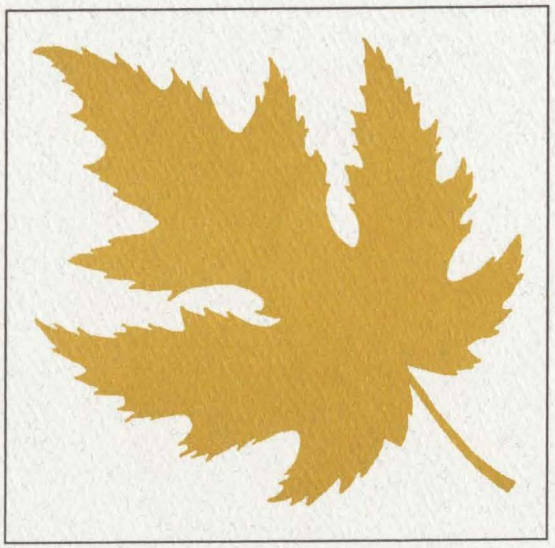
COURSES ON THE ENVIRONMENT

A Student Guide to University of Minnesota

Courses on Environmental Issues on the Twin Cities Campus



1991 1992

COURSES ON THE ENVIRONMENT

A Student Guide to University of Minnesota

Courses on Environmental Issues on the Twin Cities Campus

1991 - 1992

A publication of the Center for Urban and Regional Affairs, 330 Humphrey Center, 301 19th Avenue S., Minneapolis, Minnesota 55455.

1991

Publication No. CURA 91-5

Compiled by Margaret R. Wolfe.

♻ Cover printed on recycled paper.

CONTENTS

GENERAL INFORMATION

Courses on the Environment is a supplemental guide to official University bulletins of the various colleges and institutes of the University of Minnesota. Although there is no environmental studies department at the University and no formal undergraduate degree program in environmental studies, a large number of courses and programs at the University have implications for the study of environmental issues. There are 340 courses in 43 different departments listed in this 1991-1992 guide.

There are programs in the College of Liberal Arts and University College in which students can design their own environmental studies major. For information about CLA's special learning opportunities and individualized programs contact the Office for Special Learning Opportunities, 220 Johnston Hall (624-7577). For information about UC's degree programs contact the Inter-College Program, 7 Wulling Hall (624-2004), or the University College Program for Individualized Learning, 201 Wesbrook Hall (624-4020).

Part I of this guide is a subject index where courses are arranged by twenty-two subject areas. It is designed to help students interested in pursuing an interdisciplinary area of environmental study find courses of interest in various colleges and departments. While some courses are obviously found in a certain department, it is difficult to be aware of all the courses which pertain to a particular area. For example, courses dealing with the area of environmental health and pollution control or courses about resource management are found in several departments and described in various University bulletins, but can be located by using the subject index. All courses listed in Part I are described in Part II.

Part II lists courses by field of instruction and gives course descriptions and the name of a contact person who is prepared to advise students desiring more information. Several collegiate units offer, through their departments, degree programs that include a primary concentration on environmental studies. Part II is designed to serve as a guide to students pursuing an environmental studies emphasis within a given departmental major or minor. Students interested in exploring the full extent of degree programs and course offerings in a specific department should consult the appropriate college bulletin.

Part III of this guide provides a listing of special centers and libraries. The special centers section lists units at the University of Minnesota that participate in environmentally related activities (often including research) in which interested students and faculty members might become involved. In some cases students may obtain credit for work completed in such activities. The libraries section lists University and other Twin Cities libraries that have material on the environment in their collections.

REGISTRATION THROUGH DAY SCHOOL AND/OR EXTENSION CLASSES

Registration for courses at the University of Minnesota is possible through day school and/or Extension Classes, depending on the course. Information on how each course is offered is noted for the first time in this 1991-1992 guide. There are three types of courses, and the type for each course is noted at the end of the line giving credit and prerequisites information.

1. **Day class.** A course for which registration is possible only through day school.

2a. **Joint Day/Extension class.** A single course for which registration is possible through both day school and Extension Classes. The course usually meets at 3:30 p.m. or later and is listed in both the daytime *Class Schedule* and the *Extension Classes Bulletin.*

2b. **Joint Day/Extension class: refer to daytime *Class Schedule*.** A single course for which registration is possible through both day school and Extension Classes. The course usually is offered during the day and is listed in the daytime *Class Schedule* but not in the *Extension Classes Bulletin.*

3. **Extension class.** A course for which registration is possible only through Extension Classes. It usually meets in the evening.

Please note that some courses are offered through *both* day school *and* Extension Classes. These are two separate courses which meet at two different times. Such courses are noted as "**Day class and Extension class.**"

There are certain requirements and restrictions for students registering for both day school and Extension classes, and it is suggested that students consult with their college offices and/or Extension Classes.

ADDITIONS TO 1991-1992 GUIDE

Twenty-four courses have been added to the 1991-1992 course guide. These courses are marked "**new**" at the beginning of the course description in Part II. Courses offered by General College are included for the first time. Forty-eight courses have been dropped because they are no longer offered.

COURSE SYMBOLS

†	All courses preceding this sign must be completed before credit will be granted for any quarter of the sequence.
§	Credit will not be granted if equivalent course listed after this symbol has been taken for credit.
¶	Concurrent registration allowed with course listed after this mark.
#	Consent of instructor is required for registration.
Δ	Consent of department or school offering the course is required for registration.
H	Honors course.

