense efforts are being made by many individuals and agencies to conserve the high level of biodiversity on our planet. This is especially true with the very rare and endangered species as they are the ones most at risk of imminent extinction. Some of these efforts have succeeded, as was the case with the Peregrine falcon. But unfortunately, many species will pass from history without our having even become familiar with them.

With a current population of 6.5 billion and an ever-expanding appetite for energy and natural resources, humans are having a greater impact on the biodiversity of the planet than any other single factor since the last great extinction event at end of the Cretaceous Period.

Objective
The objective of this exercise is to examine the effects of anthropogenic activities on the biogeography of an important and endangered species.

Relevance of this lab to the lectures
In order to fully understand the effects that humans have on wild species, it is necessary to consider the entire field of biogeographic thought. This includes such things as species richness, physical and biological interactions, the role of dispersal, evolutionary traits and geographic distribution patterns.

Applying this body of knowledge to a single species will allow you to better understand the factors causing the decline of its population and what actions are required to preserve this species.

Relevance of this lab to professional science
As with the paper you wrote for lab 4 (*Biogeography of a species*), you will be following the same path taken by scientists and environmental managers over the past half century: before determining how best to preserve a species, you must understand the characteristics and life history traits of that species.

Lab procedures
For this lab, you will be writing a research paper on a single endangered species. The objective is to examine those biogeographic characteristics of this species which have rendered it susceptible to severe population decline due to human activities. You must also determine which aspects of its ecology, morphology, physiology, behaviour, etc., need to be understood before something like a species conservation plan can be devised and implemented.

This research paper is worth 10% of the final course mark and is due on Friday, April 8, in class.

Your assigned species is ______________________ (It can be found in the file titled "Lab 8 - Endangered species list" on the course website).

Paper format

Your paper should be structured as follows:

1 Introduction – outline the objectives of your paper; thesis/purpose statement.
2 Discussion – the analysis of your topic.
3 Conclusion – present your conclusions regarding the objectives you stated in the introduction.
4 Literature Cited – all information sources, references, etc., need to be included.

Discussion

The discussion section of the paper must include the following four sections.

1. Natural history of the (*species name*)

A detailed description of the species and its ecological requirements. Include relevant details about its:

- habitat requirements.
- reproductive capability.
- seasonal variations in niche, range, food preferences, habitats, etc

Include enough detail to make the reader cognizant of the important aspects of this species' natural history and its ecological niche.
Include a detailed description of its traditional range, i.e., before human intervention. What biotic and abiotic factors were influencing this range? Why did those range limits exist (climate, topography, etc)?
Include a map of the traditional range.

2. Current status

What is the official status of this species: threatened, endangered, etc.?
Is this status consistent throughout its range?
What are the biotic/abiotic determinants which resulted in this status?
What were the major human activities which resulted in the species being listed as threatened/endangered?
Were any environmental (i.e. non-human) perturbations also contributing to the rarity of this species?
Include a detailed description of its current range.
Include a map of its current range.

3. Ecosystem status

What is the position of this species within its undisturbed ecosystem, i.e. trophic level, realized niche, etc.?

How will the ecosystem and the other species within it be affected by the extinction of this one species?
Are there any other species which can take over the niche of this species should it go extinct?
How will the range of its competitor species change as a result of the extinction of this one species?

4. Conservation needs
How is the dispersal ability of this species hindering its continued population viability?
How is the reproductive ability of this species hindering its continued population viability?
Has a population viability analysis been done for this species? If so, what is the minimum viable population size for this (or a similar) species?
Which SLOSS strategy is considered optimal for the preservation of this species?

Conclusion
The conclusion should address your personal assessment, based on the information in your paper, about whether the species in question will survive to the end of the 21st century or become extinct.

References
In addition to information that is found exclusively on the internet, you must include at least five (5) refereed publications (academic textbooks, scientific journal articles), although you will probably use more than that.

You must cite the sources of all information used in this report, using a standard citation format. In this course (as in all biology, geography and environmental sciences courses at the Augustana Faculty) citations will follow the Council of Biology Editors (CBE) style, as outlined in:

Pechenik, J.A. 2004. A short guide to writing about biology. Pearson-Longman, NY. 302p.

