Environmental Science II

The Northwest Center for Sustainable Resources is an Advanced Technological Education project funded by the National Science Foundation.

Environmental Science II was developed at Chemeketa Community College, Salem, Oregon, and was tested and revised at Everett Community College, Everett, Washington. Materials were prepared by Wynn Cudmore, Ph.D., Principal Investigator for the Center. Cudmore holds a Ph.D. degree in Ecology/Systematics from Indiana State University and a B.S. degree in Biology from Northeastern University.

Technology education programs in which this course is incorporated are described fully in the Center's report entitled, "Visions for Natural Resource Education and Ecosystem Science for the 21st Century." Copies are available free of charge.

Course materials will also be posted on our website:

www.ncsr.org

Please feel free to comment or provide input.

Wynn Cudmore, Principal Investigator

Susie Kelly, Project Director
Northwest Center for Sustainable Resources
kels@chemeketa.edu/503-315-4583

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Environmental Science II
4 Credits—3 hours lecture, 3 hours lab

INTRODUCTION TO ENVIRONMENTAL SCIENCE

Environmental Science was developed at Chemeketa Community College as a sequence of three courses that addresses environmental topics. Each 4-credit course requires a 3-hour lab that meets once per week and 3 hours of lecture. The courses are targeted towards several audiences including:

- students in natural resource areas (e.g., Forestry, Fish and Wildlife, agriculture)
- transfer students in areas other than biology who need a lab science course or sequence
- biology majors who wish to broaden their background in environmental biology
- anyone interested in learning more about environmental issues

I consider the courses to be "Environmental Science for the Citizen," and emphasis is placed on those concepts and issues that in my judgement should be understood by all citizens. The approach is science-based, and a distinct effort is made to present opposing viewpoints in contentious environmental issues. The three-term sequence was added as a requirement for students in the Forest Resources Technology Program at Chemeketa, where it serves primarily to introduce students to basic ecological concepts and environmental issues that relate to natural resource management. The following goals have been established for the sequence:

- introduce students to science as a "way of knowing"
- introduce students to basic ecological concepts
- introduce students to environmental problems at local, national and global scales
- work cooperatively in small groups
- communicate effectively in written and oral formats
- apply appropriate technology to scientific exploration
- access and use supplemental information relevant to course topics
- engage students in hands-on, field and laboratory experiences that require critical thinking
- use ecosystem management as a major theme in natural resource management
- introduce students to societal aspects of environmental issues
- apply mathematical concepts to scientific inquiry

This document describes several laboratory activities that have been developed for *Environmental Science II* in an attempt to meet these general goals. It is my hope that others who have similar goals for related courses will find them useful.

TEXT: Botkin, D. and E. Keller. 2000. *Environmental Science: Earth as a Living Planet*. 3rd ed. John Wiley and Sons, Inc. New York. 649 pp.

COURSE DESCRIPTION:

The primary goal in Environmental Science II will be to familiarize students with environmental problems associated with biological resources. Ecosystem management will be used as an underlying theme to evaluate issues concerning resource use and management such as food production, deforestation, fisheries management, soil erosion, water-related issues, and the loss of biodiversity. Additionally, the impacts of global climate change on biological resources will be examined.

PREREQUISITE

Environmental Science I or *General Biology* or permission of instructor.

COURSE OBJECTIVES

Upon successful completion of the course, students should be able to:

1. Measure environmental variables and interpret results
2. Evaluate local, regional and global environmental topics related to resource use and management
3. Propose solutions to environmental problems related to resource use and management
4. Interpret the results of scientific studies of environmental problems
5. Describe threats to global biodiversity, their implications, and potential solutions

STUDENT ASSESSMENT

Grades are based on a point system with an approximate breakdown as follows:

Exam #1	100 points
Exam #2	100 points
Final Exam	100 points
Labs	125 points
Article reviews	25 points
	450 points

The term's grade is based on a percentage of total points accumulated according to the following schedule:

90 - 100 %	A
80 - 89 %	B
70 - 79 %	C
60 - 69 %	D
< 60 %	F

READING SCHEDULE (BOTKIN AND KELLER, 2000)

WEEK	CHAPTER	TOPICS
1	Chap. 10	World Food Supply
	Chap. 11	Effects of Agriculture on the Environment
2	Chap. 10	World Food Supply
	Chap. 11	Effects of agriculture on the Environment
3	Chap. 12	Wild Living Resources: Plentiful and Endangered
4	Chap. 12	Wild Living Resources: Plentiful and Endangered
5	Chap. 13	Landscapes and Seascapes
6	Chap. 13	Landscapes and Seascapes
7	Chap. 19	Water Supply, Use and Management
8	Chap. 19	Water Supply, Use and Management
9	Chap. 21	The Atmosphere, Climate and Global Warming
10	Chap. 21	The Atmosphere, Climate and Global Warming
11		FINAL EXAM

PLEASE NOTE:

1. In addition to text readings, students are required to read selected articles in the *Capital Press* on a regular basis. The *Capital Press* is a weekly regional agricultural newspaper that regularly covers natural resource management issues (See pp. 101-102).

2. From time to time additional readings will be assigned to supplement reading material in the text. These are generally provided for students as handouts and used for class discussion.

TOPICS

I. Measurements of Human Impact on Ecosystems

A. Local to global scales
B. Direct vs. indirect impacts
C. Methods of imaging (aerial photography, satellite imagery, GIS)
D. Ecological footprint analysis

II. Natural Resource Management approaches
A. Sustained yield/multiple use
B. Ecosystem management
1. Elements and goals
2. Examples of implementation

III. Agricultural Ecosystems
A. World food supply
B. Agricultural vs. natural ecosystems
C. History of agriculture
D. Impacts of agricultural systems on the environment
1. Impacts on soils
2. Impacts on water resources
3. Impacts on native plants and animals
4. Impacts on global systems
E. Physical and biological characteristics of soils
F. Sustainable agriculture
1. Elements and goals
2. Integrated pest management
3. Precision agriculture
4. Role of genetically engineered crops
5. Incorporation of agroecosystems into landscapes
6. Societal aspects (government policies, economics, etc.)

IV. Wildlife Resources
A. Definitions of "wildlife"
B. Loss of Biodiversity
1. Measures and evidence for extinction
2. Causes and consequences of extinction
3. Endangered Species Act
C. Wildlife management
1. Goals
2. GAP analysis, wildlife refuges and other efforts
3. Cores, buffers and corridors
4. Species management vs. ecosystem management
5. Maximum sustainable yield vs. optimum sustainable yield

V. Fisheries Resources

A. Types and importance of fisheries resources

B. Status of global fisheries resources

C. Fisheries management

1. Case studies - anchovy, salmon, atlantic cod
2. Ecological restoration efforts
3. Hatchery programs and aquaculture
4. Optimum vs. maximum sustainable yield
5. Application of ecosystem management
6. Population biology and genetics
7. Fisheries legislation

VI. Forest Resources

A. Types and importance of forest resources

1. Human goods and services
2. Ecosystem services

B. Deforestation

C. Forest management

1. Multiple use and sustained yield
2. Definitions of sustainability
3. Old growth forest characteristics and management
4. New approaches—"New Forestry," FEMAT, etc.

VII. Water Resources—Supply, Use and Management

A. Types and status of resources

B. Water use and conservation

C. Watershed management

D. Stream and river ecosystems

1. Role of riparian zones
2. Role of organic input
3. Stream food webs
4. Flood ecology

E. Wetlands

1. Ecological roles
2. Wetland mitigation
3. Everglades Restoration Project—a Case Study

VIII. Global Warming

A. Atmosphere and climate

B. Causes of "The Greenhouse Effect"

C. Evidence of global warming

D. Biological effects of global warming

1. Impacts on forests
2. Impacts on agriculture
3. Impacts on fisheries and wildlife

E. Solutions and current efforts

LABORATORIES & ACTIVITIES

Ecosystem Management—an Overview

Sustainable Agriculture

Soils I: Physical and Biological Analysis

Soils II: Analysis and Applications

Biodiversity I: Wildlife refuges—Field Trip to Baskett Slough Wildlife Refuge

Biodiversity II: Habitat Determination—Northern Spotted Owl Habitat Associations

Biodiversity III: California Condor Case Study/American-Indian Perspectives

Biodiversity IV: Pacific Northwest Salmon—Complex Issues* ***See note below***

Tribal Land Management: Field Trip to Grand Ronde Stream Restoration Project

Dendrochronology—Introduction and Applications

Weekly assignments: *Capital Press* article reviews and discussion

☞ ***Important Note: students will need lead time for the salmon issue lab. Please refer to lab introduction well before its delivery to alert students to pre-lab assignments.***

Environmental Science II—Detailed Schedule

Date	Topic/Activity
Week 1	Lecture 1 — Course Introduction, Syllabus, Text discussion, Current topics
	Lecture 2 — Human Impacts on Ecosystems/Ecological Footprint analysis
	Lecture 3 — Introduction to agriculture
	LAB #1 Overview of Ecosystem Management (lecture/readings/videotape presentation)
Week 2	Lecture 4 — History of agriculture /Traditional vs. Sustainable agriculture
	Lecture 5 — Physical and Biological aspects of Soil
	Lecture 6 — Physical and Biological aspects of Soil/Impacts of agriculture on Natural Systems
	LAB #2 Sustainable agriculture
Week 3	Lecture 7 — Impacts of agriculture on Natural Systems/Sustainable agriculture
	Lecture 8 — Elements of Sustainable agriculture/Video-"High Tech agriculture"
	Lecture 9 — Elements of Sustainable agriculture
	LAB #3 Soils Lab I—Physical and Biological Characteristics of Soils
Week 4	Lecture 10 — Introduction to Wildlife
	Lecture 11 — EXAM #1
	Lecture 12 — Endangered Species/Biodiversity
	LAB #4 Soils Lab II—Physical and Biological Characteristics of Soils

Week 5	Lecture 13 — Endangered species/Biodiversity/Wildlife Management
	Lecture 14 — Wildlife Management "What's being done?"
	Lecture 15 — Endangered Species Act Discussion
	LAB #5 Biodiversity I: Field Trip to Baskett Slough Wildlife Refuge
Week 6	Lecture 16 — Introduction to Forestry
	Lecture 17 — Forest Management on Private Lands (Forest Industry Video)
	Lecture 18 — Forest Management on Public Lands/Old Growth Forest Characteristics
	LAB #6 Biodiversity II: Condor Video and Biodiversity Slides
Week 7	Lecture 19 — Old Growth Forest Characteristics/Spotted Owl activity
	Lecture 20 — Old Growth Forest Management/Wind River Canopy Crane Video
	Lecture 21 — Introduction to Fisheries
	LAB #7 Salmon Presentations I
Week 8	Lecture 22 — Status of Fisheries
	Lecture 23 — Fisheries Management
	Lecture 24 — EXAM #2
	LAB #8 Salmon Presentations II
Week 9	Lecture 25 — Water Resources and Management
	Lecture 26 — Water Resources and Management/Flood Ecology
	Lecture 27 — Everglades Ecological Restoration Project/Wetland Mitigation
	LAB #9 Field Trip to Grand Ronde Stream Restoration Project

Week 10	Lecture 28 — Global Warming/Greenhouse Effect
	Lecture 29 — Biological Impacts of Greenhouse Effect
	Lecture 30 — Biological Impacts of Greenhouse Effect/Summary of Term
	LAB #10 Dendrochronology/Global Warming
Week 11	FINAL EXAM

Ecosystem Management
An Overview

INTRODUCTION

As we have consumed, exploited and manipulated natural resources for human use (food production, lumber production, mining, recreation, etc.), it has become obvious that the resources we value do not exist in isolation—rather, they are part of larger systems. In these systems, each component plays an important role. It may be argued that to maintain the integrity of these systems, the "best management is no management." However, given that we will continue to manipulate natural and artificial ecosystems, it is in our best long-term interest to do so in a manner that assures (or at least improves the likelihood of) the integrity of those systems. **Ecosystem Management (EM)** has been proposed as a mechanism that strives to achieve this goal and will be used as a recurring theme in this course.

The concept of EM is currently under development. It has been labeled everything from an oxymoron to a guiding principle that will "protect the environment, maintain healthy ecosystems, preserve biological diversity, and ensure sustainable development" (Lackey, 1995). The concept has led to antagonism from pro-development interests who see it as a smoke screen by environmentalists to preserve more acreage in its natural state. Nevertheless, the U.S. Forest Service and the Bureau of Land Management adopted EM as their guiding philosophy in 1992, and 16 additional federal agencies and departments in 1993 did the same. At the very least it appears that ecosystem management provides some options or insurance for the future that may not be available under other management philosophies. Attempts to apply EM on a large scale include the President's (Northwest) Forest Plan (Option 9) in the Pacific Northwest and the Everglades Ecosystem Project in Florida. The concept has achieved a great degree of acceptance in scientific, socioeconomic and political circles and it appears, at least for now, that "ecosystem management represents our best opportunity to describe, understand and fit in with the natural world" (Grumbine 1994).

WHAT IS ECOSYSTEM MANAGEMENT?

Ecosystem management attempts to:

- maintain existing biodiversity at genetic, species and ecosystems levels
- maintain evolutionary and ecological processes within ecosystems
- maintain or enhance long-term productivity of ecosystems
- manage over temporal and spatial scales that are appropriate for the ecosystem
- accommodate human uses within these constraints

A sampling of definitions of EM by various authors:

"Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term." Grumbine (1994)

"EM is an approach to the management of natural resources that strives to maintain or restore sustainability of ecosystems and to provide present and future generations a continuous flow of multiple benefits in a manner harmonious with ecosystem sustainability." Unger (1994) Associate Chief of U.S. Forest Service

"Protecting or restoring the function, structure and species composition of an ecosystem, recognizing that all components are interrelated." U.S. Fish and Wildlife Service

"EM is a process that considers the total environment. It requires the skillful use of ecological, economic, social, and managerial principles in managing ecosystems to produce, restore, or sustain ecosystem integrity and desired conditions, uses, productivity, values, and services over the long term.... EM recognizes that people and their social and economic needs are an integral part of ecological systems." U.S. Bureau of Land Management (1993)

SOME UNDERLYING PRINCIPLES AND IMPLICATIONS

Ecosystem management has ecosystem science at its core. This includes concepts such as interconnectedness of ecosystem components, biodiversity, nutrient cycling, energy flow, population growth, limiting factors, species interactions, competition, symbiosis, etc. Ecosystem management will require unprecedented cooperation between various parties (public and private) responsible for stewardship of various land holdings since management will be based on *ecological* rather than *political* boundaries.

Ecosystem management requires thorough understanding of the ecosystems we are managing. **Adaptive management** recognizes that our knowledge of ecosystems is incomplete and uses management as an ongoing process to gain further understanding of our impact on complex systems. A close working relationship between "managers" and "researchers" assures that management activities incorporate the latest scientific information and that management activities will be updated on an ongoing basis as our understanding of ecosystems improves. A close working relationship between researchers and managers is of mutual benefit. Managers gain access to state-of-the-art information on the systems they are managing. Researchers gain feedback that fine tunes the focus of scientific studies and provides them with a better understanding of the practical difficulties faced by managers. The results of management activities are monitored continually, providing a feedback loop to managers. Management practices can, therefore, be adjusted as we learn of inadequacies or mistakes.

Ecosystem management goals are *socially* defined. People must be recognized as an integral component of ecosystems. Human values will play an important role in defining the goals of ecosystem management. This may be the most problematic component of EM, for even if we gain the *scientific* knowledge to manage ecosystems sustainably, conflicting societal goals and human values may prevent this from happening. There is evidence to suggest that some interests are using this aspect of EM to justify "business as usual"; e.g., short-term, single-commodity based management with minimal regard for ecosystem integrity.

Where is Ecosystem Management Being Discussed, Implemented or Practiced?

- Ecosystem management has been a major theme at national and international conferences including the Seventh American Forest Congress (1996) and the Canadian Institute of Forestry Annual Meeting (1996).
- *Journal of Forestry* has published a number of major articles on ecosystem management and adaptive management in recent issues. Articles in the February and June 1996 issues address EM in non-industrial private forests.
- Boise Cascade Corporation is developing a plan for management of an 300,000 acre area in Minnesota that will be used as a demonstration project for ecosystem management. Another demonstration project is planned by Boise Cascade in Idaho.
- Implementation of ecosystem management in large rivers and floodplains is addressed in a series of articles in *BioScience: 45(3)*.
- Some examples of projects that are being presented as attempts to implement ecosystem management:

    - Clayoquot Sound, Vancouver, British Columbia
    - Eastside Ecosystem Management Project—Eastern Washington
    - Columbia Basin Ecosystem Management Project
    - President's Forest Plan—Option 9 (Northwest Forest Plan)
    - Greater Yellowstone Ecosystem
    - Everglades Restoration Project—Florida
    - Wildlands Project—North America

- The U.S. Forest Service adopted EM as a major emphasis in 1993. Concepts of EM are being implemented on National Forests across the United Sates.

Sustainability, and Applications of Ecosystem Management

EM and **sustainability** are closely aligned. The term generally refers to longterm economic, environmental, and community health. It was popularized in the 1992 "Earth Summit," and sustainability was defined in the World Commission on Environment and Development's 1987 report, "Our Common Future," as: *Meeting the needs of the present generation without jeopardizing the ability of future generations to meet their own needs.*

I have listed below some natural resource emphasis areas where EM is important. The term *sustainability* is a frequent component of these topics and the margins between EM and "sustainable development," "sustainable forestry," "sustainable agriculture," etc., often blur. This might provide a starting point for application components of EM.

FORESTRY. In forest ecosystem management, the products taken from the system are an important secondary objective. Integrity of the forest ecosystem comes first. Ecosystem management would identify forest sustainability as the foremost goal of national forest management, and use the conservation of biodiversity as the mechanism to that end.

AGRICULTURE. Sustainable agriculture is a systems-level approach to understanding complex interactions within agricultural ecosystems. It produces adequate amounts of high quality food while protecting other resources by using practices that are both environmentally safe and profitable. A sustainable farm relies as much as possible on beneficial natural processes and renewable resources drawn from the site itself. Integrated pest management and holistic agriculture are examples of its application.

FISH & WILDLIFE. The conservation of wildlife and fish populations is achieved by practicing ecosystem management. Maintaining the system over the long term protects species which depend on it. Applications and examples of incorporating systems-based management and conservation approaches include GAP analysis, application of island biogeography theory to wildlife management, establishing minimum critical size for ecosystem studies, providing wetland and riparian buffer protection and ecological preserve designs; i.e., core reserves, buffers and corridors.

Ecosystem Management: Current Resources

A number of authors have published articles that define ecosystem management and describe attempts to implement it. The following articles are representative of some of these publications. Educators interested in incorporating ecosystem management into the curriculum should find these to be valuable resources.

Books & Publications

1. Grumbine, R.E. 1994. *What is ecosystem management?* Conservation Biology 8(1):27-38.

   An excellent article used for many of the Center's (and my) original materials.

2. Nielsen, L.A. and D.J. Decker. 1995. *Educating natural resource professionals for ecosystem management*. Renewable Resources Journal. Spring 1995:12-17.

   This article addresses some of the issues concerning the preparation of natural resource workers in a world where ecosystem management is implemented.

3. Seastedt, T. 1996. *Ecosystem science and society*. BioScience 46(5):370-372.

4. Several authors. 1996. Ecological Applications 6(3)

   This issue contains a series of articles from a number of authors who describe their insight on ecosystem management. Authors include representatives of the wood products industry, universities and federal agencies.

5. Kohm, K.A. and J.F. Franklin (eds.) 1997. *Creating a forestry for the 21st century: the science of ecosystem management.* Island Press, Washington, D.C. 475 pp.

   This book addresses ecosystem management as it applies to forestry. It represents the first attempt to place ecosystem management in an "operational context"; i.e. from theory to practice.

6. Christensen, N.L. 1996. *The scientific basis for ecosystem management: an assessment by the Ecological Society of America*. Ecological Applications 6: 665-691.

   This document is available via e-mail. You can order a copy at esahq@esa.org

7. LaRoe, E.T., et al. 1995. *Our living resources: A report to the nation on the distribution, abundance and health of U.S. plants, animals and ecosystems.* U.S.D.I. National Biological Service, Wash., D.C. 530 pp.

   This report is the first comprehensive publication to come out of the biological science branch of the Department of the Interior—the National Biological Service. It is a large collection of short articles that addresses most biological resource issues in the United States. GIS- generated maps and data summaries are found throughout the document. I have found it to be a valuable resource and a good starting point for researching any biological resource issue. It is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; Stock # 024-010-00708-7

8. Baker, J.P. et al. 1995. *Ecosystem management research in the Pacific Northwest—five year research strategy.* U.S. Environmental Protection Agency, Corvallis, OR. 251 pp.

This report outlines EPA's view of ecosystem management and describes this agency's plan for implementation in the Pacific Northwest. The document number is EPA/600/R-95/069 and it is available from:

Western Ecology Division
National Health and Environmental Effects Research Laboratory
U.S. Environmental Protection Agency
200 SW 35th Street
Corvallis, OR 97333

9. Logan, R.S. and R.A. Fletcher. 1996. *Forest Ecosystem Stewardship.* Montana State University Extension Service #EB141. 49 pp.

This document describes current thinking on forest ecosystem management to a person without an extensive background in forestry or ecosystem science. Jargon is kept to a minimum, yet the most important ecosystem principles are introduced, defined and examples are given. The use of "ecosystem science" as a basis for natural resource management is a dominant theme. There is a good balance between principles/theory and practical, "how to" information that could be applied by a timber owner. The document represents a good approximation of the level of understanding of EM for students in natural resources technician programs.

10. Oliver, C. 1996. *Forest Ecosystem Management: A Graphic Overview.* Boise Cascade Corporation, LaGrande, Oregon. 52 pp.

This document is a bit more technical than Logan and Fletcher (1996) and addresses ecosystem management on industrial forests. It contains a wealth of information and flashy graphics to illustrate major points. The main elements of ecosystem management are addressed in the document—maintaining biodiversity, ecological processes, and site productivity while managing on larger scales of time and space and meeting human needs. Expectedly, there is a clear emphasis on the latter and the message of meeting the social and economic need of humans receives priority.

11. Yaffee, S.L., A.F. Phillips, I.C. Frentz, P.W. Hardy, S.M. Maleki and B.E. Thorpe.1996. *Ecosytem management in the United States: An assessment of current experience.* Island Press, Washington, D.C. 352 pp.

This publication is a collaborative effort of the University of Michigan and the Wilderness Society. Using the definition proposed by Grumbine (1994), the authors examine in detail 105 ecosystem management projects throughout the U.S. General characteristics, goals, challenges and expected outcomes are described for ecosystem management projects.

12. Bennett, M. 1996. *Ecosystem management—opportunities and implications for woodland owners.* EC 1469, Oregon State University Extension Service, 11 pp.

This short Extension Service bulletin is designed to explain ecosystem management to private woodland owners. Various definitions of ecosystem management are given and the characteristics and rationale for implementation of EM are succinctly explained.

13. Forest Ecosystem Management Team (FEMAT). 1993. *Forest ecosystem management: An ecological, economic, and social assessment.* U.S. Departments of Agriculture, Commerce and the Interior and Environmental Protection Agency, Washington, D.C.