PART I. COURSES LISTED BY SUBJECT AREA

BIOLOGICAL PEST AND DISEASE CONTROL

Entomology

Ent 1005. ECONOMIC ENTOMOLOGY.
Ent 5210. INSECT PEST MANAGEMENT.
Ent 5250. FOREST ENTOMOLOGY.
Ent 5280. LIVESTOCK ENTOMOLOGY.
Ent 5610. AQUATIC ENTOMOLOGY.
Ent 8240. COLLOQUIUM IN INSECT ECOLOGY.

Forest Resources

FR 5500. URBAN FOREST MANAGEMENT.

Plant Pathology

PlPa 5002. INTRODUCTORY PLANT PATHOLOGY.
PlPa 5007. AIR POLLUTION AND THEIR EFFECTS ON PLANTS.
PlPa 5050. FOREST PATHOLOGY.
PlPa 5102. FUNGAL ECOLOGY.
PlPa 5105. INTRODUCTION TO THE STUDY OF FUNGI.
PlPa 5106. MYCOLOGY: ASCOMYCETES - FUNGI IMPERFECTI.
PlPa 5107. MYCOLOGY: BASIDIOMYCETES.
PlPa 8003. PLANT DISEASE THEORY III, POPULATIONS.
PlPa 8111. FUNGAL GENETICS.

CULTURE, SOCIETY, AND ENVIRONMENTAL PROBLEMS

Anthropology

Anth 5116. CULTURAL ECOLOGY.
Anth 5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT.

Architecture

Arch 3001. ENVIRONMENTAL DESIGN: THEORY AND PROCESS.
Arch 3002. ENVIRONMENTAL DESIGN: PEOPLE AND ENVIRONMENT.
Arch 3060. TECHNOS: FORCE, FORM AND ARCHITECTURE.

Business, Government, and Society

BGS 3002. BUSINESS AND SOCIETY.

General College

GC 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS.

History of Science and Technology

HSci 3331/5331. TECHNOLOGY IN AMERICAN CULTURE.

Humanities

Hum 3366. LANDSCAPE AND IDEOLOGY, 1600-1875.

Landscape Architecture

LA 1021. HISTORY OF ENVIRONMENTAL DEVELOPMENT: ARCHITECTURE.
LA 1022. HISTORY OF ENVIRONMENTAL DEVELOPMENT: LANDSCAPE ARCHITECTURE.
LA 1023. HISTORY OF ENVIRONMENTAL DEVELOPMENT: PLANNING.
LA 3001. ENVIRONMENTAL DESIGN: PEOPLE AND ENVIRONMENT.
LA 3002. ENVIRONMENTAL DESIGN: TOOLS AND PROCESSES.
LA 8330. CONCEPTS OF LANDSCAPE EVALUATION.

Rhetoric

Rhet 1310. HUMANITIES: THE LAND IN AMERICAN EXPERIENCE.
Rhet 3375. HUMANITIES: AGRICULTURAL HERITAGE.

Sociology

Soc 3551. WORLD POPULATION PROBLEMS.

EARTH SCIENCES

Extractive Metallurgical Engineering

MetE 5800. MINERAL PROCESSING I.
MetE 5801. MINERAL PROCESSING II.
MetE 5901. PRINCIPLES OF METALS EXTRACTION.

General College

GC 1171. PHYSICAL GEOLOGY.

Geography

Geog 1401. PHYSICAL GEOGRAPHY.
Geog 3441. LANDFORM GEOGRAPHY.

Geology

Geo 1001. THE DYNAMIC EARTH: AN INTRODUCTION TO GEOLOGY.
Geo 1012. INTRODUCTION TO COMPARATIVE PLANETOLOGY.
Geo 1021. INTRODUCTION TO GEOLOGY LAB: GEOLOGY OF MINNESOTA.
Geo 1111. INTRODUCTORY PHYSICAL GEOLOGY.
Geo 1601. OCEANOGRAPHY.
Geo 3401. INTRODUCTORY MINERALOGY.
Geo 5004. MINERALOGY.
Geo 5108. ADVANCED ENVIRONMENTAL GEOLOGY.
Geo 5201. STRUCTURAL GEOLOGY.
Geo 5251. GEOMORPHOLOGY.
Geo 5261. GLACIAL GEOLOGY.
Geo 8617. TRANSPORT PHENOMENA IN NATURAL POROUS MEDIA.

ECOLOGY

Anthropology

Anth 5116. CULTURAL ECOLOGY.

Biology

Biol 5041. ECOLOGY.
Biol 5841. ECOLOGY.

Conservation Biology

CB 8452. CONSERVATION BIOLOGY:GENETIC AND DEMOGRAPHIC ISSUES.

Ecology, Evolution, and Behavior

EEB 3001. INTRODUCTION TO ECOLOGY.
EEB 3101. ECOLOGY FOR ENGINEERS AND PHYSICAL SCIENTISTS.
EEB 5004. DYNAMICS OF GLOBAL CHANGE: QUATERNARY HISTORY OF ECOSYSTEM RESPONSE.
EEB 5008. QUATERNARY ECOLOGY.
EEB 5014. ECOLOGY OF PLANT COMMUNITIES.
EEB 5016. ECOLOGICAL PLANT GEOGRAPHY.
EEB 5606. ECOLOGY OF FISHES.
EEB 5607. ECOLOGY OF ANIMAL PLANKTON.
EEB 5608. ECOSYSTEMS: FORM AND FUNCTION.
EEB 5613. ASSESSING THE ECOLOGICAL EFFECTS OF POLLUTION.
EEB 5814. PLANT COMMUNITY ECOLOGY.
EEB 5817. VERTEBRATE ECOLOGY.