This short paper should describe all situations you will encounter regarding the wide variety of references in print (paper and digital). A copy of it is provided in Appendix II of this lab manual. References must be provided for both written literature and web references.

Some good websites with information about citations include:
Augustana Faculty Library
http://www.library.augustana.ca/citation.html

University of Wisconsin-Madison
http://www.wisc.edu/writing/Handbook/

San Francisco State University
http://www.library.sfsu.edu/instruction/guides/citref.html#ecite)

Plagiarism
Research work in academia and industry is based on previous work done by other people. Scientist A discovers something, which leads scientist B to discover something else, which in

turn, allows scientists C through Z to advance their own work. In fact, this is the entire basis for advances in human endeavour in just about every field.

So, it is inevitable that you will have to incorporate the work of other people into your research paper. And it is perfectly acceptable to do so, **but only if you acknowledge their work**. Using someone else's ideas, words, data, research, etc., in your paper without providing the credit to this person is a form of literary theft known as **plagiarism**.

Plagiarism is a growing problem in universities, whether a student does it knowingly or by accident. Either way, the university has a very low tolerance towards plagiarism. For more information on this policy, please see the Code of Student Behaviour, which can be found at section 30.3.2(1) of the University of Alberta Calendar.

There is a very simple way to avoid any problems in this regard: simply provide a citation (in the Literature Cited section) for each reference, idea, data, etc., you use in your paper. If you are uncertain about whether you are straying into the dreaded plagiarism minefield, please feel free to talk to me about it. If you are unsure about how to cite articles, books, journals, etc., I will be happy to show you how it's done.

Format of the paper

- Length: 1500 - 1800 words (include word count on title page).
- Paper is to be typed, double-spaced on one side of the page, on letter-sized paper; one inch margins; paginated.
- Separate page for Literature Cited section.
- Title page with your name and student ID number.
- The maps and any other diagrams, figures, tables, etc., you choose to incorporate can be appended to the end of the paper.

How this paper will be graded

There are a number of things I will be looking for when grading this paper:

1 Completeness – how thorough is your discussion of the topic.
2 Information sources – authority of the source materials; the variety of sources.
3 Clarity – is the paper well organized and the material clearly presented?
4 Style – good grammar and syntax.
5 Writing - clear, concise writing; no deadwood; sticks to the topic (is well focused).

Marking scheme for this paper:

Section	**Mark**
Introduction	5
Natural history of the species	10
Current status	10
Ecosystem status	10
Conservation needs	10
Conclusion	10
Literature Cited	15
Total	**70**

Appendix I - BIO/GEO 351 Biogeography

Winter Term 2005

Instructor:
Office:
Telephone:
E-mail: @ualberta.ca
Office hours:
Course website:

CLASSES
Lectures:
Location:

Labs:
Location:

CALENDAR DESCRIPTION
Analysis of the spatial patterns of biotic systems and species. The course examines the past and present distribution patterns of species assemblages in the context of biological and ecological processes as well as human impacts. The course employs several methods of analysis, including geographic information systems.
Prerequisite: BIO 251.

COURSE OBJECTIVES
Biogeography is the science which examines the spatial distribution of all living species on earth and the underlying causes of those distributions. We will examine these spatial distributions at scales ranging from the local to the global, as they are influenced by a wide range of causal factors. Students will develop an understanding of the physical factors (climate, glaciation, topographic barriers, etc) and the biological factors (speciation, competition, succession, dispersal, migration, invasion, etc) which have contributed to large-scale geographic patterns of life on earth.

Biogeography studies not only the spatial but also the temporal distribution of biota and as such, relies heavily on theory from evolutionary and population biology, systematics, physiology, the earth sciences, and, of course, geography. As an assemblage of several discreet but related systematic and integrative studies, biogeography is a true interdisciplinary science.

The goal of this course is to advance student understanding of local, regional, and global biogeographic patterns and their underlying processes. The effects of human activities on biotic distributions will also be discussed. The lab/research component of this course is quite important and will address the quantitative aspects of biogeographic research through the use of local examples.