14. Lackey, R.T. 1995. *Seven pillars of ecosystem management*. The Environmental Professional. 17(4)

15. Moote, M.A., Burke, S., Cortner, H.J. and M.J. Wallace. 1994. *Principles of ecosystem management.* Water Resources Research Center, Univ. of Arizona. 14 pp.

16. Cortner, H.J. and M.A. Moote. 1999. *The politics of ecosystem management*. Island Press, Washington, D.C. 179 pp.

For those interested in the social and political aspects of ecosystem management, this book provides both historical context and a look to the future. The underlying theme is that natural resources management is not, and never has been, driven solely by science.

17. U.S. Department of Interior, Bureau of Land Management. 1993. *Grazing administration regulations: proposed rules.* Federal Register 58(155):43208-43231. August 13, 1993

18. Cunningham, W.P. and B.W. Saigo. 1999. *Environmental Science: A Global Concern*. Wm. C. Brown/McGraw-Hill Publishers, Boston, MA. pp. 85-86.

I believe this widely used text is the first non-majors Environmental Science text to discuss ecosystem management. EM is described as a "new discipline in environmental science that attempts to integrate ecological, economic and social goals in a deteriorating environment or economy." Grumbine's 1994 article forms the basis for the description of principles and goals of EM while a forest management project from Peru is used as an example.

Videotapes

1. *Managing the Ecosystem—More than the Sum of Its Parts*. (19 min) Blue Mountain Natural Resources Institute, 10901 Island Ave., LaGrande, OR 97850; 503-962-6590

This video describes ecosystem management and gives views of EM from different people involved in natural resource management.

2. *Perspectives on Ecosystem Management*. 1988. College of Forestry, Oregon State University, Corvallis, Oregon.

3. *Forest Fragmentation and Implications*. 1990. College of Forestry, Oregon State University, Corvallis, Oregon.

NOTES FOR INSTRUCTORS

Ecosystem management is a dominant and recurring theme in this course, and it will be applied to all topics addressed. This laboratory is comprised of lecture, reading assignments, and videotape presentations. Information is intended to provide a fundamental overview of this relatively new management approach. Instructors can pick and choose among materials presented; e.g., lecture format, provide resource lists for students to review current material, show suggested videotapes.

Instructors may incorporate these activities/presentations into the lab:

☞ Provide the materials on the previous pages for students as a background to the subject.

☞ Show the videotape presentations (listed in references)

☞ Suggested discussions:

What is meant by the term "management" in the context of natural resources?

There is an assumption that current management goals are so established that they are perhaps accepted with "blind faith" as correct; and that resources are being manipulated in some way to increase the abundance or quality of some commodity. As a result, there is an increase in the value of the resource. Also, management often entails regulation of some type, especially when there is competition for that resource.

During settlement of North America by European settlers, there was probably little perceived need for management. Resources were seen as infinite for all practical purposes. However, as populations and demands on natural resources increased, it became apparent that management would be required to maintain these resources.

As we have consumed, exploited and manipulated our natural resources for our use (food production, lumber production, recreation, etc.), it has become obvious that the resources we value do not exist in isolation, rather they are part of larger systems. In these systems, each component is connected to other components as a result of energy flow, nutrient cycling, predator-prey interactions, symbiosis and other relationships. **Ecosystem management** has been proposed as an approach that recognizes that all natural resources are part of functioning ecosystems and that to maintain the resource requires that we maintain the ecosystem of which they are part.

- If the primary goal in management is to maintain the ecosystem, it could be contended that *the best management is no management*. However, given that we will continue to manipulate, disturb and exploit natural and artificial ecosystems, it is in our best long-term interest to do so in a manner that assures (or at least improves the likelihood of) the integrity of that system in perpetuity.

- The concept of EM is currently under development; the idea continues to evolve.

- The U.S. Forest Service and Bureau of Land Management adopted EM as their guiding philosophy in 1992, and 16 additional federal agencies and departments in 1993 did the same.

- Attempts to apply EM on a large scale include the Northwest Forest Plan (Option 9) in the Pacific Northwest and the Everglades Ecosystem Project in Florida.

- The concept has achieved a great degree of acceptance in scientific, socioeconomic and political circles and it appears, at least for now, that "ecosystem management represents our best opportunity to describe, understand and fit in with the natural world."

The concept of EM generally attempts to meet the following goals:

- to maintain existing biodiversity at genetic, species and ecosystems levels
- to maintain evolutionary and ecological processes within ecosystems
- to manage over temporal and spatial scales that are appropriate for the ecosystem
- to maintain long-term site productivity
- to accommodate human uses within these constraints

A sample working definition:
Ecosystem management integrates scientific knowledgeof ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term. Grumbine (1994)

Adaptive Management occurs as a cycle at regular intervals in decision-making processes. It involves a team of land managers, scientists and other professionals.

The Adaptive Management cycle:

1. *Plan:* Use current information to help define goals and "preferred future condition" for an area (called an *Adaptive Management Area* in the Northwest Forest Plan).

2. *Act:* A management experiment is designed by scientists and implemented by land managers.

3. *Monitor:* Scientists and/or managers measure effects of management experiment; information is typically sent to a central Adaptive Management Center.

4. *Evaluate:* Information collected in previous steps is used to see if action results in progress towards goals; as a result of this evaluation, the plan may be modified and the cycle begins again.

For example, the Northwest Forest Plan identified ten Adaptive Management Areas (AMA's) where adaptive management is to be implemented.

Sustainable Agriculture

INTRODUCTION

Sustainable agriculture has been offered as an alternative to modern intensive farming. Although the concept is complex and continues to develop, it generally encourages a more ecological approach to agriculture. Intended results are that sufficient crops are produced to feed the growing population in a manner that does not degrade the ecosystem. In today's lab we will explore some of the elements of sustainable agriculture and compare them to both pre-industrial farming and modern intensive farming.

PROCEDURE

View the videotape, "Save the Earth—Feed the World," from the *Race to Save the Planet* series. After viewing the videotape, discuss possible responses to the following questions with members of your lab group. Take notes while viewing the videotape and during discussion with group members.

1. Compare and contrast the farming practices demonstrated at Sturbridge Village, typical of New England 150 years ago, with prevailing farming methods today in the U.S.

2. Describe the "Green Revolution" and use an example from the program to describe the advantages and disadvantages of this type of farming.

3. If products that are produced organically attract higher prices in the marketplace, why is it that less than 5% of U.S. farmland is farmed organically?

4. Detractors of sustainable agriculture practices such as organic farming, integrated pest management and crop diversification contend that it is simply a return to pre-industrial farming. How would you respond to this statement?

5. Are the sustainable agriculture practices described in the video elements of "ecosystem management"? Defend our answer. If your answer is "yes," describe how each of the criteria of EM is met. If your answer is "no," indicate which criteria of EM are *not* met by these practices and what changes would have to occur before they could be considered part of ecosystem management.

After discussion within each group, there will be a more general discussion in which each group will "report out" to the class. This is an opportunity for you to hear points of view that may not have come up in discussions within your group. Again, take notes on these new points.

LAB PRODUCT

Each student should respond to the above questions. Questions #3, 4 and 5 will require some original thought, and therefore, more extensive answers. Use the following as sources of information:

1. Videotape
2. Group discussions
3. Supplemental reading handouts
4. Text readings in Botkin and Keller; Chapters 10 and 11

NOTES FOR INSTRUCTORS

Students should:

- Read the following article prior to lab: Reganold, J.P., R.I. Papendick and J.F. Parr. 1990. *Sustainable Agriculture*. Sci. Am. June 1990:112-120.
- View video, *Save the Earth —Feed the World*. 1990. (Part 7 from the "Race to Save The Planet" series. 60 min.)
- Discuss responses to questions within lab groups
- Submit individual lab products

FROM VIDEO

Modern intensive farming involves growing crops as monocultures, and heavy dependence on irrigation and agrochemicals. Technological advances have tripled yields since 1950, but consequences have included significant environmental damage. New ways to farm are being developed that make more ecological sense than past practices. These new ideas are presented in the video, and specific examples are provided from MacFarland, California in Central Valley; Sturbridge Village, Massachusetts; Indonesia (rice farming); Northeast Australia; Southwest U.S. (Dust Bowl of the 1930's); and the Sahel region of sub-Saharan Africa.

LAB PRODUCT

Suggested answers:

1. Compare and contrast the farming practices demonstrated at Sturbridge Village, typical of New England 150 years ago, with prevailing farming methods today in the U.S.

   Sturbridge Village, Massachusetts — an 1800's era working farm
   How does it differ from modern farming?

   Key feature is diversification of crops.

   - crop rotation for natural pest control and N-fixation
   - animals fed crops not consumed by humans
   - manure used to enrich soils

   This system was abandoned as populations increased in favor of industrial farming. At first this was a great success as measured by production.

2. Describe the "Green Revolution" and use an example from the program to describe the advantages and disadvantages of this type of farming.

The Green Revolution tripled crop yields in Indonesia by allowing:

1. Multiple rice crops in a single year by irrigation
2. Development of rice varieties that grow year round—but these new varieties require more fertilizer and pesticides

3. If products that are produced organically attract higher prices in the marketplace, why is it that less than 5% of U.S. farmland is farmed organically?

Why don't more farmers switch to organic farming?

Conventional farming reflects the economic environment in which farmers operate, due to:

- relatively low chemical prices
- few penalties for pollution
- a history of agricultural programs geared to the production of a few basic crops

"Wide adoption of sustainable farming methods required that they be at least as profitable as conventional methods, or have significant non-monetary advantages such as preservation of rapidly deteriorating soil or water resources" (1989 NAS Alternative Agriculture).

1987 survey of farmers who had switched to sustainable techniques:

50% - no change in yield
35% - yield decrease
15% - yield increase

Of those with a yield decrease—42% cited nutrient deficiencies, 72% cited weed problems as principal reason.

- Sustainable practices often require different skills and more hours devoted to farming. There is a time tradeoff; places more importance on education
- Divergence of public benefits and private costs is a major problem (e.g., the dairy farmer who reduces runoff into a stream incurs cost but benefit is primarily a public benefit)
- Replacement of *crop subsidies* with *environmental subsidies* may be a partial solution (some large scale federal programs are being piloted—for more info see pp. 6-7 in Chiras. 1994. *Regional Modules to accompany Environmental Science*. 4th ed.)
- Increased taxation on agrochemicals and other products that are not part of sustainable agriculture represent another solution (commercial nitrogen taxed at $0.75/ton in Iowa)
- Most federal crop programs favor conventional farming over sustainable farming; e.g., crop rotations that include a "non-program" crop reduced the acreage in a particular subsidy program and reduced benefits to farmer; the 1995 Farm Bill changed some of this
- Active promotion on farms of agrochemical use by chemical companies
- Tradition and human nature. It's hard to admit something you have been doing for 30 years isn't the best way it could be done! Includes farmers and agricultural researchers.

4. Detractors of sustainable agriculture practices such as organic farming, integrated pest management and crop diversification contend that it is simply a return to pre-industrial farming. How would you respond to this statement?

   High technology is a critical component of sustainable agriculture—ecosystem science, biological control, genetic engineering of crops, etc.

5. Are sustainable agriculture practices described in the video elements of "ecosystem management"? Defend your answer. If your answer is "yes," describe how each of the criteria of EM is met. If your answer is "no," indicate which criteria of EM are not met by these practices and what changes would have to occur before they could be considered part of ecosystem management.

   - to maintain existing biodiversity at genetic, species and ecosystems levels
   - to maintain evolutionary and ecological processes within ecosystems

   Although agriculture, by definition, replaces natural ecosystems with artificial ones, it could be argued that several aspects of sustainable agriculture maintain biological diversity and ecological processes in soil. The use of composted material, for example, increases the organic content of soils, and as a result, increases the diversity of soil organisms such as beneficial insects, mites, fungi and bacteria.

   - to manage over temporal and spatial scales that are appropriate for the ecosystem
   - to maintain long-term site productivity

   Sustainable agriculture practices should improve the long-term productivity of soils. However, there has been little effort to place agriculture into a broader spatial scale that takes into account other ecosystems.

   - to accommodate human uses within these constraints

   Meeting human concerns is the main focus of agriculture.

Soils 1
Physical and Biological Analysis

INTRODUCTION

Soils are complex systems of organic and inorganic components. Their composition greatly influences plant and animal communities, as well as the potential human uses for a given site. Land management decisions are fundamentally tied to soil types—whether the dominant use is forestry, agriculture, horticulture, building/construction, or otherwise. For the next two weeks we will be examining various physical and biological characteristics of soils, and then we'll discuss implications and applications.

OBJECTIVES

1. Analyze soils chemically for important physical properties (texture, pH, etc.) and levels of important soil nutrients (nitrogen, phosphorus and potassium).
2. Analyze soils biologically for soil organisms.
3. Be able to determine appropriate uses for a plot of land based on soil characteristics.
4. Become familiar with the type of information that can be gathered from a soil survey.

BACKGROUND

Five Polk County locations representing a wide array of local soil types were identified as sampling locations. Each group will be assigned one of these locations and will conduct a series of observations and tests on soil samples collected at that site. The sites are identified as follows:

Site #1: Mill Creek Park. 6.9 mi. NW of Dallas. A park-like, grassy area along Mill Creek with some scattered Douglas-fir trees. ***Soil designation—12A*** (from local Soil Survey, available at the Natural Resources Conservation Service District office)

Site #2: Willamette Industries Tree Farm. 7.0 mi. NW of Dallas. A steep area managed for timber production by Willamette Industries. This area was clearcut approximately 12 years ago and was replanted with Douglas-fir seedlings. The seedlings are now about ten feet tall and mixed with bigleaf maple, sword fern and blackberry vines. ***Soil designation—41E***

Site #3: Baskett Slough Wildlife Refuge. 3.5 mi. NE of Dallas. Relatively flat field on a refuge planted in grass seed. Canada geese feed in the field in the winter, farmers harvest grass seed in late summer. ***Soil designation—65B***

Site #4: Miller's Pasture. 2.9 mi. N of Dallas. Gently sloping, wet pastureland with a small seasonal creek. Some wetland vegetation (rushes) near seasonal creek. Cows graze on pasture throughout the year. ***Soil designation—27C***

Site #5: Cudmore Forest. 2.6 mi. N of Dallas. Steep forested area with mixed Douglas-fir and Garry oak. Dominant trees are 50-70 years old. ***Soil designation—74E***

SAMPLING DESIGN

At each site, the following samples were taken:

1. *Soil core samples:* A 12" soil core sampler was used to collect samples for **chemical analysis** (pH, organic content and macronutrients). Three representative locations at each site were sampled. These samples were combined and stored in small, 1-gallon zip-lock plastic bags labeled with the sample site. These samples have been dried in a drying oven at 55°C for 4 days.

2. *Litter samples:* The litter layer in a 1 m^2 area was raked at each site and placed in large plastic bags. These samples will be placed in a *Berlese Apparatus* that extracts soil invertebrates.

PROCEDURES

Perform each of the procedures described below on soil or litter samples collected at your site. Each group will have a *LaMotte Soil Macronutrients Kit* which will be used to measure pH and soil macronutrients. As you complete each procedure, keep careful records of your results (use data sheets on page 30).

1. Soil Invertebrates in Leaf Litter

Soil invertebrates play critical roles in the long-term stability and fertility of soils. Their activities aerate the soil, accelerate decomposition of organic materials, distribute important nutrients and disperse fungal spores and bacteria throughout the upper layers of soil. They are also the most abundant primary and secondary consumers in soil ecosystems.

Soil invertebrates from leaf litter samples that have been collected at all locations will be extracted using a Berlese apparatus. The apparatus relies on the negative reaction that most soil organisms have to light, heat and desiccation. Since I have recorded data on the habitat for each collection, and approximately equal amounts of leaf litter (one meter square plots were raked) were used for each sample, this provides us with an opportunity to *quantitatively* evaluate soil invertebrate communities from different habitats.

In today's lab we will examine litter samples manually and set up the Berlese apparatus with litter samples from each location. Invertebrates will be collected over a one-week period. In our next lab, we will analyze these samples by identifying and counting invertebrates from each.

A. Place your litter sample on a large tray and collect any large invertebrates in the sample (earthworms, beetles, etc.); place them in a vial containing a 50% ethanol solution.
B. Fill a funnel from the Berlese Apparatus with a representative subsample from your litter sample.
C. Fill the flask below the funnel about half way with ethanol.
D. Label the flask and funnel with your site number.
E. Adjust position of light to approximately 2 inches above sample.

2. Organic Content

CAUTION!! WEAR GOGGLES DURING THIS PROCEDURE!

Organic materials increase the tilth, water holding ability, and aeration of soil. As they decompose, decaying plants add important nutrients and influence the pH. The amount of organic material in soil is therefore an important consideration in the evaluation of soil characteristics.

Organic materials burn at high temperatures and decompose to CO_2 and H_2O (gas). In general, the inorganic component of the soil does not decompose at high temperatures. Therefore, the loss in weight of a soil sample after burning can be used as a method for estimating organic content.

A. Weigh a glazed porcelain crucible (without the cover) to the nearest 0.01 gram.
B. Fill the crucible approximately two thirds full with an oven-dried sample of soil.
C. Reweigh the sample plus crucible to the nearest milligram.
D. Subtract the weight of the crucible. This is the "dry sample weight."
E. Place the uncovered crucible over a flame (Bunsen burner) and cook for 15 minutes. While cooking, stir with a probe, but be careful not to remove any soil in the process.
E. Using tongs and asbestos gloves, remove the crucible from the flame, cover, and allow to cool on an asbestos pad.
F. When cool enough to weigh (about 5 minutes), remove cover and reweigh sample to the nearest 0.01 gram. Again, subtract the weight of the crucible. This is the "cooked sample weight."
G. Calculate the "percent (%) organic matter" in the soil sample using the formula:

$$\text{Percent Organic Matter} = \frac{(\text{dry sample weight} - \text{cooked sample weight}) \times 100}{\text{dry sample weight}}$$

H. Record the percent organic matter for your sample on the data sheet.

3. pH

pH is a measure of soil acidity expressed chemically as the concentration of hydrogen ions (H^+). The pH scale runs from 0 to 14. A value of 7 indicates neutrality—a solution that is neither acidic nor alkaline. Values below 7 are progressively more and more acidic (a solution with a pH of 4 is more acidic than a solution with a pH of 5). Values above 7 are progressively more and more alkaline (basic).

Plants grown as agricultural crops or as components of the native vegetation often have specific soil pH requirements. Consequently, soil pH has some influence on the most appropriate crop for an area as well as the native vegetation there. Crops such as blueberries and strawberries, for example, prefer more acidic soils while most vegetable crops require somewhat more alkaline soils. In our area, soils closely associated with Douglas-fir forests are often acidic. The accumulation of tannic acid as a result of decomposition of conifer needles and branches results in acidic soils in coniferous forests. In agricultural soils that are too acidic, calcium and magnesium are easily leached from the soil, hindering plant growth. The addition of lime (ground limestone) is often practiced in agricultural areas to adjust the pH to more appropriate levels for vegetable crops.

We will use *Soil pH Test Kits* to measure the pH of soil solutions made from each sample. Use soil from your soil core samples for this procedure. Follow the instructions that come with the Test Kit. Record your measurements on the data sheet.

Interpretation of soil pH levels:

pH 4.0	strongly acidic
pH 5.0	moderate to strong acidity
pH 6.0	slight to moderate acidity
pH 7.0	neutral (neither acidic nor alkaline)
pH 8.0	slight to moderate alkalinity
pH 9.0	moderate to strong alkalinity

4. Macronutrient levels

CAUTION!! USE GOGGLES WHEN HANDLING CHEMICALS DURING THIS PROCEDURE!!

NOTE: *For each of the following procedures, soil samples should be air or oven-dried, thoroughly mixed, and then screened through a soil sieve about the same mesh size as a window screen.*

Nitrogen (N), Phosphorus (P) and Potassium (K) are the primary macronutrients in soils used by plants. A measure of these three components can give a good approximate measure of soil fertility. Efforts to improve soil fertility or determine the most appropriate crop for a given plot of land must begin with a measure of N, P and K. Not surprisingly, most commercial fertilizers contain varying amounts of these three macronutrients. These percentages are reflected in the 3 numbers seen on bags of commercial fertilizer. A label of "16-16-16," for example, indicates 16% by weight for each—N, P and K.

Nitrogen (N)

Note: *You will find a review of the nitrogen cycle (Botkin and Keller pp. 66-67) to be very beneficial for this portion of the lab.*

Nitrogen may exist in several forms in soil:

A. Nitrates: various nitrate compounds (NO_3^-). Usually the most abundant and persistent form in agricultural soils. Nitrogen in this form can be used readily by plants.

B. Ammonia: NH_3 and NH_4+. Nitrogen fixation converts nitrogen gas (N_2) into ammonia. In the humus layers of forest soils (Organic and A horizons), the rate of this conversion may be quite high, resulting in high levels of ammonia. Ammonia is then converted to nitrites and nitrates by nitrifying bacteria in the soil. In most agricultural soils, ammonia levels are typically low since nitrogen fixation is not usually occurring at a high rate. This varies, of course, from one crop to another.

C. Nitrites: NO_2^-. Nitrites are formed as intermediates in the conversion of ammonia to nitrates. In well-drained and well-aerated soils they are found in only small amounts. Under these conditions, the conversion is so rapid that nitrites do not ordinarily accumulate. Excess nitrites are toxic to most plants; therefore, high levels indicate a soil condition that is not favorable for plant growth.

We will measure only *nitrate-nitrogen* levels in this exercise. Using the instructions in the soil analysis kit, measure levels of *nitrate-nitrogen* in your soil sample.

Phosphorus (P)

Phosphorus is required for seed formation, root development and plant maturity. It is especially important in the formation of color, fragrance and size of flowers. Phosphate complexes are generally found in crop residues and manure which decompose into forms that are useable by plants. Soil phosphate levels can also be increased by applying commercial fertilizers containing phosphate.

Using the instructions in the soil analysis kit, measure levels of phosphorus (P) in your soil sample.

Potassium (K)

Potassium strengthens stems and stalks and increases winter hardiness. It is also required for the production and movement of plant sugars and starches. It is sometimes referred to as "potash." Wood ashes, dried fish scraps, seaweeds and commercial fertilizers may be applied to boost potassium levels in soil.

Using the instructions in the soil analysis kit, measure levels of potassium (K) in your soil sample. Record all of your values for soil macronutrients on the data sheet.

5. Soil Texture

Soil texture is a physical soil property concerned with size of mineral particles—specifically, to the relative proportion of particles of various sizes in a given soil. Soils are generally made up of larger mineral fragments embedded in or coated with microscopic or submicroscopic particles called colloids and other fine materials. In some cases, larger mineral particles predominate and gravelly or sandy soils result, whereas in others, mineral colloids are more prevalent, leading to clayey soil characteristics. Soil texture is very important in determining plant growth by affecting nutrient, water, and air supply at the roots' levels.

To study mineral particles in soils, scientists usually separate particles into convenient groups according to size. In order of size, the largest soil particles are gravels (2.0 mm in diameter), followed by sands (between 0.02 mm and 2.0 mm dia.), then silts (between 0.002 and 0.02 mm dia.), with the smallest particles, clay, having diameters less than 0.002 mm (or 2 microns).