Entomology

Ent 5040. INSECT ECOLOGY.
Ent 5250. FOREST ENTOMOLOGY.
Ent 5320. ECOLOGY OF AGRICULTURE.
Ent 8240. COLLOQUIUM IN INSECT ECOLOGY.

Fisheries and Wildlife

FW 1002. WILDLIFE: ECOLOGY, VALUES AND HUMAN IMPACT.
FW 5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS.
FW 5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION.

Forest Resources

FR 3101. FIELD FOREST ECOLOGY.
FR 3104. FOREST ECOLOGY.
FR 5104. FOREST ECOLOGY.
FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
FR 5215. FOREST FIRE MANAGEMENT.
FR 5406. FORESTRY WORKSHOP FOR TEACHERS.
FR 5408. FORESTRY IN THE URBAN ENVIRONMENT.
FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION

FR 8105. ADVANCED FIELD SILVICULTURE.

General College

GC 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS.

Geology

Geo 5108. ADVANCED ENVIRONMENTAL GEOLOGY.

Landscape Architecture

LA 5119. PLANTING DESIGN: ECOLOGICAL PRINCIPLES/LAND USE CONCEPTS AND IMPLEMENTATION.

Microbiology

MicB 5611. MICROBIAL ECOLOGY.

Natural Resources and Environmental Studies

NRES 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.

Plant Biology

PBio 3201. INTRODUCTORY PLANT SYSTEMATICS.

Plant Pathology

PlPa 5102. FUNGAL ECOLOGY.
PlPa 5106. MYCOLOGY: ASCOMYCETES - FUNGI IMPERFECTI.
PlPa 5107. MYCOLOGY: BASIDIOMYCETES.

Soil Science

Soil 5605. MICROBIAL ECOLOGY.

ENERGY USE

Anthropology

Anth 5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT.

Architecture

Arch 3064-3065. ENVIRONMENTAL MANAGEMENT AND CONTROL.

Business, Government, and Society

BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT.

Civil Engineering

CE 5212. TRANSPORTATION PRODUCTIVITY AND ENERGY CONSERVATION.

Geography

Geog 3345. ENERGY AND MINERALS.

Geology

Geo 1005. GEOLOGIC PERSPECTIVES ON ENERGY.

Mechanical Engineering

ME 5712. SOLAR ENERGY UTILIZATION.

Natural Resources and Environmental Studies

NRES 1040. NATURAL RESOURCES AS RAW MATERIALS.

Public Affairs

PA 5711. ENERGY POLICY I.
PA 5712. ENERGY POLICY II.
PA 5792. TOPICS IN ENVIRONMENT AND ENERGY POLICY.
PA 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.

Soil Science

Soil 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.

ENVIRONMENT, TECHNOLOGY, AND PUBLIC POLICY

Biology

Biol 3051. BIOLOGY AND THE FUTURE OF THE EARTH.
Biol 5951. SOCIAL USES OF BIOLOGY.

Business, Government, and Society

BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT.
BGS 8019. MANAGEMENT TOPICS: BUSINESS, THE PHYSICAL ENVIRONMENT, AND NATURAL RESOURCE ISSUES.
BGS 8055. BUSINESS, GOVERNMENT AND MACROECONOMICS.
BGS 8202. EXTERNAL AFFAIRS MANAGEMENT.

Forest Resources

FR 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.

Interdepartmental Study

ID 3970. DIRECTED STUDIES.
ID 5525-5526. GARBAGE, GOVERNMENT, AND THE GLOBE.

Journalism

Jour 5133. INTERPRETIVE REPORTING ABOUT SCIENCE.

Law School

Law 5215. ENVIRONMENTAL LAW.
Law 5885. ADVANCED ENVIRONMENTAL LAW.

Natural Resources and Environmental Studies

NRES 1010. ISSUES IN THE ENVIRONMENT.
NRES 1040. NATURAL RESOURCES AS RAW MATERIALS.

Plant Pathology

PlPa 5007. AIR POLLUTION AND THEIR EFFECTS ON PLANTS.

Political Science

Pol 5523. THE POLITICS OF THE REGULATORY PROCESS.

Public Affairs

PA 5701, 5702. TECHNOLOGY PLANNING I AND II.
PA 5721. ENVIRONMENTAL POLICY I.
PA 5722. ENVIRONMENTAL POLICY II.
PA 5791. SCIENCE, TECHNOLOGY POLICY.
PA 5792. TOPICS IN ENVIRONMENT AND ENERGY POLICY.
PA 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.

Soil Science

Soil 1020. THE SOIL RESOURCE.
Soil 1500. BIOTECHNOLOGY: BASIC CONCEPTS AND APPLICATION.

ENVIRONMENTAL HEALTH AND POLLUTION CONTROL

Civil Engineering

CE 5506. ENVIRONMENTAL WATER CHEMISTRY.
CE 5510. SOLID AND HAZARDOUS WASTE MANAGEMENT.
CE 5515. WATER AND WASTEWATER MICROBIOLOGY.
CE 5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY.
CE 8560. SEMINAR: SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING.