Learning outcomes

At the completion of this course, students will be able to:

- articulate an understanding of the discipline of Biogeography, and describe and explain its theoretical and applied significance.
- provide appropriate explanations for categories of spatial and temporal distribution shown by plants and animals at different taxonomic scales.
- understand the major factors which have shaped and changed the "Earth as habitat", and how adaptation and biodiversity have responded to those changes through time.
- understand how environmental factors influence biodiversity, distributional patterns, adaptation, migration, rarity and endemism.
- develop an acquaintance with research methods in biogeography.
- explore, in depth, the distribution of a particular group of organisms.
- develop familiarity with library and Internet resources in biogeography.
- have the opportunity to improve their writing skills.

STRUCTURE AND FORMAT OF THE COURSE

The format of this course will consist of classroom sessions of formal lectures, with accompanying laboratory exercises and research projects.

Critical, constructive discussion is welcomed, and you should feel free to participate by questioning assumptions: the instructor's, those of other students in the class, and – perhaps most importantly – your own. Feel free to ask questions at any time, inside or outside of class times.

GRADING

	Value (%)	**Date handed out**	**Date due**
Labs	6 labs @ 5% each	in lab	in lab
Research paper 1	10	Feb 11	Feb 18
Midterm exam	20	---	Feb 18
Research paper 2	10	April 1	April 8
Final exam	30	---	April 23

Each lab exercise, research paper and exam will be marked on a percentage basis and the total of these marks will be converted to the university's letter grading system at the completion of the course. The overall course percentages will translate approximately into the following grades (bearing in mind that the final values may vary somewhat):

A+ = 91+	A = 86-90	A- = 80-85
B+ = 76-79	B = 73-75	B- = 69-72
C+ = 66-68	C = 62-65	C- = 57-61
D+ = 54-56	D = 50-53	
F = <50		

EXAMS

Midterm exam: will take place on February 18, 2005, during the regular class time.
Final exam: will take place on Saturday, April 23, 2005, at 6:30 pm in the Main Gym.

REQUIRED READING

- MacDonald, G. 2003. *Biogeography: Introduction to Space, Time and Life*. New York, John Wiley & Sons.
- Legris, A. 2005. BIO/GEO 351 *Biogeography Lab Manual and Reading Packet*. Augustana Faculty, University of Alberta, Camrose, AB.

COURSE POLICIES

Attendance

You are required to attend all class meetings, for several reasons. First, the textbook readings are intended to supplement lecture materials and class discussions, and they will not adequately cover all of the material which will be discussed in the class sessions.

Second, this course is one in which it is possible to have some very good and wide-ranging class discussions. And since learning is an active process, you will benefit much more if you are a participant in the classes.

Lastly, whether you acknowledge it or not, each one of these classes is costing you a fair amount of money. So if you want to get your money's worth in this course, you should take as much from it as you can.

Please try to arrive in class on time, so as not to disrupt your colleagues. If you are running late, however, it is better to come to class late than to miss it entirely. And please keep the talking during class down to a minimum; even low voices can be quite disruptive to the students around you.

Late assignments/lab reports

Assignments can be handed in late although they will be docked 10% of the mark for each day it is late. All assignments must be submitted in paper format; digital submissions (unless specifically required) will not be accepted. Lab reports (unless otherwise specified) must be handed in at the end of the lab period.

Academic Honesty

"The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour (online at www.ualberta.ca/secretariat/appeals.htm) and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University."

Course Outline Policy

Policy about course outlines can be found in Section 23.4(2) of the University Calendar.

BIO/GEO 351 Class Schedule

Date	Class	Subject	Chap	Pages	Lab
Jan 12	1	Introduction to biogeography	1	1-5	
Jan 14	2	The hierarchy of life	2	9-22	
Jan 19	3	Physical geography of the earth	2	22-41	
Jan 21	4	Physical environment factors	3	43-60	Lab 1
Jan 26	5	Physical environment factors	3	60-73	
Jan 28	6	Biological interactions	4	77-90	Lab 2
Feb 2	7	Gradients and niches	4	90-94	
Feb 4	8	Environmental disturbance	5	97-112	Lab 3
Feb 9	9	Environmental disturbance	5	113-127	
Feb 11	10	Dispersal, colonization and invasion	8	227-246	Lab 4
Feb 16	11	Dispersal, colonization and invasion	8	246-259	
Feb 18	12	Mid-term exam	---	---	
Mar 2	13	The changing earth	7	191-205	
Mar 4	14	The changing earth	7	205-223	Lab 5
Mar 9	15	Evolution, speciation and extinction	9	262-279	
Mar 11	16	Evolution, speciation and extinction	9	280-296	Lab 6
Mar 16	17	Biogeographic subdivisions of the earth	10	299-321	
Mar 18	18	Communities, formations and biomes	6	132-145	Lab 7
Mar 23	19	Geography of biodiversity	14	406-428	
Mar 30	20	Geography of biodiversity	14	428-447	
April 1	21	The human factor	12	350-372	Lab 8
April 6	22	Biogeographic distributions	13	377-393	
April 8	23	Biogeographic distributions	13	394-404	
April 13	24	Biogeography and conservation biology	15	451-463	
April 15	25	Biogeography and conservation biology; Course review	15	464-480	