Using various *mechanical analyses,* a number of different classifications have been devised, and soils can be "rated" as sandy, silty, or dominated by clay. Generally, when sand dominates in a soil, it is coarse-textured, and it is called *light* because it is easily tilled and cultivated. On the other end of the spectrum, soils made up of mostly silt and clays are plastic and sticky, and are called *heavy* due to difficulties in tilling and cultivating them.

To test soil textures from your samples, the instructor has set up a demonstration using a soil sieve which seperates soil components on the basis of particle size. Also, you will use your soil test kits (settling time test) to ascertain texture. A simple field test that uses your sense of touch can be used to approximate soil texture. Try the following:

- Place a small (handful) sample of dry soil in the palm of your hand
- Add enough water to moisten it to the point that it can be worked with the fingers
- Knead the soil between thumb and fingers breaking up soil aggregates and removing any sticks, gravel or pebbles
- Estimate sand content by the amount of "grittiness" that is detected as soil is rolled between thumb and fingers (note: silt adds a "slippery feel" to soils):

    1. Sandy soils: more than 50% sand, sand dominates
    2. Loam or Clay loam soils: 20-50% sand, sand present does not dominate
    3. Silt loam, Silty clay loam or Clay soils: less than 20% sand, silt and clay dominate

- Estimate clay content by forming a ribbon as moistened soil is pushed up between thumb and index finger:

    1. Loam soils: less than 27% clay; ribbon is less than 1.5" long
    2. Clay and loam soils: 27-40% clay; ribbon is 1.5-3" long
    3. Clay only soils: more than 40% clay; ribbon is >3" long

Estimates of sand and clay content can be used to assign soil to a texture category:

	SAND			
CLAY		>50%	>20-50%	<20%
	>40%	Sandy clay	Clay	Clay or Silty clay
	27-40%	Sandy clay loam	Clay loam	Silty clay loam
	<27%	Sandy loam Loamy sand	Loam	Silt loam

Please clean and dry all soil kit components and pack neatly back in the case. Wipe down your lab table. Next week we will analyze the results from today's lab. Keep careful records and be prepared to share your data with other lab groups.

Environmental Science II
Soils Lab I Data Sheet

Soil Characteristics

	Site #1	Site #2	Site #3	Site #4	Site #5
% Organic Matter					
pH					
Nitrate N (lbs/acre)					
Phosphorus (lbs/acre)					
Potassium (lbs/acre)					
Soil Texture					

MATERIALS

Quantity	Materials and Equipment
1	Berlese apparatus (6-sample) with 50% ethanol supply
12	250 or 500 ml Erlenmeyer flasks
1	Soil sampler
1	Soil sieve set
12	Metric rulers
12	Safety goggles
12	Porcelain crucibles with covers
6	Ring stands and clamps (for crucibles)
6	Clay triangles for crucibles
6	Bunsen burners
6	Asbestos pads
6	Tongs (for crucibles)
2	Digital balances (0.01 g precision)
6	Asbestos gloves
6	Calculators
6	LaMotte soil testing kits
6	Large aluminum trays (for litter samples)
6	Plastic basins
24	Filter paper
12	Glass funnels
12	Wash bottles filled with water
12	Keys to soil invertebrates
6	pH meters (optional)
12	Glass stirring rods
6 books	Matches
12	Screw cap vials (approx 200 ml) for soil invertebrates
6	Needle probes
12	Fine ("watchmaker's") forceps
6	Aluminum pans (approximately 8" X 12" for drying soil samples)

NOTES FOR INSTRUCTORS

Today's lab begins our examination of physical and biological components of soils. This lab and the next examine various aspects of soil and how this information can be applied. After completion of these two labs, students should leave with a good understanding of:

- Chemical and physical components of soil (texture, pH, soil nutrients, etc.)
- Biological components of soils
- Appropriate uses for a plot of land based on soil characteristics
- The type of information that can be gathered from a county soil survey

SAMPLING DESIGN

I show an overhead slide of a county map which details general locations of soil sampling sites. Then I show a series of slides that illustrate general characteristics of each of the five study sites; these sites were selected to represent a variety of local soil types and land uses. Prior to lab, I collected soil and litter samples from each study site.

Assign sample sites to each of five groups of students and demonstrate how soil and litter samples were collected.

PROCEDURES

Each group will analyze soils from their study site as described on the lab handout. Soil analysis kits and other equipment are set up for each group on lab benches.

A. Soil Invertebrates in Leaf Litter

- Describe principle of operation for Berlese apparatus.

- Have students put a representative litter sample in Berlese apparatus; then they will pick through a portion of the litter sample manually. Place all invertebrates in vial for each site. The Berlese sample will be examined in next week's lab.

B. Organic Content

- Briefly describe procedure.

C. pH and Macronutrient Levels

- Follow instructions in soil kits.

- Safety concerns:
  1. Wear goggles where indicated
  2. Open flames
  3. Chemical contact with skin

D. Next week we will analyze the results from today's lab. Keep careful records and be prepared to share your data with other lab groups.

E. Student groups should enter their data on data sheet, and class data should be entered on a transparency so each group has access to data from all sites.

- Set up 5 soil samples (labeled from each of the five sites)
- Water supply, stirring rods, 500 ml beakers and soil sieve set
- Note differences in soil texture, color, clumpiness, etc.
- Particle size relative amounts of sand, silt and clay are very important in determination of other soil characteristics (nutrient and water retention, percolation rates, etc.)

There are several methods for making this determination:

1. Soil sieve (DEMONSTRATE)
2. Settling time (see soil kits)
3. Using sense of touch (especially useful in field)

Have students select a soil sample and illustrate how touch can be used to measure soil texture using directions provided in lab.

NOTE: For more on soils, please see NCSR *Soils* course.

REFERENCE

Huddleston, J.H. 1996. *Manual for judging Oregon soils*. Manual #6. Oregon State University Extension Service. Corvallis, Oregon. 93 pp.

Soils II
Analysis and Applications

INTRODUCTION

Last week we devoted most of our time to the physical and chemical analysis of soils. The focus of this week's lab is to apply what you have learned about soils to appropriate uses and management of land. In addition, we will examine the invertebrate community of soil ecosystems.

PROCEDURES

A. Examine the litter sample you placed in the Berlese Apparatus last week for extracted invertebrates (for identification purposes, see "key" provided):

1. Carefully pour the sample (in 50% ethanol) into a finger bowl or large watch glass and observe using the dissecting microscope.

2. Use available identification guides and keys to identify the various groups ("spiders," "earthworms," "springtails," etc.) and segregate each group into a separate container. BE SURE TO KEEP ALL SPECIMENS IN 50% ETHANOL SO THEY DON'T DRY OUT.

   NOTE: *Soil invertebrates are a diverse group and their identification can be a challenge for the novice. Consult instructor if you are having particular trouble with some specimens.*

3. Count the numbers of individuals for each group and record these numbers on the data sheet on the next page. Data from all locations will be shared with the class.

4. Respond to question #1 from the first soils lab. *Use your data* to answer #1 A and B; *use class data* to answer #1 C and D.

Soil Invertebrates

	Site #1	Site #2	Site #3	Site #4	Site #5
Springtails					
Earthworms					
Roundworms					
Beetles					
Beetle larvae					
Slugs					
Snails					
Flies					
Fly Larvae					
Millipedes					
Centipedes					
Proturans					
Pseudoscorpions					
Spiders					
Sowbugs					
Mites					
Ants					
Caterpillars					
True bugs					
Harvestmen					
(other)					
(other)					
Miscellaneous					
Total # Individuals					
Total # Species					

B. Now that soil characteristics and invertebrates are recorded both individually (as groups) and for the class, answer the following:

1. Soil Invertebrates in Leaf Litter

Use your sample data to answer a. and b.; use class data to answer c. and d.

- a. Identify the invertebrates in your litter sample and enter the data on attached data sheet.
- b. Construct a food web that represents energy flow in your sample.
- c. What differences are you finding between the invertebrate communities at the various sites? Use the data we have collected *and be specific.*
- d. What do you think accounts for these differences?

2. Organic Content

- a. Is the organic content in your sample relatively high or relatively low compared to other sites?
- b. What is the significance of this measurement for soil fertility?
- c. What do you think accounts for the differences between samples from different sites? Use information from other groups for comparison.

3. pH

- a. What is your interpretation of the pH measurement of your soil sample?
- b. Is it significantly different from other groups?
- c. What do you think accounts for the differences between samples from the various sites?

4. Macronutrient Levels

- a. What is your interpretation of values for nitrate, phosphorus and potassium obtained for your samples?
- b. Are any of these values significantly different from those of other groups? If so, explain why.
- c. Considering what you know about your site and nutrient cycling, what do you think are the *most likely sources* for each of these macronutrients?

C. Use information from the Polk County Soil Survey to answer the following questions about your soil sample:

1. What is the *specific* classification of your soil? Give numerical designation and any other labels that have been assigned.

2. In what *broad category* does your soil fall? Use the colored General Soil Map provided in the Survey. What are the *general characteristics* of soils in this area?

3. What is the average annual rainfall for your site? What limitations, if any, does this put on how this land might be used?

4. How common is your soil type in Polk County? What percentage of Polk County is represented by your soil type? (e.g., how many acres?)

5. An "animal unit month" (AUM) is defined as the amount of forage required to feed one animal unit (one cow, one horse, 5 sheep or 5 goats) for 30 days. If you decide to put your land into pasture, how many AUM's (if any) will your site support assuming you do not irrigate? How does this number change when you do irrigate?

6. Is your land suitable for growing winter wheat or barley? If so, how many bushels per acre would you expect to harvest?

7. Is your land suitable for the commercial production of trees? If so, what species is/are best to plant? What are the major woodland management concerns for this site? Assuming that one of your tree species is Douglas-fir, what is the "site index" for this site? What does this number mean?

8. Is your site suitable as a building site? What site or soil characteristics may limit the type of building that occurs on this site?

9. What kind of recreational activities would be most appropriate for your site? What site or soil characteristics may limit the type of recreation that occurs on this site?

10. What kind of potential does your site have for wildlife habitat? What species of wildlife would use the site if the habitat were developed?

11. Is your site at risk for flooding? If so, during which months?

12. If your site is to be used for agricultural purposes, would the pH of the soil need to be adjusted? Explain.

13. Based on your chemical analysis of macronutrients, if your site is to be used for agriculture, what type of fertilizer should be applied?

D. Assume you and your lab partners have just inherited 100 acres of the same land from which your sample was taken. Taking into account the preferences of your lab group and what you have learned about the characteristics and limitations of the soil, describe what you will do with this land. Prepare a two-page narrative that describes the objectives of your plan and how you intend to accomplish them. *Note: your plan* ***must make use of information*** *from last week's analysis and the county soil survey.*

The following questionnaire is adapted from a document prepared by a Resource Conservationist with the Natural Resources Conservation Service. It is used to assist land owners in planning for the appropriate use of their land. You do *not* need to answer each of these questions, but they may assist you in deciding what to do.

1. Do I need or want to do anything *actively* on my property? (e.g., for tax deferral, personal interest, income, enjoyment, etc.)

2. Do I need or want to make a profit on my activity? If so, how soon does the operation need to show a profit? (e.g., grapes or Christmas trees may take several years to realize any income)

3. What do I like doing? Could this operation be a hobby rather than a business?

4. How much time can I devote to this enterprise?

5. How much money can I invest in this enterprise?

6. Will livestock be part of my plan? Is the land suitable for raising livestock? If so, what species? Do I have the time, knowledge and physical ability to properly care for livestock?

7. Do I have the required machinery or will I need to rent or buy?

8. Is there a market for what I will produce?

9. What are the water requirements for my operation? Is this supply available?

10. What limitations do the soils, topography and location present that restrict what I can reasonably do?

Key to Soil and Litter Sample Invertebrates

PLEASE NOTE: Some immature insects such as fly larvae, beetle larvae and moth larvae may not key out.

1. Legs present 4
   Legs absent 2

2. Body spindle-shaped, smooth, unsegmented, slender, usually light-colored, minute (approx. 0.5-1.5 mm long)..**Phylum Nematoda** (roundworms)
   Body not spindle-shaped, or if spindle-shaped, animal is segmented, usually darker in color and 1.5 mm long..3

3. Body distinctly segmented and worm-like, shell absent..............**Phylum Annelida** (earthworms)
   Body not segmented, soft and smooth, with or without shell.. ....**Phylum Mollusca** (snails and slugs)

4. Three pairs of legs present..5
   More than three pairs of legs present..14

5. With functional wings..6
   Without functional wings..10

6. With only one pair of wings; second pair of wings replaced by a pair of short, pin-like structures (halteres)..**Order Diptera** (flies)
   With two pairs of wings..7

7. Front and hind wings similar in texture and thickness..8
   Front and hind wings unlike in texture; front wings may be horny or leathery..............................9

8. Wings usually covered with scales, sucking mouthparts.. ....**Order Lepidoptera** (moths and butterflies)
   Wings transparent, chewing or sucking mouthparts........................**Order Hymenoptera** (wasps)

9. Front wings horny or leathery and usually meeting in a straight line down the back, forming a veinless sheath over the abdomen; hind wings folded under front wings when not in use, chewing mouthparts..**Order Coleoptera** (beetles)
   Front wings thickened and leathery at base and membranous at tip, mouthparts a piercing-sucking beak arising from the anterior portion of the head...........**Order Hemiptera** (true bugs)

10. Abdomen terminating in two or three tail-like appendages (cerci); long antennae, chewing mouthparts..**Order Thysanura** (silverfish)
    No cerci at end of abdomen or, if cerci-like appendages are present, they are pointed in an anterior direction (i.e., the springs of springtails)..11

11. Narrow-waisted, chewing mouthparts ....**Order Hymenoptera** (ants)
Not narrow-waisted..12

12. Ant-like, but broad waisted and usually light-colored.............................**Order Isoptera** (termites)
Not ant-like...13

13. Small, delicate insects with long, usually double, appendages on underside of abdomen; chewing mouthparts (very common in litter samples!)..................**Class Collembola** (springtails)

Small, soft-bodied, plump insects with two short tubes at end of abdomen; piercing mouthparts in a beak that arises from back of head...........................**Order Homoptera** (aphids)

14. Four pairs of walking legs present, head and thorax fused to form cephalothorax Arachnida)..15
More than four pairs of walking legs present...18

15. First pair of appendages (pedipalps) with large pincer-like claws and abdomen distinctly segmented, generally less than 10 mm long...............**Order Pseudoscorpionida** (pseudoscorpions)
First pair of appendages not usually highly modified, abdomen not distinctly segmented, length is variable...16

16. Minute, total length less than 2 mm, body generally oval or shield-like.....**Order Acari** (mites)
Larger, total length greater than 2 mm, body shape variable 17

17. Cephalothorax distinct from abdomen, leg length less than 3X body length....................................
....**Order Aranae** (spiders)
Cephalothorax not distinct from abdomen, leg length greater than 3X body length.......................
....**Order Opiliones** (harvestmen, daddy-long-legs)

18. Two pairs of appendages per abdominal segment...........................**Class Diplopoda** (millipedes)
One pair of appendages per abdominal segment...19

19. Thorax composed of 8 overlapping segments, abdomen composed of 6 segments; 7 pairs of legs plus one pair of maxillipeds (anterior)..**Order Isopoda** (sowbugs)
Thorax and abdomen variable; more than 7 pairs of legs...20

20. Antennae with 3 distinct prongs, 9 pairs of legs..**Class Pauropoda**
Antennae not as above, more than 9 pairs of legs...21

21. Minute, total length less than 10 mm, 10 to 12 pairs of legs, poison claws absent on first trunk segment...**Class Symphyla**
Larger, total length generally more than 10 mm, generally more than 12 pairs of legs, poison claws present on first trunk segment..**Class Chilopoda** (centipedes)

MATERIALS

Add the following to materials list for the first soils lab:

Quantity	Materials and Equipment
6	County soil surveys
100	10 ml beakers (or other similar small containers for invertebrates)
24	Identification keys to invertebrates
12	Dissecting microscopes
12	Fine forceps
6	Finger bowls
12	Large watch glasses
12	Eyedroppers

NOTES FOR INSTRUCTORS

There are three primary objectives for today's lab (Soils Lab II):

1. Identify invertebrates in litter samples and compare the invertebrate communities at the five study sites.
2. Students should apply what they have learned about soils to identify appropriate uses of the land (appropriate land use should be based on physical, chemical and biological characteristics. of the site; and decisions should include essential elements of sustainable agriculture and ecosystem management).
3. Become familiar with the information available in local soil surveys.

Review procedure for processing invertebrate samples (segregation, identification and analysis):

- Empty soil invertebrate sample into finger bowl.
- Using fine forceps and eyedroppers, segregate invertebrates into 10 ml beakers or watch glasses containing a small amount of 50% ethanol.
- Identify soil invertebrates to level indicated on data sheet ("springtails," "nematodes," etc.) using dichotomous key and identification guides (describe use of dichotomous key).
- After identification is completed, *count* numbers of individuals for each invertebrate category.
- For those categories with >100 individuals, estimate the number of individuals being sure to assign a *number* rather than a descriptor such as, "lots n' lots!"
- Record data on data sheet.

Show videotape.

"Creatures of the Forest Soil" 1992. Communication Media Center, Oregon State University Corvallis, OR 97331 20 min.

This videotape describes common forest invertebrates and their ecological roles.

- Review food web basics (energy flow, trophic levels, etc.)

- Students should construct a food web for their study site

LAB PRODUCTS

Data sheets and answers to questions from both labs, as well as those to *procedures* in this lab.

REFERENCES

Borror, D.J. 1970. *A field guide to the insects*. Houghton Mifflin Co., Boston, MA 404 pp.

Borror, D.J., D.M. DeLong and C.A. Triplehorn. 1979. *An introduction to the study of insects*. 5th ed. Saunders College Publishing. Philadelphia, PA 827 pp.

Arthropod or insect identification guides such as the two above will assist in identification of soil invertebrate samples.

Moldenke, A.R. 1994. Arthropods: Chapter 24 in Methods of Soil Analysis, Part 2. Microbiological and Biochemical Properties — Soil Science Society of America, Madison, WI

This publication describes the various methods available for the collection, identification, preservation and analysis of soil arthropods. Extraction by the Berlese apparatus is described.

Biodiversity I
Field Trip—Wildlife Refuge

A. Introduction to the National Wildlife Refuge System

The National Wildlife Refuge System is one of the four cornerstones of the federal public lands system—National Wildlife Refuges, National Parks, Bureau of Land Management lands and U.S. Forest Service lands. In 1929, the Migratory Bird Conservation Act was passed to create wildlife refuges for migratory waterfowl. Money to purchase and manage wildlife refuges was to come from Migratory Bird Hunting Stamps ("Duck Stamps") required to hunt migratory waterfowl. Although originally established as "inviolate sanctuaries" for wildlife, hunting has been allowed on some wildlife refuges since 1948. Other extractive activities such as farming, logging, sheep and cattle grazing, mining and oil drilling are allowed on some refuges.

There are approximately 500 national wildlife refuges in the U.S. encompassing 92 million acres. They occur in all 50 states and all five U.S. territories. Funding levels for the refuge system are generally considered insufficient to maintain according to modern, science-based management philosophies. The operating budget for 1995 was $168 million—about $1/taxpayer/year. The refuge system operates at approximately $1.81/acre/year vs. $13.23/acre/year for National Parks. There have been a number of efforts in recent years to change the mission of wildlife refuges from one of wildlife protection to one that allows more extraction of commodities such as timber, oil and mineral reserves.

B. Baskett Slough National Wildlife Refuge (BSNWR) [Near Salem, Oregon]

During this field trip, you will become familiar with the following aspects of the refuge:

- life history characteristics of Canada geese
- management strategy for Canada geese
- other common bird species (record your observations on attached species list)
- recent "ecological restoration" efforts on the refuge
- elements of "ecosystem management" met and not met by refuge management
- current thinking on the value of small reserves such as BSNWR

From the table below, the following bird species are commonly seen in winter at BSNWR. Record all of your observations on that list by placing a check beside those species we observe while on the field trip. The number in parentheses after each species name is the page in the field guide (*) where that species is diagramed and discussed.

You will be responsible for the identification all bird species seen during the field trip that appear on this list.

Birds of Prey	Ducks, Geese and Swans	Wading Birds
Red-tailed hawk (72)* American kestrel (80) Bald eagle (78) Northern harrier (70)	Canada goose (42) Mallard (46) Northern pintail (48) Northern shoveler (50) Green-winged teal (50) Bufflehead (56) Ruddy duck (62) Tundra swan (40)	Dunlin (130) Great blue heron (96) American coot (106)

* Page numbers in Robbins, C.S., B. Bruun, and H.S. Zim. 1983. *Birds of North America—A guide to field identification*. Golden Books Publ. Co., Inc. New York, NY 360 pp.

C. Vegetation History of Willamette Valley

An appreciation for the current vegetation of the Willamette Valley requires an understanding of both plant ecology and Oregon's pre-settlement history. See attached article for details.

D. Kincaid's lupine and Fender's blue butterfly

The rare Fender's blue butterfly (*Icaricia icarioides fenderi*) is found only in remnants of native Willamette Valley prairie. Once thought extinct, it was rediscovered in 1989 and is now found at six sites, one of which is Baskett Slough Wildlife Refuge. The butterfly is found in close association with a rare plant—Kincaid's lupine (*Lupinus sulphureus kincaidii*). Although we will not see the butterfly today, we can see the habitat and perhaps the basal leaves of this plant. Adult butterflies emerge in May, the female mates and lays eggs on the lupine where the larvae hatch and feed on the plant. In a curious relationship, ants tend the larvae of the butterfly and protect them from predators. In return, ants feed from the larvae's "honey-secreting" gland. The male Fender's Blue is more showy than the female, and reveals its sky blue color when it opens its wings. Revisit this site in May or June to have a look at this rare species.

Willamette Valley Vegetation History

The Willamette Valley was seen as "A Garden of Eden" at the end of a long and perilous journey by the first Euro-American pioneers to cross the Oregon Trail. From their accounts we know that the valley was dominated by tall grasses and deep, fertile soils. When the first pioneers arrived they found not a deep, impenetrable forest but rather a park-like landscape of open meadows dotted with large oak trees. Although unknown to the early settlers, this ecosystem was not "natural," or undisturbed by humans, but rather, it was one that had been carefully managed by Native Americans of the area (the Kalapuya tribe) for tens of thousands of years. The Kalapuyas periodically burned the valley to promote the growth of plants and animals that were essential to their culture and diet.

The Native people burned the region regularly, to promote stable and easily accessible populations of deer, waterfowl, grasshoppers and a variety of early successional plants. Foremost among these was camas lily, the staple of their diet. While most of the coastal tribes such as the Chinook tribe of the Columbia River and the Coast Salish of Puget Sound relied heavily on salmon as their main food source, the Kalapuyas apparently relied more heavily on plants as a food source. Perhaps for this reason, lower population densities of Kalapuyas were supported. It has been estimated that at their peak, the Kalapuyas numbered about 13,500 or approximately 50 per square mile.