Ecology, Evolution, and Behavior

EEB 5613. ASSESSING THE ECOLOGICAL EFFECTS OF POLLUTION.

Environmental Health

PubH 5151. ENVIRONMENTAL HEALTH.
PubH 5152. ENVIRONMENTAL HEALTH.
PubH 5153. CASE STUDIES IN ENVIRONMENTAL HEALTH.
PubH 5155. ISSUES IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH.
PubH 5158. HEALTH RISK EVALUATION.
PubH 5171. ENVIRONMENTAL MICROBIOLOGY.

PubH 5181. AIR POLLUTION.
PubH 5184. AIR ANALYSIS.
PubH 5186. ENVIRONMENTAL CHEMISTRY.
PubH 5201. RADIATION PROTECTION AND MEASUREMENT.
PubH 5202. RADIATION LABORATORY.
PubH 5253. INTRODUCTION TO HAZARDOUS WASTE MANAGEMENT.
PubH 5261. GENERAL ENVIRONMENTAL TOXICOLOGY.
PubH 5262. METABOLISM AND DISTRIBUTION OF XENOBIOTICS.
PubH 5266. RISK ASSESSMENT AND MANAGEMENT.
PubH 5267. ENVIRONMENTAL AND OCCUPATIONAL TOXICOLOGY.
PubH 5268. SEMINAR: TOXICOLOGY AND HUMAN POPULATIONS.
PubH 8185. ANALYSIS OF TOXICANTS.

Fisheries and Wildlife

FW 5460. POLLUTION IMPACTS ON AQUATIC SYSTEMS.

Interdepartmental Study

ID 5525-5526. GARBAGE, GOVERNMENT, AND THE GLOBE.

Law School

Law 5885. ADVANCED ENVIRONMENTAL LAW.

Mechanical Engineering

ME 5609. AIR POLLUTION.

FISH AND WILDLIFE

Ecology, Evolution, and Behavior

EEB 5136. ICHTHYOLOGY.
EEB 5606. ECOLOGY OF FISHES.
EEB 5817. VERTEBRATE ECOLOGY.
EEB 5834. FIELD ORNITHOLOGY.

Fish and Wildlife

FW 1001. ORIENTATION IN FISHERIES AND WILDLIFE.
FW 1002. WILDLIFE: ECOLOGY, VALUES AND HUMAN IMPACT.
FW 1101. ETHICS AND VALUES IN RESOURCE MANAGEMENT.
FW 3052. INTRODUCTION TO FISHERIES AND WILDLIFE.
FW 3167. TECHNIQUES OF FOREST WILDLIFE MANAGEMENT.
FW 3600. FISHERIES AND WILDLIFE FIELD TECHNIQUES.
FW 5129. MAMMALOGY.
FW 5455. AQUACULTURE.
FW 5459. PHYSIOLOGY AND BEHAVIOR OF FISH.
FW 5570. AVIAN CONSERVATION AND MANAGEMENT.
FW 5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS.
FW 5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS.
FW 5604. FISHERY AND WILDLIFE MANAGEMENT.
FW 5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION.

Forest Resources

FR 3106. IMPORTANT PLANTS: FISHERIES AND WILDLIFE HABITATS.
FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.

Veterinary Biology

VB 5330. WILD BIRD MEDICINE.

FOREST RESOURCES

Forest Resources

FR 1001. FOREST RESOURCES ORIENTATION.
FR 1100. DENDROLOGY.
FR 1200. INTRODUCTION TO FOREST RESOURCES.
FR 1202. FARM AND SMALL WOODLANDS FORESTRY.
FR 3100. IMPORTANT FOREST PLANTS.
FR 3101. FIELD FOREST ECOLOGY.
FR 3104. FOREST ECOLOGY.
FR 3110. COLLOQUIUM IN NATURAL RESOURCES.
FR 3201. FIELD FOREST MEASUREMENTS.
FR 3225. DIRECTED STUDY EXPERIENCE.
FR 5100. SILVICULTURE.
FR 5101. FIELD SILVICULTURE.
FR 5103. ADVANCED FOREST TREE BIOLOGY.
FR 5104. FOREST ECOLOGY.
FR 5106. SENIOR SILVICULTURE SEMINAR.
FR 5110. FORESTRY APPLICATIONS OF MICROCOMPUTERS.