APPENDIX II

See separate handout titled “Pechenik Citation Style Quick Guide”

Appendix III - Evaluating Information on the Internet

This document, which was revised from the original version produced by Elizabeth E. Kirk (of Johns Hopkins University), provides a brief overview of the things you need to consider when looking for information on internet web sites.

The World Wide Web offers information and data from all over the world. Because so much information is available, and because that information can appear to be fairly "anonymous", it is necessary to develop skills to evaluate what you find. When you use a research or academic library, the books, journals and other resources have already been evaluated by scholars, publishers and librarians. Every resource you find has been evaluated in one way or another before you ever see it. When you are using the World Wide Web, none of this applies. There are no filters. Because anyone can write a Web page, documents of the widest range of quality, written by authors of the widest range of authority, are available on an even playing field. Excellent resources reside along side the most dubious. The Internet epitomizes the concept of:

Caveat lector: Let the reader beware.

This document discusses the criteria by which scholars in most fields evaluate print information, and shows how the same criteria can be used to assess information found on the Internet.

What to consider:
1. Authorship
2. Publishing body
3. Point of view or bias
4. Referral to other sources
5. Accuracy or Verifiability
6. Currency
7. Caveats

1. ***Authorship*** is perhaps the major criterion used in evaluating information. Who wrote this? When we look for information with some type of critical value, we want to know the basis of the authority with which the author speaks. Here are some possible filters:

- In your own field of study, the author is a well-known and well-regarded name you recognize.
- When you find an author you do not recognize:
    - the author is mentioned in a positive fashion by another author or another person you trust as an authority;
    - you found or linked to the author's Web/Internet document from another document you trust;
    - the Web/Internet document you are reading gives biographical information, including the author's position, institutional affiliation and address;
    - biographical information is available by linking to another document; this enables you to judge whether the author's credentials allow him/her to speak with authority on a given topic;

- if none of the above, there is an address and telephone number as well as an e-mail address for the author in order to request further information on his or her work and professional background. An e-mail address alone gives you no more information than you already have.

2. The ***publishing body*** also helps evaluate any kind of document you may be reading. In the print universe, this generally means that the author's manuscript has undergone screening in order to verify that it meets the standards or aims of the organization that serves as publisher. This may include peer review. On the Internet, ask the following questions to assess the role and authority of the "publisher", which in this case means the server (computer) where the document lives:

- Is the name of any organization given on the document you are reading? Are there headers, footers, or a distinctive watermark that show the document to be part of an official academic or scholarly Web site? Can you contact the site Webmaster from this document?
- If not, can you link to a page where such information is listed? Can you tell that it's on the same server and in the same directory (by looking at the URL)?
- Is this organization recognized in the field in which you are studying?
- Is this organization suitable to address the topic at hand?
- Can you ascertain the relationship of the author and the publisher/server? Was the document that you are viewing prepared as part of the author's professional duties (and, by extension, within his/her area of expertise)? Or is the relationship of a casual or for-fee nature, telling you nothing about the author's credentials within an institution?
- Can you verify the identity of the server where the document resides? Internet programs such *dnslookup* and *whois* will be of help.
- Does this Web page actually reside in an individual's personal Internet account, rather than being part of an official Web site? This type of information resource should be approached with the greatest caution.

3. ***Point of view or bias*** reminds us that information is rarely neutral. Because data is used in selective ways to form information, it generally represents a point of view. Every writer wants to prove his point, and will use the data and information that assists him in doing so. When evaluating information found on the Internet, it is important to examine *who* is providing the "information" you are viewing, and what might be their *point of view* or *bias*. The popularity of the Internet makes it the perfect venue for commercial and sociopolitical publishing. These areas in particular are open to highly "interpretative" uses of data.