In the absence of fire, successional changes resulted in the disappearance of camas and the appearance of later successional stages dominated by Garry oak on dry sites and a mixture of cottonwood, alder, bigleaf maple, grand fir and Douglas-fir on wetter sites along rivers and streams and on north slopes. Geographical and climatic factors made lightning strikes and natural fires a rare (yet far from nonexistent); therefore, the Kalapuyas would set their own fires. Fires were set on alternate sides of the Willamette River to assure that while one area was being regenerated the other could be used for home sites. In the early 1800s, early explorers of the Willamette Valley, including English botanist David Douglas, commented in their journals about the "burned over nature" of the land. By burning the Willamette Valley periodically, the Kalapuyas altered the natural ecosystem in such a way that made it more suitable for their needs. The intersection of this prairie ecosystem with the forested ecosystem of the foothills of the Coast Range and the Cascades Range provided ideal habitat for deer and elk, which were also important sources of food. Native grasses would proliferate in burned areas when the fall rains came. These native grasses attracted grazing waterfowl such as geese, ducks, swans and other species. These waterfowl would concentrate on the burned-over prairie/savannahs, thus making hunting much easier. The grassy meadows also supported large populations of grasshoppers which were collected, baked and eaten as a supplemental food source.

In the absence of fire, Garry oak (*Quercus garryana*) would grow in dense stands in which individual trees were in competition with each other and other species. Frequent fires, which were tolerated by the oaks due to their thick bark, opened up these stands and enhanced production of another important food source to the Indians—acorns. Results were human-created landscapes which dominated the Willamette Valley—prairie savannahs dotted by large, sprawling, open-grown oaks referred to as "savannah oaks," a name derived from the similarity with vegetation in savannah biomes such as the Serengetti Plains of Africa.

Although it is clear from journals of David Douglas that he regarded the Kalapuyas as "inferior savages," from what we know of their culture, they had a deep awareness of their environment and the knew ways to alter it for their benefit. Like so many other Native Americans, contact with Euro-Americans led to the demise of the Kalapuyas. A number of factors contributed to their decline. First, exposure to European diseases took their toll—the Kalapuyas had no immunity to diseases such as smallpox, venereal disease and malaria—all were brought in by European settlers. In addition, starvation resulted from the disruption of their food-gathering culture. Their practices of periodic burning of the valley, followed by the gathering of food, were simply not compatible with European systems based on permanent agriculture and grazing livestock. By the mid-1840s, the demise of the Kalapuyas was nearly complete—only 300 remained. With the decline of the Kalapuya culture, areas of the Willamette Valley that were not put into cultivation by European settlers reverted to natural successional changes. Dense oak forests and scrub oaks replaced the previous savannah.

Today, the vegetation of the Willamette Valley is dominated by introduced grasses grown for animal feed and grass seed. On the uncultivated knolls of the valley, such as those on Baskett Slough National Wildlife Refuge, a plant community dominated by Garry oak and a mixture of native and introduced grasses can be seen. Two distinct age classes of Garry oak can be identified. The larger diameter, sprawling *savannah oaks* are remnants of those that were present during the reign of the Kalapuyas. Core samples from these trees indicate that their average age is 293 years. The smaller diameter, straight-trunked, *forest grown oaks* appear in dense stands on these knolls. They represent those trees that were able to reproduce as the fires of the Kalapuyas were extinguished. Their average age is about 100 years. Age classes between these two extremes are virtually non-existent.

NOTES FOR INSTRUCTORS

This three-hour field trip is designed to illustrate an example of an area that is managed primarily for the preservation of biological diversity. Efforts to incorporate ecosystem management are emphasized. We are fortunate at Chemeketa Community College to have a national wildlife refuge within a 30 minute drive from campus. Recognizing that not all colleges will have this resource so close at hand, a number of alternative areas may be substituted. Public lands such as state and county parks, national forests, research natural areas, state fish and wildlife areas, etc., can be used to illustrate the main points. Lands managed under an ecosystem management philosophy will be particularly useful. The instructions and notes included here are written specifically for Baskett Slough Wildlife Refuge in western Oregon and are included to give some indication of the types of information and experiences provided to students. Obviously, the content would have to be modified to accommodate other sites.

The primary objective of the field trip is to have the students see how wildlife management is implemented at a refuge that is being managed under the philosophy of ecosystem management. Also, natural history of the area is described, with particular emphasis on American-Indian activities and land use prior to European settlement.

MATERIALS

Quantity	Materials and Equipment
note: students will be in pairs.	
12	Binoculars
1	Spotting scope
12	Bird identification guides
24	Clipboards
24	Student handouts

Introduction to the National Wildlife Refuge System

The National Wildlife Refuge System is one of four cornerstones of federal public lands system—National Parks, Bureau of Land Management and U.S. Forest Service are the other three.

In 1929, the *Migratory Bird Conservation Act* was passed to create wildlife refuges for migratory waterfowl. Important points:

- under the control of the Secretary of Interior (now Bruce Babbitt)
- oversight agency is U.S. Fish and Wildlife Service (USFWS)
- operated as "inviolate sanctuaries"
- money to purchase and manage wildlife refuges was to come from Migratory Bird Hunting Stamps ("Duck Stamps") required to hunt migratory waterfowl; hunting has been allowed on some wildlife refuges since 1948 (40% was "huntable" by 1959)
- other activities are allowable—farming, logging, sheep and cattle grazing, mining and even oil drilling; technically, these activities must be done without harming wildlife, but this is not always the case

There are approximately 500 national wildlife refuges in U.S., encompassing 92 million acres Malheur Wildlife Refuge and Klamath Basin Wildlife Refuge are large Oregon examples. Over one-third of these areas are in wetlands. Wildlife refuges are found in all 50 states and all five U.S. territories.

Inadequate funding is a persistent concern:

- $168 million for 1995—about $1/taxpayer/year
- the system operates at approximately $1.81/acre/year vs. $13.23/acre/year for National Parks

National Wildlife Refuge management issues are commonly reported in the news:

- Representative Donald Young (R-Alaska) has proposed a bill (National Wildlife Refuge System Improvement Act) that would give hunting, fishing, and other recreational uses priority in management decisions. It also allows for commercial uses, agricultural, and mining. The bill is supported by National Rifle Association. Current law allows these activities *only if* they are compatible with wildlife management.

- For years now, the *Arctic National Wildlife Refuge* has been proposed to be opened for oil exploration.

Baskett Slough National Wildlife Refuge
Added note to instructors: the following is intended as a local example of ecosystem management practices and issues surrounding BSNWR. You are encouraged to find and present similar local information to your students.

Baskett Slough National Wildlife Refuge (BSNWR) is approximately 2400 acres in size and is one of three National Wildlife Refuges that have been established in Oregon for the threatened Dusky Canada goose (*note:* all of these properties are managed by a single wildlife biologist!).

Dusky Canada goose is one of seven subspecies of Canada geese that occupy the refuge. Subspecies differ somewhat genetically, and they are adapted for different conditions—naturally selected for different colors, sizes, beak shape, size, etc. The western Canada goose is one of the larger subspecies and the only one to nest in the Willamette Valley—although it is not native to this area!

Population Status:

About 250,000 Canada geese over-wintered in the Willamette Valley in 1999. This number has dramatically increased since the mid-1970's when populations were approximately 40,000. The population size *doubled* from 1993 to 1996! The Aleutian Canada goose (one of the 7 subspecies present) is already listed as "federally threatened" under the Endangered Species Act. The Dusky Canada goose has been in decline since the mid-1970's and is being considered for federal status. Declines from 20,000 in the mid-1970's to 9000 in 1997 to less than 8000 in 1999 have occurred.

Mounts of Dusky and Taverner's Canada goose are later shown in class to illustrate differences between subspecies.

Reasons for Goose Decline
A combination of several factors:
- hunting mortality on wintering grounds (especially prior to 1975)
- loss of wintering habitat (development of wetlands in Willamette Valley)
- changes in breeding grounds in Copper River Delta in Alaska due to an earthquake in 1964 that raised the delta two to six feet draining water from nesting grounds. This has had two effects that have contributed to the decline of Dusky Canada geese:

1. allows access to eggs and chicks by mammalian predators such as wolves, coyotes, bears, foxes and raccoons
2. vegetation changes from mixed forb/low shrub community preferred by geese to large shrub community (alder and willow)

Goose Management:
1. On the breeding grounds in Alaska

- Artificial nest islands have been built on the delta to provide more protected nest sites away from shrubby cover.
- Relaxation of hunting regulations on coyotes and translocation of bears
- Transplant Dusky Canada geese to an island 60 miles offshore in an attempt to establish an additional breeding site (first successful nesting occurred in 1996)

2. On the wintering grounds in the Willamette Valley

- Vegetation management: a single farmer leases land on refuge and plants grass crops which feed geese in winter; farmer harvests remains of grass crop under a "cooperative farming agreement." Strict regulations determine when farmer can occupy fields, apply fertilizer, etc. Annual ryegrass and fescue are planted as high protein food source for geese. Geese arrive in October and leave in April when they migrate to the Copper Delta in Alaska for nesting (Therefore, greatest value of refuge is as wintering habitat; summer diversity and abundance on refuge are lower).

- Hunter education is required for goose hunting in Willamette Valley. This includes instruc tion on identification of different subspecies of geese to reduce hunting mortality on Dusky Canada goose. Once a quota of dusky's (165 in 1999) is reached for the year, hunting is terminated for that season.

- Ecological restoration efforts will be discussed later.

On wintering grounds on the refuge, main predators are bald eagles and golden eagles. Geese respond immediately to these predators, but will ignore red-tailed hawks, and even coyotes, which feed almost exclusively on mice on the refuge.

Wildlife-Agriculture Conflict
Farmer-goose conflict has been well-publicized and is currently being evaluated. Farmers contend that geese damage grain and grass seed crops in winter. There is great concern that an ESA listing for Duskys would have severe impacts on Willamette Valley farmers.

"The farming community doesn't want any more refuges since they are frustrated over refuge management and loss of property on the tax rolls. Most important, the reduction of green forage areas on the refuges is causing farmers increasing losses on their lands. The only avenue left is to compensate farmers for their losses." Gerry Pavelek, Marion County farmer, Capital Press (9/3/99)

- Geese probably do not recognize refuge boundary. Propane cannons and other hazing techniques are being used to scare geese off farmers' fields
- In a 1997 study conducted by Oregon Department of Agriculture, Oregon farmers reported $14.9 million in damages caused by geese
- A 1996 study done by O.S.U. found that winter wheat fields damaged by geese had 36% lower yields than fields without geese
- Winter wheat can be damaged at tender stage in winter. Geese may pull it from the ground; therefore, farmers are being advised to not plant that crop in high goose concentration areas.
- Interestingly, annual ryegrass and fescue yields from fields that are grazed by geese are equal to or exceed those that are not grazed by geese!
- Damage to annual rye grass fields appears to be largely due to water damage or slug damage

- Farmers are eligible for "Wildlife Damage Reimbursement" from USDA if damage is 50% or greater. Some farmers actually want to assure that damage is at least at this level to be sure to get this payment from government.
- Farmers that are adjacent to refuge sell hunting rights for $700-1000/year/ hunter. This income would not be possible without refuge as a reservoir of geese.
- In 1998, a new program that expanded hunting seasons for Canada geese and teamed up farmers with hunters was designed to address concerns over crop losses incurred by farmers. *From a high vantage point on the refuge, students assess goose grazing patterns which can be clearly seen over large areas. Heavily grazed areas appear dark with exposed soil, un-grazed areas appear green with intact vegetation and partially grazed areas are intermediate.*

BSNWR and other refuges study field use by geese to determine those characteristics of fields that are used most heavily. Generally geese favor fields that do not have fencerows that may harbor predators (many farms have fencerows removed), and those that are adjacent to open water. Geese tend to shun upland fields that are drier and adjacent to woodland. For this reason, fields that were originally maintained for geese (e.g., those that skirt Baskett Butte) are being allowed to return to native grasslands which will harbor other species (e.g., Fender's blue butterfly).

The relationship between current and historic vegetation patterns, pre-European cultural practices and wildlife management are discussed.

Kincaid's lupine and Fender's blue butterfly

Most wildlife preservation centers on vertebrate animals (vs. plants and invertebrates) despite the fact that over 50% of Earth's 1.5 million species are insects. For lands managed under ecosystem management, however, there is a need for consideration of the entire system. BSNWR harbors a diversity of plant and animal species that directly or indirectly are associated with the primary management target, the Dusky Canada goose. Included are a plant (Kincaid's lupine) and a butterfly (Fender's blue butterfly).

- Fender's Blue butterfly is found in only 6 prairie remnants in Willamette Valley (some support fewer than 50 butterflies!)
- Once thought to be extinct, rediscovered in 1989 in MacDonald-Dunn Forest in Benton County (prior to that it was known only from collections from 1929 to 1937)
- There is a close association between the butterfly and Kincaid's lupine:
  1. Adults emerge in May, mate and lay eggs on lupine
  2. Larvae hatch to feed
  3. Larvae over-winter and transform into adults the following spring
  4. Ants tend the larvae and protect them from predators while feeding from the secretions of a special gland on body of larvae (high sugar content)

USFWS is currently (8 March 1998) reviewing a proposal to list Fender's Blue and Kincaid's lupine as threatened species. Both are already listed as "state threatened" by Oregon under the Endangered Species Act of 1987.
Kincaid's Lupine—a long-lived perennial reaches 2 to 3 feet in height; occurs on 51 remnant sites totaling 360 acres of native prairie in Yamhill, Polk, Benton and Lane counties (about half are at

Baskett Slough). Most sites are roadsides and fencerows in populations that are too small to support butterfly populations. Habitat once spread for more than a million acres in the Willamette Valley before settlement in 1840's. Since then more than 99% has been lost to agriculture. Even in protected areas such as BSNWR species are not safe due to invasion of non-native grasses and shrubs (crowd out native species).

Bird identification at 3 observation points
Commonly seen winter species include:

Birds of Prey	**Ducks, Geese and Swans**	**Wading Birds**
Red-tailed hawk	Canada goose	Dunlin
American kestrel	Mallard	Great blue heron
Bald eagle	Northern pintail	American coot
Northern harrier	Northern shoveler	
	Green-winged teal	
	Bufflehead	
	Ruddy duck	
	Tundra swan	

Ecological restoration

In addition to vegetation management and hunter education, there are a number of more recent wildlife management activities that fall under the heading of **ecological restoration**. These efforts began in 1995 and include the following:

1. Changes in hydrology by adding earth levees to increase water holding capacity. Several levees have been added along a canal that was originally installed along with tiling to drain these fields for farming. The canal can be seen perpendicular to new road in viewing area. Several shallow water wetlands have been created as a result (about 400 acres of what were originally fields). Note the relatively flat topography on map. Ponds have maximum depth of 18 inches. This has improved habitat for waterfowl and probably contributed to increases in diversity and numbers geese, ducks, wading birds and other wetland species. Recall that based on observations of grazing patterns, geese are more likely to use fields adjacent to open water. Therefore, by increasing availability of open water, more fields are being used.

   Water control structures exist at each levee to control water level on refuge ponds. Therefore, a drawdown-flood cycle can be maintained to encourage germination and development of native aquatic vegetation. Over time, refuge wetlands will change from open shallow water to that more typical of marsh with emergent vegetation (cattails, rushes, etc.).

2. Steep-sloped, upland fields that are adjacent to woodlands have been taken out of farm program to encourage native grasses and, therefore, other wildlife species. This reflects a broadening of management goals beyond "goose management" (i.e., ecosystem management vs. single species management of a few years ago).

3. Planting programs of various types:

   - various grasses as food for geese
   - native riparian vegetation (alder, maple, willow, etc.) in fall 1996 by private organizations in cooperation with USFWS
   - test plots of Romer's fescue in an attempt to generate a seed source for this native grass that is thought to have been the dominant native grass prior to European settlement of this area
   - establish large areas of native grasses

4. Construction of artificial islands which serve as safe havens for waterfowl. These islands are heavily used in winter.

5. Road improvements and construction of new observation sites have improved public access

6. Restoration efforts at BSNWR are part of a larger program, *Oregon Wetlands Joint Venture*, intended to restore over 2000 acres of Willamette Valley wetlands. A number of partners are involved including U.S. Fish and Wildlife Service, Ducks Unlimited, Oregon Waterfowl and Wetlands Association, U.S. Bureau of Reclamation and U.S. Natural Resources Conservation Service.

Questions for discussion

Based on your understanding of the goals of ecosystem management and wildlife management at Baskett Slough National Wildlife Refuge, is "ecosystem management" being practiced here? What elements are missing? What elements are there? Consider the following in your answer:

1. Is this single species management or are multiple species being considered? What is the management unit at the refuge—single species, groups of species or the entire ecosystem? How do you know?
2. Is BSNWR "connected" to other refuges? If so, how? How could this connectivity be improved for at least some species?
3. Is this an "artificial ecosystem," "natural ecosystem," or something in between? Explain.
4. Which *ecosystem processes* are being preserved as a result of management efforts?
5. Are the management scales of time and space appropriate for this ecosystem? Explain.
6. Are human requirements (hunting, agriculture, recreation, esthetics) being met at this refuge? How?
7. What actual or potential conflicts exist between "human requirements" and "wildlife requirements"?

REFERENCES

Shafer, C.L. 1995. *Values and shortcomings of small reserves*. BioScience 45(2):80-88.

This article contains much relevant information for this field trip and is summarized in the following:

Recent research in conservation biology points to the importance of maintaining large preserves to preserve all native species that are characteristic of an area. However, fragmentation has reduced most landscapes to a mosaic of small, undisturbed areas in a sea of disturbed habitats. All but the largest reserves are too small for wide-ranging species such as large carnivores.

This article provides some answers to the question—"Is it worthwhile to preserve small tracts?" It has been suggested by some wildlife managers that we trade off some small reserves for seeking larger tracts.

How do we get large preserves?

1. One approach — "umbrella species"— generally a wide-ranging species (grizzly bear, spotted owl) that is managed in hopes that "lesser species come along for the ride." Choice of umbrella species is important—*does it really meet needs of all other species?*

2. Another involves connecting existing preserves (especially Wilderness Areas) with corridors. However, many of these are found at high elevation and thus, provide limited coverage of other habitats.

What is role of small reserves?

1. Some habitats (e.g., tall grass prairie) have been so altered that only a fraction of original habitats exists.
2. Small reserves may be important refuges when associated with larger preserves and may guard against chance losses due to catastrophic events. For some species they may be important stop over points in dispersal between other reserves.
3. Many species are preserved as *metapopulations*—series of populations that go locally extinct are then recolonized. It is, therefore, best not to have "all of your eggs in one basket."
4. Even if small reserves may not preserve populations of large vertebrates they may be important for smaller organisms (insects, birds, amphibians, etc.).
   - Some Indiana cemeteries still have a significant number of prairies plants and insects
   - A national refuge 40 mi. SE of San Francisco (60 acres) is established for insects and plants.
5. Small fragments may be cores of larger future preserves.
6. Value may not be directly related to species richness (recreational value, educational value, etc., may be more important).

What problems are associated with small reserves?

1. Small reserves lose biodiversity and may erode (domino effect). In Brazil, the loss of wallowing mammals resulted in loss of temporary ponds used by frogs.
2. Small reserves are vulnerable to natural catastrophes (fire).
3. Edge effects.
4. Inbreeding and lack of genetic diversity.

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Biodiversity II
Northern Spotted Owl Habitat Associations

The determination of **habitat associations** for threatened and endangered species is an important responsibility for wildlife managers. Their decisions often carry consequences for the species of concern as well as private land owners or public land management agencies such as the Forest Service or the Bureau of Land Management.

How might we determine habitat associations for a given species?

Although a number of methods have been devised to make this determination, a simple approach is described below using the northern spotted owl as an example.

It had long been suspected, based on anecdotal information, that spotted owls were associated with late-successional forests. These forests apparently contain habitat components to which the owls are specially adapted, such as large trees, specific microclimates, availability of nest sites and preferred foods.

How could this hypothesis be tested?

One way is to survey spotted owls—noting the habitat that they are found, and analyzing the resulting data. To carry out this analysis, it is especially important to know the abundance of various forest types that are available to the owls. *Work through the activity below to see why.*

1. Let's assume (hypothetically) that forest types in western Oregon and Washington are classified according to age categories, and the abundance of each category is found to be as follows:

	Sapling (0-10 yrs.)	Young (11-79 yrs.)	Mature (80-200 yrs.)	Old Growth (200 yrs.+)
% of Acreage	25	25	25	25

As spotted owls are found, they, too, are counted and tallied according to the forest type in which they are encountered. Let's suppose that after 100 owls have been tallied, the results look like this:

	Sapling (0-10 yrs.)	**Young (11-79 yrs.)**	**Mature (80-200 yrs.)**	**Old Growth (200 yrs.+)**
% of Acreage	**25**	**25**	**25**	**25**
# Spotted Owls	**25**	**25**	**25**	**25**

What conclusion concerning habitat preferences of spotted owls would you draw from these results?

2. What if the situation was found to be as represented in the table below?

	Sapling (0-10 yrs.)	**Young (11-79 yrs.)**	**Mature (80-200 yrs.)**	**Old Growth (200 yrs.+)**
% of Acreage	**25**	**25**	**25**	**25**
# Spotted Owls	**5**	**10**	**25**	**60**

What conclusions would you draw from these data? Explain.

3. A third scenario

	Sapling (0-10 yrs.)	**Young (11-79 yrs.)**	**Mature (80-200 yrs.)**	**Old Growth (200 yrs.+)**
# Spotted Owls	**60**	**25**	**10**	**5**

What conclusions would you draw from these data? Explain.

4. What if the distribution of forest acreage was not equal for each stand age (a far more realistic scenario)?

In the table below, fill in the distribution of owls in this forested landscape that would suggest *no preference* for stand age. (That is, spotted owls do not select stands based on the age of the stand.)

	Sapling (0-10 yrs.)	**Young (11-79 yrs.)**	**Mature (80-200 yrs.)**	**Old Growth (200 yrs.+)**
% of Acreage	**10**	**60**	**20**	**10**
# Spotted Owls				

Note that in the scenario above, spotted owls are detected far more frequently in young stands than any other stand type. To the uninitiated, this might be interpreted as spotted owls preferring young stands, but this would not take into account the distribution of available habitat.

From this exercise, and specifically the scenario in Question #4, how would you describe the relationship between owl distribution and available habitat?

Now—What is the actual situation?

The tables presented up until now contain purely hypothetical data to give you some experience with these concepts. Although we do not have exact data for the actual situation, the table below provides a good approximation for Pacific Northwest forests within the range of the northern spotted owl in Oregon and Washington. Forest acreages by age were derived from Oregon Department of Fish and Wildlife digital maps of land cover. Owl numbers represent summaries from ten studies of habitat used by spotted owls that have been conducted since 1975 (note that hypothetical data presented in question #4 closely follows acreages presented).

	Sapling (0-10 yrs.)	Young (11-79 yrs.)	Mature (80-200 yrs.)	Old Growth (200 yrs.+)
% of Acreage	18	55	21	6
% Nest Sites	0	7	13	80
% Foraging and Roosting	2	9	14	75

What conclusions would you draw from these data (*only!*) concerning habitat preferences of spotted owls? *Explain.*

If spotted owls showed *no preference* for forest type, what distribution of owls would be expected?