FR 5114. FOREST HYDROLOGY.
FR 5115. FOREST HYDROLOGY, FIELD APPLICATIONS.
FR 5120. INTRODUCTORY TREE PHYSIOLOGY AND GENETICS.
FR 5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS.
FR 5140. APPLICATION OF SILVICULTURE IN NORTH AMERICAN FOREST TYPES.
FR 5152. FOREST GENETICS.
FR 5153. ADVANCED FOREST HYDROLOGY.
FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
FR 5200. AERIAL PHOTO INTERPRETATION.
FR 5212. NATURAL RESOURCES INVENTORY.
FR 5215. FOREST FIRE MANAGEMENT.
FR 5220. REMOTE SENSING, FOREST RESOURCES INVENTORY.
FR 5226. FOREST ECONOMICS AND PLANNING.
FR 5236. FOREST RECREATION PLANNING.
FR 5240. NATURAL RESOURCE POLICY AND ADMINISTRATION.
FR 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.
FR 5248. HARVESTING AND ENGINEERING.
FR 5264. QUANTITATIVE TECHNIQUES IN FOREST MANAGEMENT.
FR 5401. SENIOR TOPICS.
FR 5406. FORESTRY WORKSHOP FOR TEACHERS.
FR 5408. FORESTRY IN THE URBAN ENVIRONMENT.
FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.
FR 5500. URBAN FOREST MANAGEMENT.
FR 5700. COLLOQUIUM IN FOREST BIOLOGY.
FR 8100. RESEARCH PROBLEMS: SILVICULTURE.
FR 8101. RESEARCH PROBLEMS: FOREST TREE PHYSIOLOGY.
FR 8102. RESEARCH PROBLEMS: FOREST TREE GENETICS.
FR 8103. RESEARCH PROBLEMS: FOREST HYDROLOGY.
FR 8105. ADVANCED FIELD SILVICULTURE.
FR 8106. TOPICS IN SILVICULTURE—FOREST SOILS.
FR 8108. FOUNDATIONS OF RENEWABLE RESOURCES RESEARCH.
FR 8200. RESEARCH PROBLEMS: FOREST MANAGEMENT.
FR 8201. RESEARCH PROBLEMS: FOREST ECONOMICS.
FR 8202. RESEARCH PROBLEMS: FOREST MEASUREMENTS.
FR 8203. RESEARCH PROBLEMS: FOREST RECREATION.
FR 8204. RESEARCH PROBLEMS: FOREST POLICY.
FR 8205. RESEARCH PROBLEMS: REMOTE SENSING.
FR 8207. ECONOMIC ANALYSIS OF FORESTRY PROJECTS.
FR 8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES.

Plant Pathology

PlPa 5050. FOREST PATHOLOGY.

Soil Science

Soil 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.

LAKE ITASCA FORESTRY AND BIOLOGICAL STATION

Biology

Biol 5841. ECOLOGY.

Ecology, Evolution, and Behavior

EEB 5814. PLANT COMMUNITY ECOLOGY.
EEB 5817. VERTEBRATE ECOLOGY.
EEB 5834. FIELD ORNITHOLOGY.

Entomology

Ent 5600. FIELD ENTOMOLOGY.
Ent 5610. AQUATIC ENTOMOLOGY.

Fish and Wildlife

FW 3600. FISHERIES AND WILDLIFE FIELD TECHNIQUES.

Forest Resources

FR 3100. IMPORTANT FOREST PLANTS.
FR 3101. FIELD FOREST ECOLOGY.
FR 3106. IMPORTANT PLANTS: FISHERIES AND WILDLIFE HABITATS.
FR 3201. FIELD FOREST MEASUREMENTS.
FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.

LAKES AND WETLANDS

Civil Engineering

CE 8430. LAKE AND RESERVOIR HYDRODYNAMICS.
CE 8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS.

Ecology, Evolution, and Behavior

EEB 5601. LIMNOLOGY.
EEB 5607. ECOLOGY OF ANIMAL PLANKTON.
EEB 5621. LIMNOLOGY LABORATORY.

Geology

Geo 5601. LIMNOLOGY.
Geo 8602. ADVANCED LIMNOLOGY.

Plant Biology

PBio 5231. INTRODUCTION TO THE ALGAE.

LAND USE

Agricultural and Applied Economics

AgEc 5600. LAND ECONOMICS.
AgEc 8360. LAND ECONOMICS AND POLICY.

Forest Resources

FR 5262. REMOTE SENSING OF NATURAL RESOURCES.

Geography

Geog 3343. LAND USE AND STATE GOVERNMENT.
Geog 3344. LAND USE AND THE FEDERAL GOVERNMENT.
Geog 8340. SEMINAR: LAND USE PLANNING.
Geog 8344. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA.
Geog 8345. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA.

Landscape Architecture

LA 1031. INTRODUCTION TO LANDSCAPE ARCHITECTURE.
LA 5107. REGIONAL LANDSCAPE DESIGN.
LA 5119. PLANTING DESIGN: ECOLOGICAL PRINCIPLES/LAND USE CONCEPTS AND IMPLEMENTATION.
LA 5562. INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS.
LA 8390. DESIGNING THE LONG-TERM LANDSCAPE.

Public Affairs

PA 5601. LAND USE.
PA 5622. MANAGING URBAN GROWTH AND CHANGE.
PA 8691-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS.

Soil Science

Soil 3220. SOIL CONSERVATION AND LAND USE MANAGEMENT.
Soil 5560. INTERPRETATION OF LAND RESOURCES.

LIFE SCIENCES

Biology

Biol 1008. INTRODUCTORY BIOLOGY: AN EVOLUTIONARY APPROACH.
Biol 1008H. INTRODUCTORY BIOLOGY: AN EVOLUTIONARY APPROACH.
Biol 5041. ECOLOGY.
Biol 5841. ECOLOGY.

Conservation Biology

CB 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.

Ecology, Evolution, and Behavior

EEB 3001. INTRODUCTION TO ECOLOGY.
EEB 3101. ECOLOGY FOR ENGINEERS AND PHYSICAL SCIENTISTS.
EEB 5051. ANALYSIS OF POPULATIONS.
EEB 5132. HERPETOLOGY.
EEB 5608. ECOSYSTEMS: FORM AND FUNCTION.

Entomology

Ent 5040. INSECT ECOLOGY.
Ent 5320. ECOLOGY OF AGRICULTURE.

