World Ecosystem and Geography

Environmental Studies 30 Spring 2009

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INTRODUCTION

I. Objective

Some forgotten naturalist said "the idea is not to read books about nature but to read nature like a book." The main objective of this course is to give you some basic tools for reading nature and some practice applying them.

II. Background

Many of the most accessible examples of evolutionary and ecological principles are from biogeography. Geographical patterns in plant and animal distributions greatly influenced 18th and 19th Century naturalists. Much of the inspiration for Darwin's and Wallace's landmark theory of evolution came from their biogeographical observations. By knowing relatively few and relatively simple physical and biological processes, a person can understand the main reasons for the structure of ecosystems, the major adaptive structures of the plants and animals that live in them, and how human uses are (or should be) constrained.

As general knowledge, biogeography is a source of much satisfaction to anyone and it is also quite useful for professionals in agriculture, forestry and other resource sciences and the policy sciences (e.g. economics and planning). I especially notice the pleasure of biogeography when traveling. With biogeographic principles in mind, the form of vegetation, kinds of animals, and crop patterns of exotic places are comprehensible. One can observe an unfamiliar place, rather than just viewing it. Having the basic natural history in mind greatly increases the pleasure of new places, much like knowing a foreign language increases the pleasure of visiting another culture. If you can do a little nature reading, a place starts to tell you its story.

Biogeography has a practical side. Human created and managed ecosystems—farms, forests and gardens—are all faced with the same general adaptive problems that wild plants and animals encounter. Conservation and development are (at least when they work) based on the ecological principles exemplified by biogeography.

This body of knowledge is not usually taught in an integrated fashion. In general, students outside of a few biological disciplines never obtain it, and not until graduate school do most ecologists acquire enough information to get a coherent picture of the world as a richly patterned ecological system. Early exposure to biogeography gives those of you who go no further in

biology a feeling for ecology and evolution that you can verify with your own experiences and observations, and give those who do go on a useful framework to build upon with more specialized courses. I could really have used this course myself!

I want to encourage you to *look for concrete examples of principles in what you can observe yourself.* The first four lectures will outline basic principles. Each of the subsequent lectures will describe how evolutionary ecological processes produce the characteristic communities of particular biomes, the major ecological subdivisions of the earth. Because of the heavy dependence of ecosystem properties on climate, nothing will give you more information about what can or cannot be done with a particular tract of land more quickly than a look at a climate diagram, or climograph, for the region. (Climate diagrams are a graphical representation of climate; we will make considerable use of them in this class.) We will intersperse the lectures with short excursions to arboretum and elsewhere on campus to get a little hands-on experience. You will be encouraged to develop your own powers of observation by applying the principles presented in lecture. The stress will be on features that are easily observed and on the processes that underlie the similarities and the differences between biomes.

III. <u>The Biome Tool</u>

Ecosystems are awesomely complex and spectacularly diverse. Complexity refers to the tangle of species interactions and abiotic processes that comprise any given ecosystem. Outside the laboratory, we still don't understand the operation of even the simplest ecosystems in complete mechanistic detail. Diversity refers to the fact that no two ecosystems are exactly alike, and many are very different from one another.

The biome system of biogeographic classification is an attempt to capture as much of the complexity and diversity of life on earth as possible in a few basic categories. The global ecosystem contains millions of species of organisms arrayed in a very complex pattern driven by many interacting physical environmental factors, plant nutrients and other chemical factors, competition between organisms, predation, human disturbance, and other biotic interactions. The pattern is quite dynamic in time, and of course the species themselves are ever-changing on an evolutionary time scale. No simple system can really do justice to the buzzing, blooming, chaotic confusion of nature in the raw. Indeed all of modern ecology and evolution has only made a small start on the task of describing and understanding the global ecosystem. I was talking with a plant ecologist in the field in California one spring not long ago. On the hills across from us we could see a complex pattern of trees, chaparral, and grassland. I asked him how many of the boundaries he could account for. He described how a couple probably worked and then said "The rest would all be good PhD theses."

Notwithstanding its limitations, the biome system is the best shorthand system we have to the master diversity and complexity of ecosystems at the global scale. Refinements of it are routinely used as tools for applied purposes. For example, gardening in the West is guided by the climate zone system of the *Sunset Western Garden Book*, originally developed by University of California scientists. The WGB's 26 climate zones are essentially sub-biomes. If your parents

garden, you may already have some familiarity with this ubiquitous handbook. Agriculturists, foresters, house designers and others use similar systems to map physical environmental variables onto the possible human uses of the environment.