Fill in the table below.

	Sapling (0-10 yrs.)	Young (11-79 yrs.)	Mature (80-200 yrs.)	Old Growth (200 yrs.+)
% of Acreage	18	55	21	6
% Nest Sites				
% Foraging and Roosting				

Conclusions—What we do we know about spotted owl habitat? (excerpted from Thomas, et al. 1990)

"With the exception of recent studies in the coastal redwoods of California, all studies of habitat use suggest that old-growth forests are superior habitat for spotted owls. Throughout their range and across all seasons, spotted owls consistently concentrated their foraging and roosting in old-growth or mixed-age stands of mature and old-growth trees. For nest sites, owls use primarily old-growth trees, whether in old-growth stands or in remnant old-growth patches.

"Structural components that distinguish superior spotted owl habitat from less suitable habitat in Washington, Oregon and northwestern California include:

- a multilayered, multispecies canopy dominated by large conifer overstory trees
- an understory of shade-tolerant conifers or hardwoods
- a moderate to high (60-80%) canopy closure
- large, live coniferous trees with deformities (cavities, broken tops and dwarf mistletoe infections)
- numerous large snags
- ground cover characterized by large accumulations of logs and other woody debris
- a canopy that is 'open enough to allow owls to fly within and beneath it'.

"Several possibilities might explain why spotted owls select forests with old-growth structure. For foraging, such forests may have higher densities of preferred prey. Another possibility is that owls are able to forage more efficiently in old stands because of the openness of the individual canopy layers and the range of foraging perches from near-ground height to the upper canopy. Selection of old stands for nesting is most likely related to the high availability of suitable nest trees in such stands. Unless they contain remnant old growth trees, young stands generally provide few suitable nest sites. Selection for roosting in old growth stands may be related to thermoregulation. Barrows and Forsman reported that spotted owls tend to roost in small trees in the forest understory during warm weather and high up in larger trees during cold or wet weather. The layered canopy structure in old forests provides both types of roosts, whereas even-aged stands tend to include one roost type but not the other."

Literature Cited

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Biodiversity III
California Condors Case Study

INTRODUCTION

Biodiversity is the measure of the various types of organisms that currently inhabit the Earth. It may be measured at a number of different levels—genetic, species, or ecosystem level. The simplest measure of biodiversity is the total number of organisms on Earth—which has been estimated by some biologists to be approximately 30 million. Biodiversity at the genetic level refers to the great degree of genetic diversity within and between species. At the ecosystem level, we are concerned not only with a count of individual species, but also with measures of the interaction between these species and the abiotic environment.

In recent history, the loss of biodiversity has become one of our most discussed and controversial environmental problems. The "biodiversity crisis" as it has been labeled has been described by the National Academy of Sciences as the most pressing and irreversible environmental problems we face. Present extinction rates rival those of mass extinctions, including those that wiped out the dinosaurs 65 million years ago.

In today's laboratory, we will examine the biodiversity crisis. Today you will be asked to formulate opinions concerning steps that should be taken to reverse the trend. A case study in the preservation of one species—the California condor—will be explored in detail. Although some of the questions below will require relatively simple one or two-sentence answers, most are "thought questions" that require a more detailed response. For those questions that require an opinion, you will be evaluated on how well you state and support your opinion rather than whether or not I agree with it.

PROCEDURE

I. A case study—the California condor

In groups of two to three, carefully examine the following resources, and answer the questions which follow.

- Read the "Supplemental Information/California Condors" sheet at the end of this lab.
- View the videotape, *Shadow of the Condor*. 1993. NOVA: WGBH-TV Boston, MA.
- Cohn, J. 1999. *Saving the California condor*. BioScience 49(11):864-868.

- Condor web sites:
  The Peregrine Fund: www.peregrinefund.org/condrel.html
  U.S. Fish and Wildlife Service: www.fws.gov/r9extaff/biologues/bio_cond.html
  San Diego Zoo: www.sandiegozoo.org/cres/condor.html
  Los Angeles Zoo: www.lazoo.org/condorlead.html

Answer the following on a separate sheet of paper.

1. At last count, how many California condors were in existence, and where were they located?

2. What factors have contributed to the decline of the condor?

3. What federal, state and private organizations are involved in condor recovery?

4. At what population level was it decided to bring in to captivity the last wild Condors?

5. What is "double clutching" and what significance does it have in captive breeding programs?

6. What is the status of captive-bred California condors that have been released into the wild?

7. What criteria must be met before the California condor can be *down-listed* from "endangered" to "threatened"?

8. What barriers exist that might prevent these criteria from being met? Do you think the species will ever be represented by self-sustaining populations in the wild? Why or why not?

9. Like many species recovery programs, the Condor Program has been the center of some controversy. The comments below represent viewpoints that have been voiced by concerned citizens concerning condor recovery. Discuss your responses to these statements with your group members. Then, clearly state your viewpoint on each and your reasons for these opinions. Imagine that you are trying to convince someone with an opposite view, of *your* position. If opinions differ among group members (which is fine), be sure that your final answer reflects everyone's viewpoint.

   - "We should not invest $25 million on recovery of a single species with perhaps questionable hope for recovery when the money could be spent elsewhere to assist several other species with greater hope for recovery."

   - "The last wild individuals of a species should not be brought in for captive breeding programs when the problems that have caused the decline of the species in the first place still exist."

- "If condors want to go extinct, that's their business. Spend my hard-earned tax dollars on *something worthwhile*!"

II. American-Indian cultural perspectives—complete assignments on pages 65-70.

III. Loss of biodiversity—Solutions

In your groups, using these resources, answer the questions which follow.

- Eisner, et al. 1995. *Building a scientifically sound policy for protecting endangered species*. Science. 268:1231-1233.
- Mann and Plummer. 1995. *Is the Endangered Species Act in danger?* Science 267:1256-1259. Botkin and Keller: *Chapter 12*

Note: Attempts should be made to reach consensus within your group through discussion. In cases where consensus cannot be reached, answers should reflect all opinions in the group.

1. Of the various consequences of the loss of biodiversity, which one carries the greatest weight for you (personally) and why?

2. In your view, how effective has current legislation (especially the Endangered Species Act of 1973) been in the preservation of biodiversity in the United States?

3. What plan would you offer that preserves the natural biodiversity in the United States?

4. What other aspects of society will be negatively affected by your plan and how would you address these concerns?

American-Indian Cultural Perspectives—*Condors*

Objectives

1. To introduce students to Native American cultural perspectives regarding the condor, or *Thunderbird*.

2. To present historical and anecdotal information on the condor regarding its place in indigenous culture; including social, religious, and economic significance.

3. To inspire discussions about how Native peoples related to their environment; e.g., holistic approaches.

4. To present the Chumash Indian Story, "Coyote, Eagle, and Condor."

5. To raise questions regarding "special rights" of Native Americans; using the condor as an example of an endangered species in this and other contexts.

Suggested References

Koford, Carl B. *The California Condor*. New York: Dover Publications Inc. 1953.

California Department of Fish and Game studies on condors.

Audubon Society studies, research, and documentation.

Mayan heritage and culture anthropological research/studies.

Native Myths, Legends, and Stories from different tribes.

Popul Vuh. *Creation Myth of the Maya* (V685); obtain from Humboldt State University Library, Arcata, Ca. (707-826-3440).

Introduction

A historical review of myths originating from California Native tribes and their neighbors can reveal some interesting information about the Condor, although such information is relatively hard to find. For example, we can determine that geographically the Condor was known to indigenous people ranging from southernmost sections of California (some tribal territory extended into Mexico) to Canada (coastline of British Columbia). Extensive research of Native mythology does not reveal information under the topic of Condor, *per se*, except in the documents provided by the famous anthropologist A.L. Kroeber (*Yurok Myths)*. Rather, one must search under the topic of *Thunderbird* in order to find indigenous peoples' information about Condor birds.

The symbol of *Thunderbird* can be found in ancient rock drawings, carved in totem poles, and in stories normally shared with younger Indian people. These sources have been recorded in early anthropological records.

The rhetorical question can be asked, "Why did Native people call the Condor a 'Thunderbird'?" It was most obviously due to its profound size, being the largest of any other bird on the North American continent, and most probably as a result of the large roar and pounding sounds that it made while coming out of the dark clouds or fog while trying to get away from a lightning and thunder storm, and during times of landing and take off from the ground. The majority of us in contemporary society, Indian or non-Indian, have never seen a Condor. If we did, we would probably be awed, frightened, intrigued, and amazed at the size, strength, appearance, and power of such a gigantic creature. Symbolically, we would have to describe this awesome and mysterious bird, as the Indians did, in terms of supernatural significance rather than everyday physical reality.

The *Thunderbird* was not consumed as a source of food by Native American people, perhaps for logical reasons involving health and disease. Indian people would no more eat a Condor, even if they were starving, than they would a Raven, Hawk, or Eagle, because it was considered very sacred and a source of power. Native people would try to make spiritual (psychic, mythic and religious) contact and communicate through a process called the *vision quest*, making physical contact with the Condor (as similar in the case involving Ravens, Hawks, and Eagles) by setting snares and traps to get the bird's feathers.

Indigenous people were very intelligent, creative, ethnoscientific, and spiritual when it came to understanding Nature, their environment, and the ecosystems within their region (Deloria, 1992). Native people did not separate themselves from Nature and all its wonders in order to observe it, study it, understand it, and relate to it. They related to all things in the environment as a source of knowledge, subsistence, and power (Bean, 1976). They did not consider Nature, and all things in it, as their enemy—although they feared it. In terms of exploitation, they, too, had to survive, subsist, and sustain themselves, but they did so with respect, a conservative approach, and from a perspective that they were an "integral" part of Nature, not separate from it. Thus they did not kill the Condor in order to get its power or exploit its feathers or claws.

They found appropriate ways to deal with their fear, and they did not let fear destroy them; nor did they let fear become the basis for destroying that which they did not understand. Their natural evolution in a natural environment taught them how to confront their fears, find ways to overcome that which was fearful, and then convert those fears into an ally rather than an enemy. The concept of *Thunderbird* as a means to identify with, relate to, understand, and bond with in terms of natural kinship (all species in Nature are related, hence are relatives) is an excellent example of this philosophy, adaptation, and socialization process. Since Native people related to all things in the Universe as both physical and spiritual, they developed culturally based ways and means to deal with phenomena that might be considered awesome, spectacular, gigantic, supernatural, and potentially dangerous; i.e., fearful.

Condor, or *Thunderbird*, was therefore not considered an enemy that had to be conquered, destroyed, or tamed in order to be exploited. But aboriginal people wondered how such a creature fit within the scheme of things, and due to its spectacular size, it must fit somewhere within the physical hierarchy and ranking of "powers" and supernatural status. These concepts and perspectives, so common among Native peoples, are referred to in the "Law of Cosmic Duality," perhaps similar to the Chinese philosophy of Ying and Yang. Interpreting these ideas, these are "holistic" perspectives; there are two sides to everything: the physical and spiritual, seen and unseen, good and evil, male and female, day and night, pure and impure, friend and foe. And like everything else in Nature, human or otherwise, one must operate within a system of balance; otherwise, an imbalance creates problems that come in the form of bad luck, sickness, accidents, disease, depletion, unmet needs, harsh survival, and poverty in terms of subsistence. This concept of understanding balance did not therefore just pertain to human situations, but to the world in general—thus, including all things in Nature such as the environment, ecosystems, sustainable resources, and natural resources management.

"So what did the Native people know about Condor?" we may ask. "Where did Condor fit within the Native's world view, Nature, culture, and within the scheme of things?" We may safely assume that indigenous people observed, studied, and related to Condor from both a physical and spiritual perspective because surely they, too, wanted to know how Condor fit within the scheme of things, in their environment and Nature, and in terms of subsistence and supernaturalism.

With all of this in mind, and considering the fact that the Condor is on the verge of extinction, we might ask two final questions: "What can we learn from Native American people as to what they knew about Condor?" and, "Of what value is this cultural, mythological, religious, and ethnoscientific knowledge to modern science and studies?"

Chumash Indian Story "Coyote, Eagle, and Condor"
Provided with permission to share with anyone, from Chumash Medicine Man, Semu Haute.

A long, long, time ago, Coyote had been wandering all around the hills, mountains, and prairies hunting all night. He was so tired because he had traveled all over the place, searching for food, something to eat, and he went everywhere. He even looked in cracks and crevices, big caves, tried to hang over the side of cliffs, and got torn up foraging around in the thick brush. He couldn't even find a squirrel, not a rabbit was in sight, not even a bird; only grasshoppers, and these he occasionally snapped at and ate out of desperation. It was just too hot, dry" one of those drought-type seasons in mid-summer; water was scarce and food was scarce, and grasshoppers were very scratchy going down one's dry throat. So shortly after daybreak he decided to just collapse and sleep under the shade of a few old Juniper trees, among some rocks and sage. He couldn't go any further.

A couple hours later, he woke up from all kinds of noise being made, and it was coming from a prairie opening, a little distance from where he was trying to sleep and rest up. He jumped up, startled, and perked his ears, sniffed with his nose, and started searching with his keen but dried up sore eyes. It sounded like a group of people arguing and fighting, and feathers were flying all over the place. He was mad, and complaining to himself, he said, "A person can't even get any sleep around here; there's no respect anymore, so I'll just show them who is the real warrior around here! I wonder what they are fighting about, anyway?"

Coyote started down the side of the hill, stumbling over rocks and brush, and almost stepped on a Rattlesnake. The Rattlesnake shook his tail and growled at Coyote. "Hey Coyote!" he said, AWatch where you are walking, and knocking rocks all over the place, someone might get hurt!" Coyote jumped back, but he was not afraid of anything, not even a Rattlesnake. He shouted back, "Maybe you should watch where the heck you are going! And where are you going anyway? Do you know where there is some water?" Rattlesnake uncoiled himself, and as a show of respect to Coyote, because he knew Coyote had special power (and besides, Coyote would never eat a Rattlesnake), he said, "I was down there sleeping under a big log, getting some shade, close to where Mountain Lion had killed and left that deer, but a bunch of Ravens woke me up hollering and squawking, and when I heard the scream of the Eagle I thought I had better get out of there fast."

"Ummmm, food," Coyote said to himself, "I'll just go down there and get it, and the rest of them can have whatever scraps are left." But everyone knows Coyote wouldn't really share; if he had his way, he would eat every bit of it. As he got closer, he started howling and singing his hunting song. He could see Hawk circling around off in the distance looking for fresh food, and it was obvious the Hawk didn't want any part of the mess, so he was no threat. By this time, Golden Eagle had fought off the Ravens, and the Buzzards were off in the distance, too scared to come any closer, and now the Eagle was trying to peck Condor on the head and chase him away. Then, as a few more Condors came in, the feast turned into a real ruckus, and another Eagle had came in to back up his partner. No wonder feathers were flying around all over the place!

The Eagles saw Coyote coming and backed off, but Condor stood his ground. He had a claim on this food and wasn't about to give it up, and after all, he was a lot bigger and more powerful than any of the other birds, or Coyote. Now Coyote wasn't stupid either, even if he was starved, and he knew Condor had a lot of power, and he was just too weak and tired from starvation to fight. So he reached in his pocket and pulled out some manzanita berries and juniper berries as an offering and said, "Hey, Thunderbird, I'll give you this medicine if you share some food with me, and it will doctor your stomach when you need it, because I know you will eat anything that is dead." But Condor refused. Then Coyote threatened, "Then just leave this Deer alone "it belongs to me!" you can go over to the coast and eat plenty of Salmon, or even dead Sea lions or Whales for that matter. With those big wings you will be there in no time. Now get, go fast!"

But once again Condor refused; he was naturally a slow eater. In defense, he tried to slap Coyote down with his big wings. So Coyote picked up an old, hard stick, used it for a war club, and started hitting Condor on the head. He knocked all the top feathers off, put all kinds of bumps on the Condor's head, and made Condor's head all red and orange colored, and bloody. And that is why until this day Condor head is bald, all knotted up, and colored orange.

Then Coyote chased all the Condors and other birds away, except for Raven, who usually helps him and the Wolf find food, and he ate until he was stuffed. He stayed there all night, and stayed awake and defended his food from any other creatures such as Badger, other Coyotes, or even bugs that kept trying to sneak in. The next day he finished almost all of it up, gathered all the feathers, and decided it was time to go find an Indian village and buy himself a wife—the Chief's daughter. Now he not only had power, and had proven he was the most powerful, but he was also very wealthy. (And that is also why, that even to this day, I don't think you will ever see a Condor eating a dead Coyote; unless it is a real starving Condor and by the same token, I don't think you will ever see a Coyote eating a dead condor, unless it is one sick, starved, or stupid Coyote).

Questions and Assignments

What do the above Indian stories and myths, and other references, tell us about knowledge Native American tribes had concerning the Condor? For example, where can Condor species be found prior to European contact? What was the Condor's main source of food in that particular kind of habitat? What was the significance of the Condor to local Native tribes? What was the role and function of Condor birds in relation to the local ecosystem and other birds and animals? What effect has the disappearance of the Condor had on local Indian tribes and tribal ecosystems?

Considering changes in the environment since the loss of the Condor, and considering the effects of acculturation and assimilation upon local tribes, would it be possible and proper to reintroduce the species? What can we learn from tribes in that region about the Condor? What effects of Western society led to the potential extinction of the Condor? How does this create an imbalance in Nature?

Describe the significance of the Condor relating to tribes socially, politically, and spiritually. For example, what was the symbolic significance of the Condor in Native ideology, mythology, and religion?

Was the Condor considered a sustainable resource by Native people in terms of food, clothing, tools, weaponry, weather forecasting and control, or trade commerce? If so, in what ways did the bird influence the system?

Activity: Using library or Internet sources (i.e., Smithsonian Institute sites), develop a series of photos and slide presentations that demonstrate how Native people used the Condor in their heritage and cultures (i.e., religious regalia, etc.)

The following is a challenging question and assignment that deals with a very controversial subject.

Public Law 95-341, the *American Indian Religious Freedom Act* apparently gives Native people "special rights" to obtain, possess, and use rare and endangered birds and bird parts (along with other species in the ecosystem). In order to qualify, an Indian person must fill out and submit a U.S. Fish and Wildlife License/Permit, as in the case of acquiring Eagles (if they are listed as threatened or endangered on the endangered species list). The same pertains to certain birds that are protected under the Migratory Bird Act. Considering the current critical situation and status of the Condor as a very rare and endangered species, should Native Americans be allowed to hunt, kill, and use Condor feathers and bird parts as part of their religious ceremonies? If so, why or why not? What Native people would be considered "qualified" to receive Condor feathers and bird parts from the existing "recovery programs and units"? Who would make the determination as to whom or what Native person was "qualified" to possess and use such powerful, significant, sacred, and high status regalia?

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Supplemental information
California Condors

General Status. Although California condors at one time ranged throughout the United States, the species became restricted to the Pacific coast following the decline of a major food source—large Ice Age mammals. Further decline of the species has been attributed to their low reproductive rate, long generation time (6+ years), habitat loss, sport hunting, reduced food supply, pesticide contamination, accidental loss and lead poisoning. In addition, the species' genetic diversity is extremely low since all birds alive today have descended from only 14 birds. In 1985, when the wild population fell to a low of nine birds, approval was given to capture all wild birds for captive breeding programs.

Timeline

1992. Condor population numbered 52. Two California condors and two Andean condors were released in the Los Padres National Forest on January 14. Six more California condors were released at the same site on December 1.

1993. The San Diego Wild Animal Park and the Los Angeles Zoo were at capacity with 71 birds. A flock of 12 condors was sent to Idaho's World Center for Birds of Prey in Boise. Another release site was established in Lion Canyon and Los Padres National Forest near the boundary of the San Rafael Wilderness area in Santa Barbara County. Nine birds were released here.

1995. Power-line and human aversion programs were instituted at the Los Angeles Zoo for all condors that were candidates for release.

1996. Six parent-reared condors were released 30 miles north of the Grand Canyon near the Arizona-Utah border. See details below. As of August 1996, there were 118 California condors in existence—21 in Lion Canyon, California, five in Vermillion Cliffs, Arizona, and 92 in captive-breeding programs.

Condor release in Arizona. Fossil evidence and historic sightings suggest that condors inhabited northern Arizona. The area contains an abundance of suitable habitat—extremely remote with rugged sandstone cliffs, canyons, arroyos, large boulders and numerous caves. Potential food sources include mule deer, bighorn sheep, bison, pronghorn antelope, coyotes, rabbits and game birds. For these reasons, a site at Vermillion Cliffs in Coconino County, Arizona (30 miles north of the Grand Canyon) was selected as a release point for six parent-reared and aversion-trained (trained to avoid humans) California condors on December 12, 1996. This reintroduction project required the cooperation of a number of state and federal agencies and private organizations and was implemented only after an extensive period of public comment. The success of the project will be reviewed on a yearly basis and adjustments made as necessary. If the mortality rate of the population exceeds 40% or if the birds do not learn to scavenge on their own, the project will be terminated.

1997. One of the condors released at Vermillion Cliffs, Arizona, dies, presumably killed by a golden eagle. Four condors were released in the Ventana Wilderness Area near Big Sur, California.

NOTES FOR INSTRUCTORS

I. Students should be provided access to all resources prior to the lab/class activity by placing resource materials on reserve in the library or providing them with copies.

II. Students should be familiar with the following aspects of the "loss of biodiversity" issue prior to answering the questions for this laboratory (e.g., through lectures and assignments in class):

- Estimates of natural extinction rates
- Causes for natural and catastrophic extinctions
- Causes for suspected human-caused extinctions (habitat destruction, species intro ductions, environmental contamination, over-exploitation)
- Consequences of biodiversity loss (ecosystem services, direct human benefits, esthetic arguments, ethical arguments)
- Efforts to address biodiversity loss

I have put together a series of slides that summarizes the loss of biodiversity issue. This can be presented in either lecture or lab. Some of this information is also covered in Botkin and Keller, Chapter 12.

Outline of Slide Presentation

I. Introduction

A. Species protection vs. economic interests
B. Northern spotted owl controversy as an example

II. Measures of Biodiversity

A. Genetic level
B. Species level—1.7 million described species, 30 million estimated
C. Ecosystem level
D. Tropical diversity as an example—6% of the land mass, 50% of all animal species

III. Extinction

A. Natural extinctions in past
1. background extinction rates—estimated at one per year
2. catastrophic extinctions—once every 26 million years (meteorite impacts)

B. Current extinction rates
1. 1000 - 10,000 times the background extinction rate
2. There exists a *biodiversity crisis*

"The human species came into existence at the time of greatest biodiversity in the history of the earth. Today biodiversity is being reduced to its lowest level in 65 million years." E.O. Wilson

"The biodiversity crisis is the most pressing, far-reaching and irreversible environmental problem we face." National Academy of Science

IV. Causes for Current Extinction Rates (human-caused)

A. Habitat Destruction

1. Land conversion (e.g., slash and burn agriculture in tropics)

2. Documented by satellite imagery (e.g., Rondonia, Brazil)

B. Species Introductions (Exotics)

1. Out-compete native species

2. Examples: Nile perch, European starling, Asian gypsy moth, Scotch broom, Himalayan blackberry

C. Environmental contamination

1. Examples: pesticides, herbicides, acids, toxic waste

2. Direct impacts: DDT contamination and biological magnification

3. Indirect impacts: global warming

D. Over-exploitation

1. Excessive harvesting for food (*refer to "A Brief History of Atlantic Cod" following these notes; you may want to use it as a handout for students*), clothing, sport, predator control, etc.