Fish and Wildlife
FW 5129. MAMMALOGY.

Forest Resources
FR 5221. PLANT MOLECULAR EVOLUTION.

Genetics and Cell Biology
GCB 3002. HUMAN GENETICS, SOCIAL AFFAIRS.

Microbiology
MicB 3103. GENERAL MICROBIOLOGY.
MicB 5352. APPLIED MICROBIOLOGY.
MicB 5611. MICROBIAL ECOLOGY.

Plant Biology
PBio 5183. WATER, MINERALS, AND TRANSLOCATION.

Soil Science
Soil 5605. MICROBIAL ECOLOGY.

METEOROLOGY AND CLIMATOLOGY

Forest Resources
FR 3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS.

General College
GC 1111. SCIENCE IN CONTEXT: WEATHER AND CLIMATE.

Geography
Geog 1425. INTRODUCTION TO METEOROLOGY.
Geog 3421. CLIMATOLOGY.
Geog 5424. APPLIED CLIMATOLOGY.
Geog 8420. SEMINAR: CLIMATOLOGY.

Geology
Geo 8262. QUATERNARY PALEOECOLOGY AND CLIMATE.

Physics
Phys 1071. INTRODUCTORY METEOROLOGY.
Phys 1075. INTRODUCTORY METEOROLOGY LABORATORY.
Phys 5461. PHYSICS AND CHEMISTRY OF THE EARTH'S UPPER ATMOSPHERE.

Soil Science
Soil 1262. INTRODUCTION TO METEOROLOGY.
Soil 5240. MICROCLIMATOLOGY (SOILS).
Soil 5424. APPLIED CLIMATOLOGY.

NATURALIST STUDIES

Biology
Biol 5841. ECOLOGY.

Conservation Biology
CB 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.

Ecology, Evolution, and Behavior
EEB 5008. QUATERNARY ECOLOGY.
EEB 5014. ECOLOGY OF PLANT COMMUNITIES.
EEB 5016. ECOLOGICAL PLANT GEOGRAPHY.
EEB 5122. PLANT/ANIMAL INTERACTIONS.
EEB 5129. MAMMALOGY.
EEB 5132. HERPETOLOGY.
EEB 5134. INTRODUCTION TO ORNITHOLOGY.
EEB 5814. PLANT COMMUNITY ECOLOGY.

Entomology
Ent 3005. INTRODUCTORY ENTOMOLOGY.
Ent 5600. FIELD ENTOMOLOGY.

Forest Resources

FR 3100. IMPORTANT FOREST PLANTS.
FR 3106. IMPORTANT PLANTS: FISHERIES AND WILDLIFE HABITATS.
FR 5103. ADVANCED FOREST TREE BIOLOGY.
FR 5152. FOREST GENETICS.
FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
FR 5221. PLANT MOLECULAR EVOLUTION.
FR 5700. COLLOQUIUM IN FOREST BIOLOGY.

Geography

Geog 3431. INTRODUCTION TO PLANT AND ANIMAL GEOGRAPHY.

Plant Biology

PBio 1009. MINNESOTA PLANT LIFE.
PBio 1012. PLANTS USEFUL TO HUMANS.
PBio 3201. INTRODUCTORY PLANT SYSTEMATICS.
PBio 5103. ALGAE, FUNGI, AND BRYOPHYTES.
PBio 5183. WATER, MINERALS, AND TRANSLOCATION.

Plant Pathology

PlPa 5002. INTRODUCTORY PLANT PATHOLOGY.
PlPa 8003. PLANT DISEASE THEORY III, POPULATIONS.

Soil Science

Soil 5610. SOIL BIOLOGY.

OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL

Aerospace Engineering and Mechanics

AEM 5687. INTRODUCTION TO ACOUSTICS AND ENVIRONMENTAL NOISE.

Communication Disorders

CDis 5704. NOISE AND MAN.

Environmental and Occupational Health

PubH 5155. ISSUES IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH.
PubH 5185. FIELD INSTRUMENTATION.
PubH 5211. INDUSTRIAL HYGIENE ENGINEERING.
PubH 5215. APPLIED OCCUPATIONAL TOXICOLOGY.
PubH 5218. FIELD PROBLEMS IN OCCUPATIONAL HEALTH.
PubH 5233. BIOLOGICAL SAFETY.
PubH 5239. MICROBIOLOGY OF THE HUMAN ENVIRONMENT: SEMINAR.
PubH 5254. HAZARDOUS WASTE MANAGEMENT.
PubH 5267. ENVIRONMENTAL AND OCCUPATIONAL TOXICOLOGY.
PubH 5268. SEMINAR: TOXICOLOGY AND HUMAN POPULATIONS.
PubH 8185. ANALYSIS OF TOXICANTS.

Mechanical Engineering

ME 5603. THERMAL ENVIRONMENTAL ENGINEERING.

RECREATION AND OUTDOOR EDUCATION

Elementary Education

Elem 5348. WORKSHOP: OUTDOOR SCIENCE EDUCATION.

Forest Resources

FR 5231. RANGE MANAGEMENT.
FR 5232. MANAGEMENT OF RECREATIONAL LANDS.
FR 5233. PRINCIPLES OF OUTDOOR RECREATION DESIGN AND PLANNING.
FR 5236. FOREST RECREATION PLANNING.
FR 5257. RECREATION LAND POLICY.
FR 5259. ANALYSIS OF OUTDOOR RECREATION BEHAVIOR.
FR 5403. FUNDAMENTALS OF NATURAL RESOURCE EDUCATION.
FR 5406. FORESTRY WORKSHOP FOR TEACHERS.
FR 5408. FORESTRY IN THE URBAN ENVIRONMENT.
FR 8206. ADVANCED MANAGEMENT OF RECREATIONAL LANDS.