IV. Discovering the Awesome and Beautiful

The biome system is also a useful tool for the aesthetic appreciation of nature. Ecologist Ross Kiester, borrowing from the philosopher Kant, describes the aesthetics of nature under two headings, awe and beauty. That natural scenes can be beautiful is evident to practically everyone. That nature is the source of awe-inspiring forces that can stagger the imagination is also something we all know about on some level. Tools like the biome concept open hidden doors to see beauty in places that the ignorant pass by unawares--a thousand flowers where others see only patches of red, blue and yellow. The awesome processes of the natural world are sometimes easy to see--fire, flood, earthquake, epidemic. But the most awe inspiring forces are manifest either rarely or destructively (in which case observers are generally too terrified to make useful observations) or only in the long run. Biomes often testify to the existence of these forces to the practiced and knowledgeable eye.

It is a mistake to think that there is a rigid distinction between aesthetic and practical knowledge. The best practitioners of any occupation are those who love what they do. Gardening, fishing & hunting, and bird-watching ("ecotourism" more generally) are big business. Farmers may seem to be the most practical of people, but they produce precious wine, basmati rice, fat steers, and a myriad of other products that have mainly aesthetic appeal. Scratch a cattleman and you may find a nature mystic; scratch a butterfly collector and you may find a stockbroker or an auto mechanic.

V. Reading

The choice of a textbook for this course is hard. So I'll leave it up to you. On my web page, you can find a short textbook that my first TA in this course and I compiled. It is adequate and you can download it for free. We will follow the climograph and biome system developed by Heinrich Walter, an influential German biogeographer, now deceased. His *Vegetation of the Earth* was a slim masterpiece, now out of print (though you can find a used copy of the 1973 or 1985 edition for sale on the web). What is in print is Siegmar-W. Breckle's *Walter's Vegetation of the Earth* which has grown rather fat, technical (e.g. lots of Latin names of plants) and expensive. It is full of great stuff but don't spend your money lightly. It is a lot more than you need to do fine in the class, but it is the real deal. I'll also post my power-points. They will have extensive notes so that they will serve many of the functions of a textbook.

A handy book for those of us here is Elna Bakker's *An Island Called California*. Most if not all the observations you'll be able to make will be in California and California replicates all of the principles we will apply at the global scale in the diversity of communities within the state.

Beyond the textbooks, naturalists have written an ever expanding library of good

handbooks at all levels of technicality. I ask each of you to buy Tom Watts' cheap and simple, but very useful, entry level handbook *Pacific Coast Tree Finder*. This is the minimum you will need for your self-guided field trip. Beyond this, I encourage everyone to indulge their own interest. If you have some enthusiasm for geology, birds, insects, agriculture, native peoples, or whatever is in the broad compass of natural history, *go for it*! If you've spent time outside of California you may want to learn about that place. The UCD bookstore has a pretty good collection of handbooks to sample. (I never pass up a bookstore that might have some natural history and often go out of my way to find them, sometimes to the point of testing my traveling companion's patience.) Also, there are excellent books about natural history topics that are not handbooks but rather celebrate the awe and beauty of natural phenomena. John McPhee's classics on the geology of the U.S. and David Wallace's *The Klamath Knot* about the northwestern corner of California are excellent examples of this genre. I'm happy to make suggestions if you give me an idea of your interests.

You can get information on almost anything on the web. I'm addicted to Wikipedia myself.

Some useful web sites:

Here you can find a large number of Walter style climate diagrams:
http://commons.wikimedia.org/wiki/Category:Climate_diagrams_system_Walter%2BLieth

Here are some useful Wikipedia articles:

Atmospheric circulation: http://en.wikipedia.org/wiki/Atmospheric_circulation;
http://en.wikipedia.org/wiki/Earth%27s_atmosphere;
http://en.wikipedia.org/wiki/Earth%27s_energy_budget

Biomes: http://en.wikipedia.org/wiki/Biome

Soils: http://en.wikipedia.org/wiki/Soil

People: Search for specific types, eg hunter-gatherers, pastoralism, shifting cultivation, agrarian civilization, etc.