2. Examples: walrus, elephant, passenger pigeon, timber wolf

3. Species most threatened by illegal trade: black rhino, Indo-Chinese tiger, giant panda, Asiatic black bear, sharks, American box turtles, day geckos, Tibetan antelope, North American lady slippers

V. Consequences of Loss of Biodiversity

A. Biodiversity provides "ecosystem services" for which we have no replacement

1. Assigned "zero value" in economic systems
2. Examples: nutrient recycling, soil creation, maintenance of air and water quality, disease control, flood and erosion control, pollination
3. Most services provided by "lesser species" (insects, fungi, bacteria)

B. Direct benefits to humans

1. Agricultural: biodiversity as a source of new genetic information
2. Pharmaceutical: 50% of all medical prescriptions, 70% of all cancer drugs derived from tropical rainforest plants
3. Examples: rosy periwinkle (Vinblastine/Vincristine), Pacific yew (taxol)

C. Esthetics

1. Humans may have an innate need for natural diversity
2. Evidence: attendance at zoos, vacationing, wildlife-related expenditures

D. Ethical concerns

1. Humans have a moral obligation to preserve natural diversity
2. Aldo Leopold's *Land Ethic*

VI. Efforts to Preserve Biological Diversity

A. International and national environmental organizations
B. Incorporation of economic needs and cultural practices of native people
C. Research, ecosystem management, adaptive management
D. Legislation: *Endangered Species Act of 1973*

1. Successes: American bison, American alligator, whooping crane
2. Shortcomings: economic impacts, futile salvage efforts
3. Proposed alternatives: an "Endangered Ecosystem Act"

Special note: Instructors are encouraged to have students read and do assignments in "American-Indian Cultural Perspectives" Section. This section has been provided by American-Indian partners of the Center.

Other References

Cohn, J. 1993. *The flight of the California condor*. BioScience 43(4):206-209

Cohn, J. 1999. *Saving the California condor*. BioScience 49(11):864-868.

Eisner, et al. 1995. *Building a scientifically sound policy for protecting endangered species*. Science 268:1231-33.

Graham, F. 2000. *The day of the condor*. Audubon Jan-Feb 2000:46-51.

Leopold, Aldo. 1949. *A Sand County Almanac*. Oxford University Press. New York. 228 pp.

Mann and Plummer.1995. *Is the endangered species act in danger?* Science 267:1256-1259.

A Brief History of the Atlantic Cod

"Cod—A species too well known to require any description. It is amazingly prolific. Leewenhoek counted 9,384,000 eggs in a cod-fish of a midling size—a number that will baffle all the efforts of man to exterminate it." J. Smith Homans and J. Smith Homans, Jr., editors. 1858. *Cyclopedia of Commerce and Commercial Navigation*, New York

In the culture of Northern Europeans, the Atlantic cod is held in utmost esteem. Much like the relationship between the Pacific salmon and native people of the Pacific Northwest, this fish literally held the key to their survival—first as a source of sustenance and, later, as the foundation of their economies. As a result, the cod was assigned great spiritual and commercial significance. Wars were fought over its management, and the fish was revered in spiritual ceremonies and financial markets alike.

1497. Reports from historical records suggest that when English explorer John Cabot discovered North America, the coast was "churning with cod of school size and body size never before seen." Cabot's men caught cod in weighted baskets randomly thrown overboard.

1838. A 180-pound cod was caught on George's Bank.

1895. A 211-pound cod was caught off Massachusetts' coast.

1970's and 1980's. Annual harvests during this time period often removed 60% of adult cod in the Canada/U.S. population. This harvest level was three times the recommended amount to sustain healthy stocks. Female cod responded to this harvest level by spawning at an earlier age (average spawning age declined from 5-6 years to less than 3 years). This response is thought to be an adaptation to small population sizes. However, younger spawners produce smaller and fewer eggs and, therefore, smaller fry. This makes the new generation more prone to predation.

1976. In response to declining fish stocks, most countries (including the U.S. and Canada) passed a 200-mile fishing limit. This limit declared the zone within 200 miles of a country's shores to be the sole fishing grounds for that country. Foreign vessels could fish these grounds only with special permits. Over 90% of the world's fishing grounds fell within the 200 mile limit of some country.

1992. Cod populations on Canada's Grand Banks off the coast of Newfoundland and Nova Scotia continued to plummet to levels 1/100th of original population size. In an attempt to allow these stocks to recover, a moratorium on fishing was declared, putting 35,000 fishermen out of work.

1994. All Atlantic cod fisheries were closed and strict quotas placed on other species. The Atlantic cod was declared "commercially extinct." Monitoring efforts conducted since this time have suggested no sign of recovery.

"...Just three years short of the 500-year anniversary of the reports of Cabot's men scooping up cod in baskets, it was over. Fishermen had caught them all. Fishermen rarely consider regulation *their* responsibility. As they see it, that is the duty of government—to make the rules and it's *their* duty to navigate through them. If the stocks are not conserved, government mismanagement is to blame." (Quoted from: Kurlansky, M. 1997.*Cod—A biography of the fish that changed the world*. Penguin Books, NY. 294 pp.)

Biodiversity IV
Pacific Northwest Salmon—*Complex Issues*

In this activity, we will explore in detail one of the most pressing environmental concerns in the Pacific Northwest—the fate of Pacific salmon. You and a partner will be asked to research a particular aspect of this complex issue and report these findings to the class in a 15 minute oral presentation. This presentation will be followed by a 15 minute question and answer period.

Your team will be assigned one of the topics listed below to address. They are broken down into three categories: introductory (what is the basic "salmon issue"?); causes for decline (what factors have contributed to salmon declines?); and solutions (what solutions are being tried? e.g., legislative, management, etc.). Feel free to exchange topics with another team (if everyone in the group agrees).

<u>Topics List</u>

A. Introductory/overview

1. What is the current situation and how did we get here? What information is available that documents the decline of Pacific salmon from historic levels (pre-European settlement) to the current day? How do we know that there is a "salmon issue"? What species are currently listed under the Endangered Species Act?

B. Causes for decline

2. Commercial and recreational fishing (including the operation of hatcheries and Native American fishing rights): How much impact have these activities had on salmon declines?
3. Hydroelectric dams for electrical generation, flood control and water storage: How much impact have hydroelectric dams had on salmon populations? What are the issues surrounding their removal?
4. Loss and degradation of spawning habitat due to human activities such as agriculture, forest practices and urban development. Include impacts on water quality and quantity that result from agricultural runoff and the use of water for irrigation. How much impact has habitat loss and degradation had on salmon populations?
5. Losses due to predation (e.g., sea lions, sea birds and marine fish). How much impact has predation had on salmon declines? How have human activities contributed to predation losses?

C. Solutions

6. What efforts have been made thus far to encourage recovery of Pacific salmon populations? (e.g., legislation, barging of smolts, reservoir drawdowns, habitat restoration, state and federal efforts, etc.) What measures are being used to determine the success of these efforts? How successful have these efforts been?

7. Where do we go from here? What changes in management, policy, education, etc., should be made to change from the past practices to current regimes of "sustainable fisheries" or "ecosystem management"? What role may global climate change play in recovery efforts?

You will be evaluated as follows:

1. *Quality of Research* (25 points) How well have you researched the topic and prepared for the discussion? Each team should seek information from at least 5 substantial and current sources that address your particular aspect of the issue. To document this research and assist you in the preparation of your presentation, prepare a 3-4 page summary that presents the main points you plan to address. The summary should be a blending of information and ideas gathered from all of your resources (as opposed to a series of resource by resource summaries). A person completely unfamiliar with your topic should be able to read your summary and get a good understanding of the issue. Each team of 2 students should submit one summary, a complete record of the literature you have used, and copies of the articles. For resources that are book-length, simply copy the title page of the book and indicate which pages were relevant to your topic. On the front page of your summary, include the title of your topic and complete citations for each of your sources. A complete citation includes:

For a journal article:

Author(s), date, title of article, journal title, volume, pages e.g., Smith, T.S. 1998. *Historical populations of coho salmon in Oregon*. Science 46:234-238.

For a book:

Author, date, title of book, publishing company, location of publication, total number of pages e.g., Jones, F.R. 1997. *The natural history of salmon and trout*. The Benjamin Cummings Co., New York, NY. 235 pp.

For a web site:

Author or organization, date, title, web address
e.g., American Fisheries Society. 1999. *Causes for decline of Washington salmon*.www.amfisheries.org

Suggested sources for information: attached list of resources, libraries, websites, personal interviews with knowledgeable persons (e.g., biologists with state and federal departments of fish and wildlife, U.S. Fish and Wildlife Service, other federal agencies, environmental and management organizations).

NOTES: No more than *three* of your sources may be obtained on the Internet! *Do not* use newspaper articles or CD-ROM Encyclopedias. These generally lack sufficient detail to be useful sources.

2. *Quality of Presentation* (15 points) How well have you organized and presented the information you have collected? To get a maximum number of points:

- Each member should contribute during the presentation.
- Visual aids of some type should be used—overhead transparencies, short clips of videotape, poster, handouts, etc. *Please feel free to use your imagination!* If you need assistance with copying or production of any of these, let me know.
- Presentation should be clear and concise. Your presentation will be timed — *do not run past 15 minutes!* Find time to practice your presentation with your partner(s). I would strongly discourage reading to your audience.
- Allow 15 minutes for questions and discussion after your 15 minute presentation. Prepare a couple of questions that you think will stimulate discussion.
- Relax and enjoy!

Pacific Northwest Salmon Presentations/Discussions—Resources

The following resource list has been compiled to assist you in finding sources of information for your presentations. It includes books, articles and videotapes that address one or several aspects of the issue. I have many of these sources on file in my office. The list is not intended to be comprehensive, and it should not be used as your sole source of information. In recent years, volumes have been published on these topics, so be sure to conduct your own research in addition to using this list.

General Topics

Each of these articles and books covers a number of aspects of the salmon issue and should be of interest for most presentations. Those marked with an asterisk (*) are comprehensive resources and should be especially useful.

*Cone, J. and S. Ridlington (eds.) 1996. The Northwest Salmon crisis—a documentary history. Oregon Sate University Press, Corvallis, Oregon 374 pp.

Phillips, S. (ed.). 1994. Vital habitat concerns. Pacific Fishery Management Council Habitat Committee. April 1994. 17 pp.

Reeves, G., et al. 1992. Factors potentially limiting natural production of Oregon coastal salmonids. Governor's Coastal Salmonid Restoration Initiative, Newport, Oregon, December 15-17, 1992.

Bourne, J. 1994. End of the line. Mother Earth News Aug./Sep. 1994:41-47.

* Cone, J. 1995. A common fate. Henry Holt and Co., New York. (reviewed in Hall. 1996. Northwest Science 70(2):185-186.)

Oregon Natural Resources Council. 1994. The saga of the salmon. Wild Oregon Spring 1994

Sims, G. 1994. Can we save the Northwest's salmon? National Wildlife. Oct./Nov. pp 40-49.

Gillis, A.M. 1995. What's at stake in the Pacific Northwest salmon debate? BioScience 45(3):125-127.

Andrus, C. 1994. Can we save the Pacific Northwest salmon? USA Today 123(2590):20-23

* National Research Council. 1996. Upstream: Salmon and society in the Pacific Northwest. National Academy Press. Washington, D.C. 452 pp.
(Summary available at: www.nap.edu/readingroom/books/salmon/summary.html)

Netboy, A. The Columbia River Salmon and steelhead trout. Univ. of Washington Press, Seattle, Washington

Daniel, J. 1993. Dance of denial. Sierra Mar./Apr. 93: 64-73

Blankenship, K. 1996. Streamside forests: keys to the living landscape. American Forests Spring 1996:13-20.

*Lichatowich, J. 1999. Salmon without rivers—A history of the Pacific salmon crisis. Island Press, Covelo, CA 336 pp.

Organizations and Agencies

The following organizations and agencies will have information on various aspects of the Pacific salmon issue. Most have web sites that can be accessed.

The American Fisheries Society
www.esd.ornl.gov/societies/AFS/

Fisheries Department of the Food and Agricultural Organization of the United Nations
www.fao.org/waicent/faoinfo/fishery/fishery.htm

National Marine Fisheries Service
kingfish.ssp.nmfs.gov/

Oregon Department of Fish and Wildlife (see Salmon Trout Enhancement Program)
www.dfw.state.or.us

U.S. Fish and Wildlife Service
www.fws.gov/

* SalmonWeb
www.salmonweb.org/

* Oregon Sea Grant Program
seagrant.orst.edu/links/salmsites.html
This is a comprehensive site on salmon with many links to other sites that cover all aspects of the salmon issue.

Wild Salmon Forever

Columbia River Inter-tribal Fish Commission

U.S. Army Corps of Engineers

Pacific Fishery Management Council

Bonneville Power Administration

Save Our Wild Salmon Coalition (Seattle)

For the Sake of the Salmon

Oregon Trout

Pacific Coast Federation of Fishermen's Association

The following resources are arranged by topic according to the original handout for the "Pacific Northwest Salmon Presentations" assignment. Be aware that there will be much overlap between topics. Even those sources that appear to address a single aspect of the issue will probably contain information for other topics as well.

1. *Introduction - Historical and current status/Life history*

Satchell, M. 1994. Fish with nowhere to run. U.S. News and World Report. Dec. 1994:34-36.

Wagner, H. 1979. Why wild coho? Oregon Wildlife Dec. 1979:3-7.

Volkman, J.M. 1992. Making room—The Endangered Species Act and the Columbia River Basin. Environment 34(4):18-43.

Nickelson, T.E., J.W. Nicholas, McGie, A.M., R.B. Lindsay and D.L. Bottom. 1992. Status of anadromous salmonids in Oregon coastal basins. Research and Development Section,Oregon Department of Fish and Wildlife, Corvallis, OR. 83 pp.

Maxwell, J. 1992. Closing the salmon circle. Audubon. Sep/Oct.1992:36-38.

Busch, L. 1995. Scientific dispute at center of legal battle over salmon catch. Science 269:1507-1508.

Myers, R.A., N.J. Barrowman, J.A. Hutchings and A.A. Rosenberg. 1995. Population dynamics of exploited fish stocks at low populations levels. Science 269:1106-1108.

National Marine Fisheries Service. 1995. Coho salmon briefing package.

Oregon Department of Fish and Wildlife. 1992. Status Report—Columbia River fish runs and fisheries 1938-91.

Zorpette, G. 1995. So many salmon, but so little. Sci. Am. May 1995:21-22.

Bogaard, J. 1994. Giving voice to salmon. Illahee Wtr. 94:251-255.

Lackey, R.H. 1996. Pacific salmon and the Endangered Species Act. Northwest Science 70:281-284.

Di Silvestro, R. 1997. Steelhead trout: factors in protection. BioScience 47(7):409-414.

Levy, S. 1997. Pacific salmon bring it all back home. BioScience 47(10):657-660.

Lichatowich, J. 1999. Salmon without rivers—A history of the Pacific salmon crisis. Island Press, Covelo, CA 336 pp.

Pacific Coast Salmon Fisheries (Unit 12)
kingfish.ssp.nmfs.gov/

2. *Causes for decline—Commercial and recreational fishing, hatcheries and Native American fishing rights*

Boyle, R. 1994. Pacific salmon—a dammed shame. Outdoor Life July 1994:32-35.

Zorpette, G. 1999. To save a salmon. Scientific American Jan. 1999:100-105.

Videotapes

Oregon Public Broadcasting, Oregon Field Guide. November 1997. "Salmon and Steelhead Hatchery Programs."

Columbia River Inter-Tribal Fish Commission. 1994. Chinook Trilogy (3 videos):
1. My Strength is From the Fish
2. Empty Promises, Empty Nets
3. A Matter of Trust

Distributed by:
Wild Hare Media
P.O. Box 3854
Portland, OR 97208
1-800-WLD-HARE

3. *Causes for decline—Hydroelectric dams*

Bodi, L. 1995. The history and legislative background of the Northwest Power Act. Environmental Law 25(2):365-368.

Winninghoff, E. 1994. Where have all the salmon gone? Forbes Nov., 21, 1994:104-116.

Damker, D.M. and D.B. Dey. 1989. Evidence for fluoride effects on salmon passage at John Day Dam, Columbia River, 1982-1986. North American Journal of Fisheries 9:154-162.

U.S. Dept of Energy. 1991. The Columbia River system: The inside story. 82 pp.

Ford, J. 1998. Gas bubble disease
gladstone.uoregon.edu/~shannie/gas.html

Chaney, E. 1978. A question of balance. Summary Report. Northwest Resource Information Center, Inc. 29 pp.

Spigal, H. 1995. The implications of salmon recovery for the Bonneville Power Administration and the region. Environmental Law. 25(2):407-416.

Joseph. 1998. The battle of the dams. Smithsonian Nov. 1998

4. *Causes for decline —Degradation of habitat—grazing, forest practices, urban development and mining*

Spain, G. 1993. Fisheries response to Option 9 mixed. Wild Oregon. Fall 1993:16

Beschta, R.L., et al. Stream temperature and aquatic habitat: fisheries and forestry interactions. Chapter 6

Lipske, M. 1995. Cracking down on mining pollution. National Wildlife June/July 1995:20-23.
Gregory, S.V. et al. Influence of forest practices on aquatic production. Chapter 7

Willson, M.F., S.M. Gende and B.H. Marston. 1998. Fishes and the forest. BioScience 48(6):455-461.

5. *Causes for decline—Agricultural activities and predation by sea lions*

Videotape

Sea Lion Predation on Salmon. January 1996. Northwest Reports. Portland, Oregon

6. *Solutions—Efforts for recovery*

Roper, B.B., J.J. Dose and J.E. Williams. 1997. Stream restoration; Is fisheries biology enough? Fisheries 22(5)6-11

Oregon Department of Fish and Wildlife (see Salmon Trout Enhancement Program)
www.dfw.state.or.us

State of Oregon. 1997. The Oregon Plan for salmon and watersheds. Legislative Review draft-Executive Summary. Salem, OR. 15 pp.

Brouha, P. and W. Chappell. 1997. An ecological perspective of riparian and stream restoration in the western United States. Fisheries 22(5)12-24.

Spence, B.C., G.A. Lomnicky, R.M. Hughes and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. Management Technology TR-4501-96-6057. 356 pp.

State of Oregon. 1997.Coastal Salmon Restoration Initiative—Executive Summary 13 pp.

Reeves, G.H., et al. 1995. A disturbance-based approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the pacific Northwest. Am. Fisheries Symposium 17:334-349.

Bottom, D. 1995. Restoring salmon ecosystems. Restoration and Management Notes 13(2): 162-170.

Smith, C.L., J.O. Gliden, J.S. Cone and B.S. Steel. 1997. Oregon Coastal Salmon Restoration: Views of coastal residents. ORESU-S-97-001 16 pp.

Videotapes

Oregon Public Broadcasting, Oregon Field Guide. January 1996. Salmon Habitat Restoration on the Umatilla River.

Green Means—Salmon Habitat

Oregon State University Sea Grant Program. Return of the Salmon.

7. *Solutions—The future*

Doppelt, B., M. Scurlock, C. Frissell and J. Karr. 1993. Entering the watershed: A new approach to save America's river ecosystems. Island Press. Covelo, CA. 462 pp.

Lackey, R.T. 1996. Pacific salmon, ecological health and public policy. Environmental Health 2(1):61-68.

Gucinski, H., R.T. Lackey and B.C. Spence. 1990. Global climate change: Policy implications for fisheries. Fisheries 15(6):433-38.

Lackey, R.T. 1995. The future of pacific salmon: Ecosystem health and public choice. Proc. Joint Conference of the American Association of Zoo Veterinarians, Wildlife Disease Assn. and American Assoc. of Wildlife Veterinarians, Michigan State Univ., East Lansing, MI pp. 22-27.

American Fisheries Society. 1995. Why isn't science saving salmon? Fisheries 20(9):4.

NOTES FOR INSTRUCTORS

This assignment must be given to students ahead of the lab. The instructor should choose how much lead time is needed for students to complete presentation preparation. The salmon issue is presented here, as a premier regional example. You may chose to use another local/regional example suitable to your area. This issue was chosen because:

- It introduces students to the complexity of the Pacific salmon issue (e.g., salmon are a commercial commodity, as well as a cultural icon to Native Americans, and the issue can relate to various concerns, ranging from recreational fishing to the fishes' roles in aquatic ecosystems)
- It impacts nearly all segments of society in the Pacific Northwest U.S., including agriculture, forestry, electrical generation, urban living, etc.

Basic format

The class will examine the Pacific salmon issue in detail through a series of student-led presentations and discussions.

Students will:

- **form teams of two-three students**
- **select preferred topics from lab handout**

Assignment has two parts:

- **research**
- **presentation**

[Each of which is described in the lab handout]

Tribal Land Management
Field Trip to Agency Creek,
Grand Ronde Indian Reservation

INTRODUCTION

We will visit Agency Creek on the Grande Ronde Indian Reservation in Yamhill County. A fish and wildlife biologist with the tribe will describe forest practices on tribal lands and the role played by fish and wildlife biologists in forest management. The biologist has developed a water quality monitoring project that uses biological and chemical indicators of water quality, and the tribe has been engaged in a stream restoration project for Agency Creek. The project is a cooperative effort between the Confederated Tribes of Grand Ronde, a private timber company, the Polk Soil and Water Conservation District and the Natural Resources Conservation Service. It is funded by grants awarded to the tribe by the National Marine Fisheries Service and the Bureau of Indian Affairs.

BACKGROUND

Past land-use practices in Upper Agency Creek, a major stream of the Yamhill River watershed, have contributed to the ecological degradation of the creek. As a result, cutthroat trout and steelhead populations have declined. Primary problems include the lack of in-stream coarse woody debris, erosion of riparian zones, increased sediment loads and a lack of back channels in the creek.

A watershed-level approach to restoration is being undertaken by the tribe and partners that includes strategic placement of large logs, boulders and root wads in the creek, falling selected deciduous trees along the creek, and planting a deciduous-dominated riparian zone with conifers. These efforts are expected to improve habitat for cutthroat trout and steelhead by creating exposed gravel beds for spawning and quiet pools with cover for migrating and resident fish. The long-term effectiveness of these measures will be monitored by the Confederated Tribes of Grand Ronde.

PROCEDURE

Consider the field trip a fact-finding mission to gain a greater understanding of the role of the wildlife biologist in forest and stream management. *You will be held responsible for information shared on the trip. Please feel free to ask questions.*

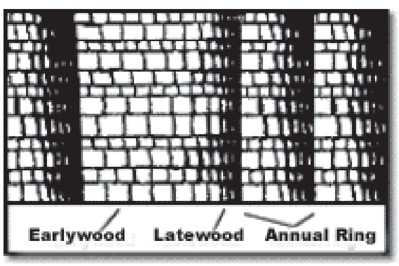
If stream conditions permit, you will also have the opportunity to implement a sampling technique for stream invertebrates. This technique is widely used to access water quality in watersheds.