Landscape Architecture

LA 5105. RECREATIONAL PLANNING AND DESIGN.

Recreation, Park, and Leisure Studies

Rec 5160. CONSERVATION OF PARK RESOURCES.
Rec 5250. FINANCING LEISURE SERVICES.
Rec 5300. FOUNDATIONS OF OUTDOOR EDUCATION.
Rec 5310. PROGRAMMING IN OUTDOOR EDUCATION.
Rec 5350. WILDERNESS OUTDOOR RECREATION PROGRAMMING.

RESOURCE MANAGEMENT

Agricultural and Applied Economics

AgEc 3610. RESOURCE DEVELOPMENT AND ENVIRONMENTAL ECONOMICS.
AgEc 5650. ECONOMICS OF NATURAL RESOURCE POLICY.
AgEc 8264. RESOURCE ECONOMICS.
AgEc 8364. SEMINAR: RESOURCE AND ENVIRONMENTAL ECONOMICS.

Anthropology

Anth 5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT.

Business, Government, and Society

BGS 8019. MANAGEMENT TOPICS: BUSINESS, THE PHYSICAL ENVIRONMENT, AND NATURAL RESOURCE ISSUES.

Economics

Econ 5611. RESOURCE AND ENVIRONMENTAL ECONOMICS.

Fisheries and Wildlife

FW 1101. ETHICS AND VALUES IN RESOURCE MANAGEMENT.
FW 5455. AQUACULTURE.
FW 5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION.

Forest Resources

FR 1201. CONSERVATION OF NATURAL RESOURCES.
FR 1203. INTRODUCTION TO MINNESOTA'S NATURAL RESOURCES.
FR 3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS.
FR 3110. COLLOQUIUM IN NATURAL RESOURCES.
FR 3250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
FR 3300. ELEMENTS OF SURVEYING.
FR 5130. GEOGRAPHIC INFORMATION SYSTEMS IN NATURAL RESOURCE ANALYSIS.
FR 5200. AERIAL PHOTO INTERPRETATION.
FR 5212. NATURAL RESOURCES INVENTORY.
FR 5220. REMOTE SENSING, FOREST RESOURCES INVENTORY.
FR 5231. RANGE MANAGEMENT.
FR 5240. NATURAL RESOURCE POLICY AND ADMINISTRATION.
FR 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.
FR 5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
FR 5262. REMOTE SENSING OF NATURAL RESOURCES.
FR 5403. FUNDAMENTALS OF NATURAL RESOURCE EDUCATION.
FR 5412. ADVANCED REMOTE SENSING.
FR 8205. RESEARCH PROBLEMS: REMOTE SENSING.
FR 8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES.

Geography

Geog 3345. ENERGY AND MINERALS.
Geog 5344. HISTORICAL GEOGRAPHY OF RESOURCE USE IN THE UNITED STATES.

Landscape Architecture

LA 8390. DESIGNING THE LONG-TERM LANDSCAPE.

Natural Resources and Environmental Studies

NRES 1001. ORIENTATION TO NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.
NRES 1040. NATURAL RESOURCES AS RAW MATERIALS.
NRES 3001. COLLOQUIUM IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.
NRES 3050. EXPERIENCE AND TRAINING IN A FIELD SETTING.

NRES 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.
NRES 3225. NRES DIRECTED STUDY EXPERIENCE.
NRES 5099. PROBLEM SOLVING IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES I.
NRES 5100. PROBLEM SOLVING IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES II.
NRES 5210. SURVEY, MEASUREMENT, AND MODELLING METHODS FOR NATURAL RESOURCES I.
NRES 5220. SURVEY, MEASUREMENT, AND MODELLING METHODS FOR NATURAL RESOURCES II.
NRES 5225. NRES DIRECTED STUDY EXPERIENCE.

SOIL RESOURCES

Agricultural Engineering

AgEn 3052. ENGINEERING PRINCIPLES OF SOIL-WATER-PLANT SYSTEMS.
AgEn 5540. WATERSHED ENGINEERING.
AgEn 5550. WATER MANAGEMENT ENGINEERING.
AgEn 8700. MOISTURE AND HEAT TRANSFER.

Agricultural Engineering Technology

AgET 5400. DRAINAGE AND IRRIGATION.

Environmental and Occupational Health

PubH 5186. ENVIRONMENTAL CHEMISTRY.

Forest Resources

FR 5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS.
FR 8105. ADVANCED FIELD SILVICULTURE.
FR 8106. TOPICS IN SILVICULTURE—FOREST SOILS.

Geography

Geog 3451. GEOGRAPHY OF SOILS.

Soil Science

Soil 1020. THE SOIL RESOURCE.
Soil 3118. SEMINAR: SOIL AND WATER POLLUTION AND PUBLIC POLICY.
Soil 3125. BASIC SOIL SCIENCE.
Soil 3220. SOIL CONSERVATION AND LAND USE MANAGEMENT.
Soil 5340. ORGANIC AND PESTICIDAL RESIDUES.
Soil 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.
Soil 5560. INTERPRETATION OF LAND RESOURCES.
Soil 5610. SOIL BIOLOGY.