VI. Grading

Your grade in the course will be based on an objective midterm and final exam, worth 30% and 40% of the total grade respectively. 5% will rest on your participation during our excursions. The remaining 25% will be based on a field trip report, as described in the next section.

VII. Self-guided Field Trip

I have written guides for three field trips to the coast or mountains around Davis. Choosing one of these trips, you are expected to write a field trip report based on your observations and

experience. Your reports are due by midnight Wednesday June 3. Send them to me as an email attachment.

The rationale for this exercise is that the art of field biology involves the ability to "see" abstract theories and principles come to life in one's own observations of the distribution and behavior of plants and animals in natural communities (and in artificial ones as well). Great evolutionists and ecologists of the past had this knack to an extraordinary degree, and modern environmental scientists still make extensive use of it as a guide to constructing more formal tests of theories. We want you to develop some appreciation for it. The idea is to use the elevation gradients and degree of exposure to maritime influences in California as an example of how biotic communities and human adaptations respond to climate, soils, and other environmental variables. Digital cameras make incorporating photos into your reports easy. Try to borrow a camera if you don't have one and use photos to illustrate your main observations. If you take hi res photos, cut them down to a reasonable size or you'll make my IT guy mad! Most word processing programs have format pictures function you can use to do that.

A good model for your reports is Charles Darwin's Voyage of the Beagle, a classic in the genre of natural history reporting. If you have never read the Beagle and don't have time this quarter, there is an excerpt on my web page. Remember, the idea is not just to describe or just to speculate, but to try to see the extent to which general theoretical ideas, as those presented in lecture, can be seen, by careful observation, to operate in concrete situations. The report should be about five double spaced, typewritten pages, and need not be excessively technical. Remember that Darwin was primarily a geologist when he left on the Beagle and taught himself field biology on the trip!

Lecture Outline & Reading Guide

Lecture # Date Title

A. Mechanisms that Generate Patterns.

Read: Walter pgs 1-104 (If you decide to tackle Walter)

1 March 30 World Climates and Their Causes

2 April 1 Vegetation Patterns in Relation to Climate

3 April 3 Biotic Adaptations - Basic Ecological Mechanisms

4 April 6 Human Adaptations - Cultural Ecology

Excursion 1 April 8 Soils Meet at Sierra to the Sea exhibit between Veihmeyer and Plant Environmental Science Bldgs

B. The Terrestrial Biomes

5 & 6 April 10 & 13 The Tropics: Equatorial Evergreen Forest, Tropical Deciduous Forest, Savannah

Read: Walter pp. 115-203

Note: just skim "Orobiome" passages in Walter's biome chapters; see lecture 14

7 & 8 April 15 & 17 Arid and Semi-Arid Lands - Subtropical Deserts, Temperate Deserts, Steppes

Read: Walter 211-246, 371-415

9 April 20 West Coasts - The Mediterranean Biome and Its Associated Winter Rain Semi-Deserts and Forests.

Read: Walter 249-293

Excursion 2 April 22 Meet at Plant Sciences Greenhouse

Excursion 3 April 24 Meet at Arboretum Desert Collection

Excursion 4 April 27 Meet at Arboretum Mediterranean Collection

l0 April 29 East Coast and Continental Forests - Warm Evergreen and Cool Deciduous Temperate Forests, Boreal Forests I. (not for midterm)

Read: Walter 295-369

11 May 1 **MIDTERM** Responsible for material through Excursion 4

12 May 1 East Coast and Continental Forests - Warm Evergreen and Cool Deciduous Temperate Forests, Boreal Forests

Excursion 5 May 6 Meet at Arboretum Redwood Grove

13 May 8 Arctic Tundra
Read: Walter 449-461

14 May 11 Mountain Biomes
Read: Walter: read "Orobiome" sections of biome chapters

C. Aquatic Biomes

15 May 13 Introduction to Aquatic Systems

16 May 15 Continental Shelf Systems

17 May 18 Estuaries

18 May 20 The Plankton and Deep-Sea Benthos

19 & 20 May 22, 27 Lakes and Streams

Excursion 6: May 29 Free day for self-guided field trip

21 June 1 Impact of Global Climate Change on Biomes

22 June 3 Conclusions and review
Field Trip Reports due: Please email me electronic version

FINAL EXAM: June 11, 10:30-12:30 PM