LAB PRODUCT
Each student should write a two-page summary that describes the main points of the field trip.

Dendrochronology
Introduction and Applications

INTRODUCTION

You are probably aware that the annual rings of trees in temperate and boreal forests can be used to determine the age of a tree. Each annual ring is composed of two, easily distinguished bands: **spring wood** ("earlywood") is laid down early in the growing season and tends to be lighter and more porous than **summer wood** ("latewood"), which is laid down later in the growing season and tends to be darker and more dense. Since growth rates can change dramatically depending on environment the tree is exposed to (e.g., crowded or open conditions, high precipitation, drought, cold, fire, injury, etc.), each annual ring represents that year's conditions.



Dendrochronology is the dating of past events (climatic changes) through study of tree ring growth. Botanists, foresters and archaeologists began using this technique during the early part of the 20th century. Accordingly, trees can be "used" to track history. An excellent Internet source for this topic is: www.sonic.net/bristlecone/dendro.html (NOTE: This webpage is copyright 1995 by Leonard Miller; the text or the graphics contained in this page may not be resold or redistributed for compensation without prior written permission from Miller.)

Dendro–: tree, tree-like, woody plant –*chronology:* science of measuring time and dating events

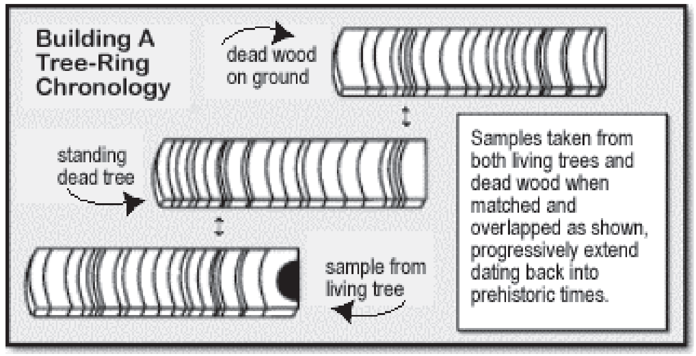
Foresters have routinely determined the approximate age of a stand by obtaining core samples from a representative sample of trees. An instrument called an **increment borer** is twisted into the bark of the tree and inserted to about half the diameter of the tree. A 1/8 inch-wide core is removed and prepared for examination of the annual rings. Bristlecone pines in Arizona as old as over 4,600 years have been aged using this method!

Chronology Building

The climatic changes or patterns in specific geographic areas can be traced by the study of old living trees. Samples taken from trees of unknown age can then be studied for matches with samples from trees with known sequences of growth. Using this process, when the rings "match" or are found to be overlapping in age, we are able to "see" even further back in time.

An example of this occurred in the 1920s when expeditions led by Douglass dated Pueblo Bonito, a prehistoric Native American settlement in New Mexico. By analyzing the timbers used in its construction, they determined its existence 800 years before Columbus.

A chronology (arrangement of events in time) can be made by comparing different samples. Using a boring tool, a long slender core sample is extracted.



Let's say the sample was taken from a standing 4,000 year-old (but long dead) bristlecone. Its outer growth rings were compared with the inner rings of a living tree. If a pattern of individual ring widths in the two samples prove to be identical at some point, we can carry dating further into the past. With this method of matching overlapping patterns found in different wood samples, bristlecone chronologies have been established almost 9,000 years into the past.

The bristlecone pine chronology in the White Mountains of California currently extends back almost 9,000 years continuously. That's back to 7,000 BC! Several pieces of wood have been collected that will extend this date back even further. The hope is to push the date back to at least 8,000 BC. This will be important as the last Ice Age ended about 10,000 years ago, and to have a record of this transition period would offer scientists a wealth of information.

In addition to aging, detailed study of annual rings can provide us with a wealth of information concerning the physical and biological conditions present during the tree's lifetime. Catastrophic events such as fires, volcanic eruptions, hurricanes, earthquakes, glacial advances, lightning strikes, floods, insect infestations, injury and disease may all be recorded in the annual rings of a tree; e.g., if a tree is tipped over by a storm but continues to grow, changes in the orientation of annual rings may occur.

Past climatic conditions can often be reconstructed from patterns in the growth of annual rings. Temperature and rainfall conditions that are optimum for the growth of that species result in particularly wide annual rings—while years of poor growing conditions result in narrow annual rings. Competition from other trees may also result in narrow growth rings and various management treatments such as thinning, herbicide spraying or fertilizing would be expected to result in a corresponding change in the width of annual growth rings.

Dendrochronology can also be used to assess historic levels of some pollutants. Trace levels of lead and mercury, for example, can be measured in annual rings—and thus provide a chronological record of the degree to which industrial pollution contributes to natural levels of these substances.

In today's lab you will be analyzing patterns of annual growth in a common western Oregon tree—western hemlock (*Tsuga heterophylla*). Climatic data will be provided, and you will test the hypothesis that there is a correlation between annual growth, average annual temperature, and annual precipitation.

CROSS SECTION SAMPLES

Each group of students will be given a cross section from a western hemlock that was harvested from a stand on Bureau of Land Management (BLM) land four years ago. Stand information was obtained from Salem District BLM records:

Site Description and Location
BLM Unit #170 Polk County, Oregon Township 7S Range 7W Section 4

This is a 25-acre unit dominated by large Douglas-fir trees 21+ inches DBH (diameter at breast height, at 4 ½ feet from the ground). BLM categorizes stands of this age as "old growth." The stand has been judged by BLM as suitable for spotted owl nesting, roosting and foraging. It is considered to be "well-stocked," meaning that the density of trees on the site is considered adequate for crop production (70-100% of normal basal area or volume). The stand was established in 1800 as determined by coring and aging a sample of dominant trees (seven years were added to the ring count to account for time required to reach 4 ½ feet). It is assumed that a stand-replacement fire occurred at approximately this time. The stand condition is considered *good,* meaning that the stand is not decadent, with very few dead and dying overstory trees. Slopes in this area range from 35-59%. The site index is 120 (a 100-year old tree would be expected to grow to 120 feet in height). No disease or insect damage has been documented for this site.

The stand is being managed as an "Adaptive Management Reserve," and silvicultural treatments are not needed at present. Regeneration since 1800 has been entirely natural on this site, and there has been no treatment (thinning, planting, etc.) of any kind.

BIOLOGICAL CHARACTERISTICS OF WESTERN HEMLOCK

Forests of western Oregon and Washington are dominated by western hemlock (*Tsuga heterophylla*), Douglas-fir (*Pseudotsuga menziesii*) and western redcedar (*Thuja plicata*). These species are adapted to moist, temperate conditions of the region. Summers are dry with only 6-9% of total precipitation falling during those months. Mean annual temperatures range from 46 to 48 degrees F, and neither January nor July temperatures are extreme. The environment is mild and quite favorable for forest development. Unlike drier western forests such as those dominated by ponderosa pine, Garry oak or western juniper, the forests of the Western Hemlock Zone tend not to be responsive to small changes in soil moisture. In fact, neither moisture nor temperature are severely limiting for these species.

Western hemlock is the "climax species" in this region, and common associates are Douglas-fir and western redcedar. The tree is very shade tolerant and reaches a maximum age of at least 400 years. It does not tolerate long periods of frozen soil in the root zone.

The following climatic data were taken from seven representative sites within the Western Hemlock Zone (Franklin and Dyrness, 1973). Use them to help define optimum growing conditions for the species and to interpret trends seen in your graphs. Ranges are given in parentheses.

Average Annual Temperature (degrees F)	48.8	(45.3-50.7)
Average January Temperature (degrees F)	33.9	(29.8-37.2)
Average January Minimum Temp (degrees F)	27.5	(25.3-31.6)
Average July Temperature (degrees F)	63.3	(60.4-66.0)
Average July Maximum Temp (degrees F)	79.4	(72.7-84.9)
Average Annual Precipitation (inches)	81.2	(57.2-126.2)
Average June-August Precipitation (inches)	5.0	(4.2-6.1)

PROCEDURE

Perform the following procedures for your woody cross section:

1. Estimate the age of the tree by counting the annual rings. Assume that the section was taken at breast height (DBH). Each annual ring is composed of two easily distinguished bands: **spring wood** is lighter and more porous; **summer wood** tends to be darker and more dense. Be sure to add seven years to account for the number of years required to for the tree to reach a height of 4 ½ feet. (*Note*: this number is specific for western hemlock. Eight years would be added for Douglas-fir.)

2. Select a representative radius from the center to the perimeter of the cross section and carefully measure the *width* of each annual ring (spring wood and summer wood combined) beginning with the ring laid down in the Spring and Summer of 1995. Use vernier or digital calipers to measure annual ring width (*to the nearest 0.1 mm*) for each year and record the width on the attached data sheet. You may find it useful to mark every 10th year or so with a pin to keep track of your measurements.

3. Historical climatological data for this site were obtained from Oregon State University's Climatological Service Web Site. You will be given a copy of these data and asked to analyze them in the next section. These data will also be stored on computers in the computer lab.

ANALYSIS

Using your observations and the background information above, answer the following questions.

1. Measure 5 radii from the center of your cross section. Are the annual rings perfect circles? If not, what factor(s) may contribute to the irregularities?

2. How old is the tree? What factors could add error to this estimate?

3. What accounts for the fact that the age of this tree is less than the age of the stand? (See background information above)

4. Western hemlock is a shade-tolerant tree while Douglas-fir is less shade-tolerant. Would you expect a dominant Douglas-fir taken from this stand to be older or younger than this tree? Explain your answer.

5. Plot *Annual Rainfall* and *Annual Growth* against time on the same graph. You may generate your graphs by hand, but I would suggest entering your data into a spreadsheet (*EXCEL*), using that program to generate your graph.

   Note: Be sure the earliest dates appear on the left end of the X-axis.

6. On a second graph, plot *Average Annual Temperature* and *Annual Growth* against time, as above.

   Note: Be sure the earliest dates appear on the left end of the X-axis.

7. Using only the *Annual Growth* portion of your graphs as a source of information, write a brief narrative that describes the growth history of this tree. What explanations can you offer for the trends you have described? Consider the background information on this stand and the biological characteristics of western hemlock (given above) in your answer.

8. How would the growth history of this tree be different if it grew for the first 40 years in a stand at very high density—and then the stand was thinned? How would this be reflected in the annual rings?

9. Carefully examine the graphs you have generated. Does there appear to be any correlation between these climatic data and annual growth? If so, explain the relationship. If not, explain why there may *not* be a relationship between climatic data and annual growth in these samples.

10. What is the *Average Annual Growth* of this tree measured as increase in diameter? Describe how you calculated this value and give your answer in millimeters.

11. Western hemlock and Douglas-fir are adapted to the cool, moist forests of the Pacific Northwest. If climatic conditions change to drier, warmer conditions (as might be expected in an "enhanced greenhouse" scenario or **global warming**), growth patterns could change from what you have seen here. What changes would you expect in reproductive success? In growth rates of mature trees? Of these two species, which would you expect to be more affected by an enhanced greenhouse effect? Why?

12. Western hemlock now occupies elevations from approximately 500 to 3300 feet in the Oregon Cascades. How would you expect this to change in a greenhouse scenario that results in an increase in global average temperature of 4-7 degrees F by the Year 2050?

13. Annual rings do not form in trees from tropical rainforests. Why not?

14. Using the website noted on the first page (www.sonic.net/bristlecone/dendro.html) research and answer the following:

- Explain "sensitivity" and ring variation; what does this mean and how does it apply to using dendrochronological data?

- When statistically analyzing this type of data, discuss why *averages* of data are important to estimate climate information.

Western Hemlock Cross Section

Year	Annual Growth (in mm)	Year	Annual Growth (in mm)	Year	Annual Growth (in mm)	Year	Annual Growth (in mm)	Year	Annual Growth (in mm)
1995									

MATERIALS

Quantity	Materials and Equipment
100	Insect pins
12	Magnifying glasses
12	Vernier or digital calipers (0.1 mm accuracy)
50 sheets	Graph paper
6	Western hemlock (or appropriate local species) cross sections
6	Meter sticks
6	Needle probes
6	Colored pencils (red)

Temperature and rainfall data will need to be obtained for a station as close as possible to the site from which the cross sections were obtained. I load up these data prior to lab on the hard drive of computers accessible to students. Climate data for this exercise were obtained from:

Oregon Climate Service
316 Strand Ag. Hall
Oregon State University
Corvallis, OR 97331
phone: 541-737-5705
www.ocs.orst.edu

NOTES FOR INSTRUCTORS

What are annual rings?

Provide a diagram and example of annual growth layers (overhead slide). *You may want to scan in a wood cross section through a computer to go over samples they have in front of them.*

Secondary growth in woody plants occurs as a result of cell division at the **vascular cambium**: a cylinder of cells close to the bark of the tree that actively divides

- vascular cambium in temperate areas is seasonally active.
- most cell division (and, therefore, growth) occurs during spring and summer with a relatively dormant period from late fall to late winter.
- periodic activity of cambium layer results in annual rings.

Spring wood is laid down in Spring (near beginning of growing season)—lighter in color, porous

Summer wood is laid down in summer (near end of growing season)—darker in color, dense

DIAGRAM ON BOARD

Show relative position of bark, cambium layer, alternating spring wood and summer wood.

The scientific study of tree rings is called **dendrochronology**.

Annual rings of trees in temperate and boreal forests can be used to determine the age of a tree. They also provide a record of the physical and biological conditions present during the lifetime of the tree. Therefore, the tree may be thought of as a "living weather station."

When provided with information concerning the biological requirements of western hemlock, students should be able to predict range shifts in response to climate changes. This can be generalized to a broader discussion of biological impacts of global warming.

In this lab students will be analyzing patterns of annual growth in western hemlock. Climatic data will be provided and the following hypotheses will be tested:

1. *There is a correlation between annual growth and average annual temperature.*

2. *There is a positive correlation between annual growth and annual precipitation.*

I also describe the following:

1. The origin of the cross sections and climate data.
2. The procedure for measuring and recording annual ring width (proper use of calipers, magnifying glasses, to nearest 0.1 mm, record on data sheet).
3. The procedure for graphing and methods for analysis of annual ring width/climate data.
4. The differences between *positive correlation*, *negative correlation*, or *no correlation* between variables.

As an optional activity, students could use the spreadsheet program to calculate **correlation coefficients** for the variables being examined and then report on their interpretation of these statistics.

REFERENCES

Internet: www.sonic.net/bristlecome/dendro.html

Provides excellent overview and simplified information on this subject.

Cook, E. et al. 1991. Climatic change in Tasmania inferred from a 1089-year tree-ring chronology of Huon Pine. Science 253:1266-1268.

A tree ring chronology is developed for Tasmania from 900 A.D. to 1988. Current growing season temperatures and Huon pine growth are shown to be causally linked.

Franklin, J.F. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. Pacific Northwest Forest and Range Experiment Station, Forest Service, USDA, Portland, Oregon. Gen. Tech. Rep. PNW-8. 417 pp.

McLaren, B.E. and R.O. Peterson. 1994. Wolves, moose, and tree rings on Isle Royale. Science 266:1555-1558.

This article describes an interesting application of dendrochronology. A trophic link between wolves, moose and balsam fir on Isle Royale, Michigan is investigated using tree ring analysis.

Phipps, R.L. 1985. Collecting, preparing, cross-dating and measuring tree increment cores. U.S. Geological Survey #261855. Water Resources Investigations Report 85-4148. 48 pp.

Increment cores taken from trees could potentially yield similar information to that gathered from tree cross-sections. This publication describes the collection, preparation and measurement of tree increment cores.

VIDEOTAPE

Wind River Canopy Crane. 2000. Oregon Field Guide, 15 min.

Oregon Public Broadcasting Productions
7140 SW Macadam Ave.
Portland, Oregon 97219-3099
1-800-241-8123

This brief segment describes current research being conducted at the Wind River Canopy Crane site that relates to carbon flux and global warming.

The *Capital Press* as a Resource for Environmental Science

The primary goal of Environmental Science II is to familiarize you with environmental problems associated with biological resources. Ecosystem management is used as an underlying theme to evaluate issues concerning resource use and management such as food production, deforestation, fisheries management, soil erosion, water issues and the loss of biodiversity. This area of study is rapidly evolving and is not without controversy.

Therefore, I have made regular reading of the *Capital Press* a course requirement to encourage you to evaluate current environmental issues in your own geographical area. The *Capital Press* is a regional agricultural newspaper published weekly in Salem, Oregon that covers a wide variety of natural resource management issues. The intended audience for this publication is farmers, ranchers and other resource users and managers. Articles and editorials should provide fertile ground for discussions in lecture and lab. I will announce the articles for your attention each Monday in class. The *Capital Press* is available in all public and college libraries in the area; I will also keep a copy on reserve in my office for your use.

As you read the *Capital Press*, I encourage you to critically review articles—and be wary of any indications of bias, hidden agendas, and “fuzzy logic.”

Select an article to summarize and evaluate it.

After reading each of the articles, select one that you find particularly interesting to summarize and evaluate. As you re-read this article, take notes that reflect the main points that are being presented as well as your impressions or comments that relate to the topic. Your notes will be used to prepare an article summary that will be turned in for credit each Friday. Only one summary may be submitted each week. Five summaries are required throughout the term; two additional summaries may be submitted for extra credit. The summaries should be at least one page long and approximately evenly divided between two areas:

1. A summary of the contents of the article.

2. Your evaluation of the main points raised by the article. Include your impressions, criticisms, opinions or comments. Try to make a connection between the article and a topic that has been discussed in class.

Be sure to include the title, author and date of the article you have reviewed at the top of the page.

Sample Review:
"**Forest Management Faces Changes,**" by Larry Swisher—*Capital Press* 13 December 1996, p.3

Senator Larry Craig of Idaho is proposing legislation that would change the way federal forests and rangelands are managed. He states that the intent of the new legislation is to "reaffirm the multiple use mandate" in response to administrative and legal challenges by environmental interests. He contends that such actions have harmed local economies as well as federal lands that produce timber and rangeland.

If enacted into law, the bill would:

- Increase the authority of the Bureau of Land Management and U.S. Forest Service to make environmental and land use decisions without consulting other federal agencies
- Weaken the ability of environmentalists, resource users and ordinary citizens to challenge these decisions
- Allow a state to take over management of federal lands within its borders if autho rized by Congress
- Set deadlines for development of land-use plans by federal agencies
- Improvement forest health
- Streamline decision making and citizen appeals

The cost of the bill has not been estimated. The bill will be reviewed by various groups over the next several weeks. Predictably, the timber industry has responded favorably to the bill, and environmental groups have condemned it. After taking comments on the bill, it will be introduced by Craig when the 105th Congress convenes in early January.

Craig is a long-time critic of current environmental policy and this bill appears to be a response to environmental protection that has resulted from the upholding of environmental laws in the courts. Craig contends that current policy excludes humans from federal lands and that we have taken a "lock it up and throw away the key" approach. This is a gross oversimplification of current environmental law which seeks to maintain *all* values in these ecosystems. I would not support this bill because:

- I generally oppose state or local control of federal lands. As management of federal lands moves towards larger scales of time and space, local or state agencies often lack the broad view and resources to properly manage the land.

- "Improving forest health" would seem to be as popular as "apple pie" (everyone wants healthy forests—right?). However, "forest health" is difficult to define and, like "beauty," it is often seen in the eye of the beholder. The maintenance of forest health has often been used in the past as an excuse to increase timber harvest.

- The bill would give free reign to the BLM and USFS to manage resources on federal lands without any checks or balances. Currently if endangered species are involved, these agencies must consult with the U.S. Fish and Wildlife Service. This bill would allow the BLM and USFS to operate without consulting outside agencies.

Sorry Larry Craig!

Study Guide Exam #1

COVERAGE:

Botkin and Keller Chapters 10 and 11
Supplemental reading (all handouts):
"Ecosystem Management"
"Sustainable Agriculture"
Readings from *Capital Press* (7 January through 21 January 2000)
Videotapes:
"Save the Earth: Feed the World" - Race to Save the Planet
"Agricultural Water Use" - Oregon Field Guide
Labs:
Lab #1 - Sustainable Agriculture
Labs #2 & 3 - Physical and Biological Characteristics of Soils

Be familiar with the following:

1. Human impacts on ecosystems—evidence and indicators.
2. Ecological footprint analysis as a method for evaluating human impacts.
3. The differences between agricultural ecosystems and natural ecosystems.
4. The barriers to producing food for a growing population in a finite world.
5. The most common animal and plant species used on a large scale for human food. How does this number compare to global biodiversity?
6. What are the similarities and differences between the 3 major stages of agriculture in human history—primitive, traditional farming; industrial, Green Revolution farming; sustainable agriculture.
7. What is aquaculture? Examples?
8. What are the impacts of agriculture on the various components of natural ecosystems? (soils, water resources, native plants and animals, global systems).
9. What are the physical and biological components of soil? (lecture and lab).
10. What are the roles of living organisms in soils? (lecture and lab).
11. How can information from a soil survey be used to determine the most appropriate land use for a given property?
12. What are the goals of sustainable agriculture? What farming methods can be employed to achieve these goals?
13. What is IPM and how is it implemented?
14. How does long-term pesticide application cause the development of pesticide-resistant strains of pests? What strategies are used to deal with resistance?
15. What barriers might discourage a farmer from adopting sustainable agriculture practices? What potential benefits are there to the farmer to adopt sustainable agriculture practices?
16. See Critical Thinking exercise on pp. 221-222
17. What is "Ecosystem Management"? Be familiar with EM objectives and how these objectives might be achieved in agricultural ecosystems.

Terminology:

agroecosystem	aquaculture	drip irrigation
green revolution	hydroponics	maximum sustainable yield
mariculture	monoculture	optimum sustainable yield
biological control	biomagnification	contour plowing
desertification	IPM	conservation tillage
overgrazing	polyculture	pesticide
herbicide	fertilizer	organic farming
genetic engineering	crop rotation	soil horizons
humus	fungi	topsoil
subsoil	silt	clay
sand	loam	tilth
pathogen	macronutrient	N-fixation
nitrification	leaching	crop residue
aeration	agrochemical	erosion
salinization	selenium	mycorrhizae
cultural eutrophication	CAFO	riparian
aquifer	exotic species	desertification
green manure	cover crop	windbreak
Bacillus thurigensis	sex pheromone	aequorin
DDT	soil texture	ecological footprint

Study Guide - Exam #2

COVERAGE:

Botkin and Keller Chapters 12 and 13
Supplemental Reading:
California condor article
Giving Voice to Salmon
OSU Extension Salmon publication
The World's Imperiled Fisheries
Capital Press readings through 18 February (see handouts for listings)
Field Trip to Baskett Slough Wildlife Refuge
Biodiversity Lab - California Condor case study and slide presentation
Salmon presentations
Videos - "Return of the Salmon", WFPA Forestry video, "Whiting Fishery"

Be familiar with the following:

1. How do traditional definitions of wildlife differ from current definitions? Be familiar with definitions of biodiversity concepts from Chapter 7 (covered last term).
2. What are the goals of wildlife management?
3. What is the biodiversity crisis and how is it measured? How do current rates of extinction compare with background rates?
4. What characteristics of species increase their probability of extinction?
5. What are the various causes of modern extinctions? Be familiar with the details of each.
6. What are the consequences of extinctions for humans? for ecosystems? What arguments have been proposed for the preservation of biodiversity?
7. What efforts are being made to preserve biodiversity?
8. How has "Ecosystem Management" been applied to wildlife management and the preservation of endangered species? Be familiar with modern wildlife refuge design.
9. Be familiar with recent efforts at Baskett Slough Wildlife Refuge and how these management activities fit into an ecosystem management philosophy.
10. What are the various resources provided by forest ecosystems?
11. In what way does deforestation impact ecosystems on a local, regional and global scales?
12. How have the concepts of "maximum sustainable yield" and "multiple use" been applied to the management of forest ecosystems? What are their strengths and weaknesses?
13. What are the ecological characteristics of old growth forests and how do these differ from second growth forests?