Steps for evaluating point of view are based on authorship or affiliation:

- First, note the URL of the document. Does this document reside on the Web server of an organization that has a clear stake in the issue at hand?
    - If you are looking at a corporate Web site, assume that the information on the corporation will present it in the most positive light.
    - If you are looking at products produced and sold by that corporation, remember: you are looking at an advertisement.
    - If you are reading about a political figure at the Web site of another political party, you are reading the opposition.
- Does this document reside on the Web server of an organization that has a political or philosophical agenda?
    - If you are looking for scientific information on human genetics, would you trust a political organization to provide it?
    - **Never assume that extremist points of view are always easy to detect. Some sites promoting these views may look educational.**

Many areas of research and inquiry deal with controversial questions, and often the more controversial an issue is, the more interesting it is. When looking for information, it is *always* critical to remember that everyone has an opinion. Because the structure of the Internet allows for easy self publication, the variety of points of view and bias will be the widest possible.

4. ***Referral to, and/or knowledge, of the literature*** refers to the context in which the author situates his or her work. This reveals what the author knows about his or her discipline and its practices. This allows you to evaluate the author's scholarship or knowledge of trends in the area under discussion. The following criteria serve as a filter for all formats of information:

- The document includes a bibliography.
- The author alludes to or displays knowledge of related sources, with proper attribution.
- The author displays knowledge of theories, schools of thought, or techniques usually considered appropriate in the treatment of his or her subject.
- If the author is using a new theory or technique as a basis for research, he or she discusses the value and/or limitations of this new approach.
- If the author's treatment of the subject is controversial, he or she knows and acknowledges this.

5. ***Accuracy or verifiability of details*** is an important part of the evaluation process, especially when you are reading the work of an unfamiliar author presented by an unfamiliar organization, or presented in a non-traditional way. Criteria for evaluating accuracy include:

- For a research document, the data that was gathered and an explanation of the research method(s) used to gather and interpret it are included.
- The methodology outlined in the document is appropriate to the topic and allows the study to be duplicated for purposes of verification.
- The document relies on other sources that are listed in a bibliography or includes links to the documents themselves.
- The document names individuals and/or sources that provided non- published data used in the preparation of the study.

- The background information that was used can be verified for accuracy.

6. ***Currency*** refers to the timeliness of information. In printed documents, the date of publication is the first indicator of currency. For some types of information, currency is not an issue: authorship or place in the historical record is more important (e.g., T. S. Eliot's essays on tradition in literature). For many other types of data, however, currency is extremely important, as is the regularity with which the data is updated. Apply the following criteria to ascertain currency:
   - The document includes the date(s) at which the information was gathered (e.g., US Census data).
   - The document refers to clearly dated information (e.g., "Based on 1990 US Census data.").
   - Where there is a need to add data or update it on a constant basis, the document includes information on the regularity of updates.
   - The document includes a publication date or a "last updated" date.
   - The document includes a date of copyright.
   - If no date is given in an electronic document, you can view the directory in which it resides and read the date of latest modification.

7. ***If you found information using one of the search engines available on the Internet***, such as AltaVista or InfoSeek, a directory of the Internet such as Yahoo, or any of the services that rate World Wide Web pages, you need to know:
   - **How the search engine decides the order in which it returns information requested. Some Internet search engines "sell" top space to advertisers who pay them to do so.**
   - That Internet search engines aren't like the databases found in libraries. Library databases include subject headings, abstracts, and other evaluative information created by information professionals to make searching more accurate. In addition, library databases index more permanent and reliable information.
   - How that search engine looks for information, and how often their information is updated

All information, whether in print or by byte, needs to be evaluated by readers for authority, appropriateness, and other personal criteria for value. ***If you find information that is "too good to be true", it probably is. Never use information that you cannot verify.*** Establishing and learning criteria to filter information you find on the Internet is a good beginning for becoming a critical consumer of information in all forms. "Cast a cold eye" (as Yeats wrote) on everything you read. Question it. Look for other sources that can authenticate or corroborate what you find. Learn to be skeptical and then learn to trust your instincts.

Johns Hopkins University
Last Updated 06/5/2002