14. What vertebrate species are associated with old growth forests and what aspects of these forests do they apparently require?
15. Be familiar with the "old growth controversy" and some of the management plans that have been proposed as potential solutions.
16. Be familiar with all aspects of the Pacific salmon issue as outlined on the "Salmon Presentations" handout and as presented in lab.
17. What are the most important commercial fisheries worldwide?
18. What evidence do we have that suggests some fishery stocks are being overfished?
19. How have fish stocks been managed traditionally?
20. What alternative management strategies have been proposed for marine species? for anadromous species? for freshwater species?

Terminology:

wildlife	ecological island	endangered
threatened	rare/vulnerable	global extinction
local extinction	extirpation	genetic diversity
biodiversity	meteorite	minimum viable population
species richness	species evenness	keystone species
mass extinction	DDT	background extinction
taxol	Pacific yew	vincristine
vinblastine	rosy periwinkle	wildlife refuge
wildlife corridor	GAP analysis	buffer area
core reserve	ESA	adaptive management
watershed	fragmentation	edge effect
deforestation	*Waldsterben*	canopy gap
Habitat Conservation Plan	sustainable yield	multiple use
stratification	ecological succession	second growth
old growth	snag	epiphyte
Lobaria	litterfall	mycorrhizae
SOMA	"New Forestry"	biological legacy
old growth reserve	adaptive management area	salvage logging
clear cutting	closed canopy forest	even-aged stand
rotation time	selective cutting	silviculture
NW Forest Plan	smolt	riparian zone
fishery stocks	estuary	upwelling
continental shelf	George's Bank	Grand Banks
200-mile limit	catch limits	aquaculture
age structure	anadromous	demersal
pelagic	hatchery	

Study Guide - Final Exam

COVERAGE:

Botkin and Keller Chapters 19 and 21
Article - "Nurturing Nature"
Videotape - "Only One Atmosphere - the Greenhouse Effect"
Field Trip - Grand Ronde Reservation
Dendrochronology Lab
Article - "Gauging the Biological Effects of Global Warming"
Capital Press Readings for 2/18, 2/25 and 3/3

Be familiar with the following:

1. The major issues in water use and management.
2. Wetland restoration in the Everglades as described in the "Nurturing Nature" article and discussed in class.
3. What impacts do floods have on Pacific Northwest ecosystems?
4. What role do wetlands play in river ecosystems?
5. What human activities may have aggravated the effects of the"Flood of 1996"?
6. The chemical and physical nature of the atmosphere.
7. The carbon cycle - long term and short term cycles.
8. Trends in temperature change at various scales of time in Earth's history.
9. Direct and indirect measurements of temperature change.
10. The "greenhouse effect."
11. What data and observations support a relationship between atmospheric CO_2 levels and global temperature? What uncertainties exist?
12. What are the greenhouse gases and what are their origins?
13. The use of Global Climate Models (GCM's) to predict climate change caused by the "greenhouse effect."
14. What are some of the predicted consequences of elevated global temperatures to the physical world?
15. Have a thorough understanding of the biological effects of global warming - impacts on agriculture, forests, fisheries and wildlife.
16. What are some potential solutions to global warming?
17. Natural resource issues on the Grand Ronde Reservation as described on field trip.
18. The use of annual rings of trees as a record of past climate conditions and disturbances.

Terminology:

channelization	mitigation	back channel
floodplain	wetland	groundwater
in-stream use	off-stream use	water conservation
desalination	hydrologic cycle	overdraft
troposphere	stratosphere	microclimate
respiration	decomposition	photosynthesis
anthropogenic	ultraviolet (UV)	infrared (IR)
wavelength	greenhouse gas	CFC
global climate model	C3/C4 plants	climatic shift
generalist	specialist	migration rates
global warming	methane	annual ring
spring wood	summer wood	dendrochronology
vascular cambium	ecological restoration	macroinvertebrate
stonefly	mayfly	caddis fly

Exam #1 Winter 2000

Multiple Choice (2 points each): Select the most appropriate answer and place the letter on the answer sheet.

1. A forest planning team designs a thinning operation that is viewed as an experiment whose results are unknown. The results of the operation will be monitored over the next 20 years and periodically evaluated by the planning team. Information gained from these evaluations will be used to alter future thinning operations as necessary. The process above is best described as:

   a. Ecosystem management
   b. Watershed management
   c. Adaptive management
   d. Timber stand improvement
   e. Species management

2. Ecosystem management (EM) has been proposed as a more appropriate way to manage our natural resources. Of the following items, which one is LEAST likely to be part of a forest management plan that uses EM as its guiding principle?

   a. maintain the processes of decomposition and nitrogen fixation in soils
   b. involve several elements of society in the decision-making process
   c. use modern imaging techniques such as satellite photos and GIS
   d. plant a monoculture of Douglas-fir
   e. consider downstream effects of management activities

3. Modern day farmers who use pesticides lose about 1/3 of their crop to insect pests. Prior to the development of these pesticides, crop losses to pests were:

   a. much higher
   b. much lower
   c. about the same
   d. insignificant

4. The "Green Revolution" refers to:

   a. a recent pro-environment movement in western Europe
   b. the shift from hunting and gathering to agriculture
   c. post-World War II efforts to increase crop yields and resistance to disease
   d. the shift from resource-based agriculture to demand-based agriculture
   e. none of the above

5. Aquaculture would include all of the following except:

a. harvesting cultured oysters in Yaquina Bay
b. raising salmon in off-shore enclosures
c. growing rice in fields covered with water
d. raising catfish in carefully tended ponds
e. raising fish in flooded rice fields

6. Each of the following is a correct statement concerning agroecosystems <u>except</u>:

a. agroecosystems maintain an early stage of succession
b. agroecosystems require significant human inputs to maintain stability
c. agroecosystems contain primarily native species
d. agroecosystems produce both animal food and human food
e. agroecosystems rely on underground biological processes to maintain productivity

7. A soil scientist grabs a handful of soil from an agricultural field, adds some water and squeezes the mixture into a three-inch "dirt worm". From this simple test she concludes that:

a. the soil sample has a high sand content
b. the soil sample has a high loam content
c. the soil sample has a high clay content
d. the soil sample has a high organic content
e. soil is dirty

8. A crop plant that is genetically engineered to fix nitrogen would:

a. require less chemical fertilizer
b. be more resistant to diseases
c. be more drought tolerant
d. be more resistant to air pollution
e. require less irrigation

9. The primary drawback to broad-spectrum pesticides is that they:

a. reduce crop yields
b. are carcinogenic
c. are toxic to beneficial organisms
d. contribute to soil erosion
e. contribute to global warming

10. Eating at a lower trophic level is more efficient than eating at a higher level. However, according to your text, conversion of all present rangeland to cropland would increase environmental damage because:

a. growing crops adds greenhouse gases to the atmosphere, but grazing does not
b. grazing benefits the environment by increasing plant diversity
c. not all land is suitable for crops; some is better suited to grazing
d. in tropical areas, growing crops requires clearing forests; grazing cattle does not

11. Contour plowing addresses which of the following problems:

a. excessive use of agrochemicals
b. soil erosion
c. biological magnification
d. reduced crop yields due to insects
e. water shortages

12. Crop rotation contributes to soil fertility by:

a. reducing the loss of soil nutrients
b. reducing soil erosion
c. providing the farmer with a variety of crops to sell
d. increasing the organic content of soils
e. none of the above

13. In 1985, the U.S. Bureau of Reclamation closed the Kesterson National Wildlife Refuge due to environmental contamination. This contamination was caused by:

a. excessive application of pesticides
b. radioactive waste from a nuclear power plant
c. runoff from surrounding agricultural areas
d. petroleum products leaking from underground storage tanks
e. chemical concentration due to heavy irrigation and evaporation

14. Although rice farming in the Sacramento Valley in California has several negative impacts on the environment, there are some benefits as well. Which of the following benefits is probably the most important?

a. flooded rice fields provide wildlife habitat for migrating birds
b. since integrated pest management is used, pesticide contamination is minimal
c. rice farming is conducted in lands that are unsuitable for other uses
d. since rice is grown in natural wetlands, irrigation is not required
e. flooded rice fields are used to raise young salmon which are later released into rivers

15. Neutron probes and infrared photographs hardly seem to be standard tools of farmers, but farmers in the Hermiston area are using these high-tech devices to:

a. conserve water
b. control insect pests
c. determine levels of soil nutrients
d. determine crop maturity
e. all of the above

16. The majority of organic material in soil is found in the ________ horizon.

a. A
b. B
c. C
d. D
e. O

17.________ is an approximately equal mixture of coarse, medium and fine soil particles.

a. Clay
b. Silt
c. Sand
d. Loam
e. Humus

18. The primary impact of CAFO's in the Willamette Valley on aquatic ecosystems is:

a. nitrate runoff into waterways
b. release of methane from cattle
c. introduction of exotic species into rivers
d. consumption of water by cattle
e. livestock grazing in riparian areas

19. As DDT passes through the food web, its levels in tissues of living organisms tend to increase. This phenomenon is known as ________. (fill in)

20. Which of the following agricultural activities contribute directly to the "Greenhouse Effect" by releasing CO_2 into the atmosphere?

a. burning of fossil fuels
b. application of commercial fertilizer
c. clearing and decomposition of native vegetation
d. a and b
e. a and c

21. Sustainable agriculture requires that agricultural operations occur in an area that is most appropriate for them. Which of the following products is probably most appropriate for the moderate climate and deep, rich soils of the Willamette Valley?

a. Christmas trees
b. Corn for human consumption
c. Grass seed for lawns and pastures
d. Pasture
e. Apple orchards

22. Conservation tillage benefits agroecosystems in each of the following ways <u>except</u>:

a. Decreases soil erosion
b. Increases soil fertility
c. Increases number of beneficial insects
d. Reduces numbers of weeds
e. Increases organic content of soils

23. Of the following plants, which one would be most useful as a cover crop in the Willamette Valley?

a. Corn
b. Clover
c. Wheat
d. Orchard grass
e. Sunflowers

24. When integrated pest management was implemented on rice farms in Indonesia, which of the following values <u>increased</u>?

a. Cost to farmers per acre
b. Yield per acre
c. Cost to government per acre
d. Number of pesticide applications

25. An oven-dried soil sample is carefully weighed and then burned for 15 minutes. After cooling, the sample is re-weighed and found to be 10 grams lighter. What soil component probably accounts for the loss of weight?

a. Water
b. Nitrogen
c. Phosphorus and Potassium
d. Organic matter
e. Earthworms

26. Most vegetable crops grow best in soils of near neutral pH. Based on measurements of soil samples in lab, it appears that:

a. Most would benefit from the addition of lime to increase pH
b. Most are already of suitable pH for growing vegetable crops
c. Most would require the addition of lime to decrease pH
d. Most would require the addition of composted material to decrease pH

27. Which of the following invertebrates found in soil litter samples taken in the laboratory would be classified as secondary or tertiary consumers?

a. Fly larvae
b. Springtails
c. Earthworms
d. Pseudoscorpions

28. In general, soil invertebrates tend to be more diverse and abundant in the litter layer of fertile agricultural soils than in forest soils.

a. True
b. False

29. What is the ecological role of forest millipedes, such as the keystone species *Harpaphe?*

a. "macro-shredder" of organic debris on the forest floor
b. predator of insect pests on Douglas fir
c. major food source for forest birds
d. controls populations of springtails
e. improves soil fertility by fixing nitrogen

30. Onions grown in the rich organic soils of the Willamette Valley rely upon springtails to:

a. disperse mycorrhizae associated with the roots of onions
b. control various insect pests that feed on the roots of onions
c. disperse onion seeds from field to field
d. pollinate other onion plants

The following questions (#31-35) were taken from *Capital Press* readings:

31. The article entitled "Biotech rice could solve nutrition problem" describes a genetically engineered strain of rice that may prevent blindness in children in developing countries. What is in this "wonder rice"?

a. retinol
b. aequorin
c. Vitamin C
d. beta carotene
e. selenium

32. Voters of the Grants Pass Irrigation District (GPID) recently voted by a 2:1 margin to:

a. allow wider riparian buffers on creeks
b. allow a greater number of farms to use water supplied by the district
c. tear down a dam that was built by the GPID
d. plant cover crops to prevent soil erosion
e. practice sustainable agriculture

33. A January 14 article describes the reaction of farmers have had to salmon rules proposed by the National Marine Fisheries Service. According to this article, which of these rules has caused the greatest concern for farmers?

a. wide buffers on salmon bearing streams
b. reductions in commercial harvest of salmon
c. restrictions on recreational fishing for salmon
d. regulation of runoff from agricultural fields
e. restrictions on the use of pesticides

34. The nation's two largest natural food stores recently made the decision to label their products as "GMO-free". What does this mean?

a. all of their products are organically grown
b. all of their products are grown on farms that practice sustainable agriculture
c. none of their products are derived from genetically engineered crops
d. none of their products have been sprayed with the pesticide "Gluco-mono-organophosphate"

35. A new study out of Oregon State University suggests that amphibian declines may be caused by ________ at levels declared by the Environmental Protection Agency as safe for human drinking water.

a. pesticides
b. phosphate
c. sediment
d. nitrate
e. ultraviolet radiation

Essay Question - 20 points

Answer the following question as completely as possible using information from lecture, lab, and supplemental reading.

36. Although it may be argued that agrochemicals (fertilizers, pesticides, herbicides, etc.) are essential for food production for the growing human population, the use of these chemicals is not without environmental costs. Describe the environmental impacts (both direct and indirect) of using agrochemicals in modern agricultural operations.

Short Answer Questions - 5 points each

Select **any two** (and only two) of the following (#37- 40) short answer questions and answer as completely as possible. Where possible, integrate information from lecture, lab and supplemental reading.

37. What is "integrated pest management"? What specific practices might be part of an IPM program?

38. Describe some of the roles of living organisms in soils. Include examples from the biological analysis of soil completed in lab.

39. Describe "sustainable agriculture" in your own words. Then, select one agricultural practice that is considered to be an element of sustainable agriculture and describe how it meets sustainable agriculture goals.

40. What is "ecological footprint analysis" and what have we learned from it?

Extra Credit Question - 5 points

Ecosystem management (EM) has been proposed as a new way of managing natural resources that makes use of our knowledge of complex ecosystems. Select **<u>one</u> goal** of EM (see "Ecosystem Management" handout) and describe some of the current efforts being undertaken in agriculture that attempt to address this element of EM.

Exam #2 Winter 2000

<u>Multiple Choice</u> (2 points each): Select the most appropriate answer and place the letter on the answer sheet.

1. Which of the following characteristics is typically found in second growth forests but <u>not</u> in old growth forests?

   a. even-aged canopy
   b. abundance of large logs
   c. greater diversity of animal specialists
   d. abundance of large snags
   e. great stratification of understory

2. Of the following species found in old growth forests, which one is most closely associated with downed woody debris?

   a. spotted owl
   b. flying squirrel
   c. Pacific giant salamander
   d. Oregon slender salamander
   e. red tree vole

3. Of the following species found in old growth forests, which one is most closely associated with cool, well-aerated, cascading streams?

   a. spotted owl
   b. flying squirrel
   c. red tree vole
   d. Oregon slender salamander
   e. tailed frog

4. *Lobaria oregana* (lungwort) is a lichen found in great abundance in the canopy of old growth forests. Which of the following is thought to be the major ecological role of this organism?

   a. It forms a mycorrhizal relationship with Douglas fir
   b. It is a major food for several mammals associated with old growth forests
   c. It shades the forest floor
   d. It contributes significant amounts of nitrogen to forest soils
   e. It provides a surface area on which water condenses

5. Approximately, what percentage of pre-settlement old growth forest in western Washington and Oregon has been harvested?

a. 25
b. 99
c. 90
d. 50
e. 10

6. The incorporation of "biological legacies" into the managed landscape is most likely to be included in a forest management plan that uses ________ as its guiding principle:

a. maximum sustainable yield
b. "new forestry"
c. selective cutting
d. multiple use
e. uneven-aged management

7. In the "Northwest Forest Plan", adaptive management areas are set aside for:

a. ecological reserves
b. intensive ecological experimentation
c. buffer zones and corridors between ecological reserves
d. spotted owl habitat
e. timber production

8. At different times of their life cycle, salmon use fresh water and salt water habitats. For this reason they are considered to be:

a. anadromous
b. salmonids
c. specialists
d. demersal
e. pelagic

9. The collapse of the anchovy fishery off the coast of Peru in 1972 can be attributed to a combination of overfishing and

a. contamination of spawning grounds
b. cooler ocean waters
c. the election of Richard Nixon
d. an El Nino event
e. a population increase of seals

10. Traditional efforts in fisheries management have emphasized the regulation of types of fishing gear that can be used, catch quotas, open and closed fishing grounds and harvest seasons. All of these are based on the concept of:

a. maximum sustainable yield
b. ecosystem management
c. biodiversity management
d. multiple use
e. optimum sustainable yield

11. In the mid-1970's severe restrictions were placed on the haddock fishery off the coast of New England. These restrictions were based on the analysis of:

a. spawning grounds
b. age structure
c. fish diseases
d. food availability
e. population genetics

12. In developing countries, forests are considered most important as a source of:

a. food
b. fuel wood
c. watershed protection
d. construction lumber
e. recreation

13. A substance called "taxol" has been derived from the bark of the Pacific yew in Oregon. How is this substance used?

a. source of genetic information for nursery growers of yew
b. food additive to reduce spoilage
c. anti-cancer drug
d. a medium for the cultivation of mycorrhizal fungi
e. none of the above

14. If you were to design a species that is most likely to become extinct, it would have each of the following characteristics except:

a. small population size
b. little genetic variability
c. long life span
d. small home range
e. large body size

15. Since specialists tend to be better adapted to their environment than generalists, specialists are less likely to become extinct.

a. True
b. False

16. The concept of "Maximum Sustainable Yield" (MSY) is commonly used to manage any resource that is harvested by humans (e.g. ducks, deer, trees, etc.). Which of the following phrases describe(s) this concept?

a. the harvest level that is exactly one-half of the carrying capacity
b. the maximum number that can be harvested indefinitely without harming the ecosystem
c. the maximum number that can be harvested indefinitely without harming the population
d. A and B
e. A and C

17. A study by the Northwest Power Planning Council was recently reported in the *Capital Press*. The study predicted costs associated with various proposals to save Pacific salmon. Which proposal had the highest cost?

a. increase hatchery production
b. increase restrictions of recreational fishing
c. remove hydroelectric dams
d. increase width of riparian buffers

e. restore degraded spawning habitat

18. In a recent letter to the *Capital Press*, retiring Idaho representative Helen Chenoweth-Hage made a recommendation to:

a. abolish the Endangered Species Act
b. decrease the required width of stream buffers
c. remove the four lower Snake River dams
d. prevent further listing of salmon under the Endangered Species Act
e. declare salmon to be the state fish of Idaho

19. Which governmental agency is responsible for listing the northern spotted owl as a federally threatened species.

a. Environmental Protection Agency
b. National Marine Fisheries Service
c. National Audubon Society
d. U.S. Fish and Wildlife Service
e. Oregon Department of Fish and Wildlife

Mass extinctions have occurred throughout geological history. The best-supported hypothesis to explain these mass extinctions suggests that they are caused by:

a. meteorite impacts
b. introduced species
c. over-harvesting by humans
d. habitat destruction
e. environmental contamination

21. The most common cause for extinctions since 1600 has been:

a. meteorite impacts
b. introduced species
c. over-harvesting by humans
d. habitat destruction
e. environmental contamination

22. "The SLOSS Argument" ("single large or several small") has been discussed by conservation biologists for years. There is some agreement as a result of this discussion that a system of several small wildlife reserves is preferable to a single large reserve of equal area.

a. True
b. False

23. Baskett Slough Wildlife Refuge was initially established to protect the:

a. native prairie ecosystem of the Willamette Valley
b. Dusky Canada Goose
c. Aleutian Canada Goose
d. Northern Spotted Owl
e. native waterfowl of the Willamette Valley

24. Which of the following is a typical "rotation time" for Douglas-fir forests that are managed primarily for timber production?

a. 20 years
b. 50 years
c. 100 years
d. 150 years
e. 250 years

25. "GAP Analysis" is a new tool used by conservation biologists to:

a. determine how may gaps should be made in a forest canopy
b. determine the best location for wildlife refuges and preserves
c. restore degraded habitat
d. improve the success of captive breeding programs
e. increase the genetic diversity of endangered species

Short Answer (10 points each) Select **any 2** of the following 3 questions (# 26 - 28) and answer as completely as possible on the blank sheet of paper.

26. The recovery program for the California Condor has been quite successful. Over 158 birds are currently in existence from a low of 9 birds in 1987. Several challenges present themselves in the recovery and protection of these birds. For each of the challenges listed below, briefly describe how they have been addressed by those who are responsible for the management of this species:

A. imprinting on humans
B. production of a single egg per year
C. accidental death
D. lack of habitat
E. low genetic variability

27. Research over the past ten years has confirmed that spotted owls are associated with old growth forests of the Pacific Northwest. How do we know this? What components of old growth forests appear to be important to these owls?

28. What are the “4 H’s” of the Pacific salmon issue? Briefly describe the impact of each “H” on salmon.

Essay Questions (15 points each) Select **any 2** of the following 4 questions (# 29 - 32) and answer as completely as possible on the blank sheet of paper.

29. Describe the various management activities that have taken place at Baskett Slough Wildlife Refuge in an attempt to conform to the philosophy of ecosystem management. Which “ecosystem management goals” are being addressed by these activities?

30. Private timber lands are managed primarily for “timber production” while federal lands are managed under a “multiple use” guideline. Describe how these two management schemes result in differences in - a) ecosystem services provided and b) resources to humans.

31. Several different lines of reasoning have been proposed as rationale for preserving biodiversity. One of these is “ecosystem services provided by living organisms”. Describe what is meant by this phrase and give some specific examples.

32. By most measures, populations of commercially harvested marine fish are in jeopardy. Increasing demands put upon these stocks by a growing human population have driven the decline. Describe how each of the following additional factors have contributed:

- improved fishing technologies
- government subsidies
- by catch
- species by species management

Extra Credit Question - 5 points

33. The forested landscape of the Pacific Northwest is a mosaic of relatively young stands, clearcuts and old growth stands. Fragmentation and the edge effect magnify the effects of deforestation. It appears that this condition has contributed to the decline and loss of some native plant and animal species. What could be done in this landscape to restore the natural biodiversity of the region? Be specific and explain the expected outcomes of your recommendations.