WASTE MANAGEMENT

Agricultural Engineering

AgEn 5910. AGRICULTURAL WASTE MANAGEMENT ENGINEERING I.

Architecture

Arch 3064-3065. ENVIRONMENTAL MANAGEMENT AND CONTROL.

Biology

Biol 3051. BIOLOGY AND THE FUTURE OF THE EARTH.

Civil Engineering

CE 5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS.
CE 5510. SOLID AND HAZARDOUS WASTE MANAGEMENT.
CE 5515. WATER AND WASTEWATER MICROBIOLOGY.
CE 8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT.
CE 8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT - PART II.
CE 8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT.

Environmental and Occupational Health

PubH 5253. INTRODUCTION TO HAZARDOUS WASTE MANAGEMENT.
PubH 5254. HAZARDOUS WASTE MANAGEMENT.

Extractive Metallurgical Engineering

MetE 5800. MINERAL PROCESSING I.
MetE 5801. MINERAL PROCESSING II.

Interdepartmental Study
ID 3525-3526. GARBAGE, GOVERNMENT, AND THE GLOBE.

Law School
Law 5885. ADVANCED ENVIRONMENTAL LAW.

Natural Resources and Environmental Engineering
NRES 1010. ISSUES IN THE ENVIRONMENT.
NRES 5600. PRINCIPLES OF WASTE MANAGEMENT.

Public Affairs
PA 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.

Soil Science
Soil 5340. ORGANIC AND PESTICIDAL RESIDUES.
Soil 5560. INTERPRETATION OF LAND RESOURCES.

WATER RESOURCES

Agricultural Engineering
AgEn 3052. ENGINEERING PRINCIPLES OF SOIL-WATER-PLANT SYSTEMS.
AgEn 8500. HYDROLOGIC MODELING - SMALL WATERSHEDS.

Civil Engineering
CE 5401. WATER RESOURCES ENGINEERING.
CE 5405. HYDROLOGY AND HYDROLOGIC DESIGN.
CE 5425. GROUNDWATER MECHANICS.
CE 5426. COMPUTER MODELING OF GROUNDWATER FLOW.
CE 8406. SEMINAR: ADVANCED HYDROLOGY.
CE 8419. WATER RESOURCES SYSTEMS SIMULATION.
CE 8425. ADVANCED GROUNDWATER MECHANICS.
CE 8505. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS.
CE 8506. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS.

Environmental and Occupation Health
PubH 5186. ENVIRONMENTAL CHEMISTRY.

Fish and Wildlife
FW 5460. POLLUTION IMPACTS ON AQUATIC SYSTEMS.

Forest Resources
FR 8213. TOPICS IN WILDLAND HYDROLOGY.

Geography
Geog 5444. GEOGRAPHY OF WATER RESOURCES.

Geology
Geo 5611. GROUNDWATER GEOLOGY.
Geo 8612. ANALYTICAL GEOHYDROLOGY.

Soil Science
Soil 3118. SEMINAR: SOIL AND WATER POLLUTION AND PUBLIC POLICY.

WATER SUPPLY AND WATER QUALITY

Agricultural Engineering
AgEn 5540. WATERSHED ENGINEERING.
AgEn 5550. WATER MANAGEMENT ENGINEERING.

Agricultural Engineering Technology
AgET 5410. HYDROLOGY AND WATER QUALITY.

Civil Engineering
CE 5500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS.
CE 5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS.
CE 5505. WATER QUALITY ENGINEERING.
CE 5506. ENVIRONMENTAL WATER CHEMISTRY.
CE 5507. TECHNIQUES OF WATER AND WASTEWATER ANALYSIS.

CE 5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY.
CE 8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT.
CE 8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT - PART II.
CE 8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT.
CE 8550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS.
CE 8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS.

Ecology, Evolution, and Behavior

EEB 5608. ECOSYSTEMS: FORM AND FUNCTION.

Environmental and Occupational Health

PubH 5242. ENVIRONMENTAL HEALTH ASPECTS OF GROUNDWATER SYSTEMS.
PubH 5243. WATER AND HEALTH.

Forest Resources

FR 5114. FOREST HYDROLOGY.
FR 5115. FOREST HYDROLOGY, FIELD APPLICATIONS.
FR 5153. ADVANCED FOREST HYDROLOGY.
FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.
FR 8213. TOPICS IN WILDLAND HYDROLOGY.

Natural Resources and Environmental Studies

NRES 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.

PART II. FULL COURSE DESCRIPTIONS LISTED BY FIELD OF INSTRUCTION

AEROSPACE ENGINEERING AND MECHANICS (AEM)

Institute of Technology

107 Akerman, 625-8000
Theodore Wilson, 107 Akerman, 625-0856

AEM 5687. INTRODUCTION TO ACOUSTICS AND ENVIRONMENTAL NOISE. (4 cr; prereq Phys 1291 or Phys 1341 or equiv, Math 3321 or equiv; IT or grad IT stu; 3 lect and 1 lab hrs per wk) Day class
Derivation of the wave equation, plane wave solution, transmission and reflection at boundaries, resonators and mufflers, three-dimensional wave propogation, properties of environmental noise sources, hearing and perception of sound, acoustical properties of rooms, laboratory experience in sound and noise measurements and noise control techniques.

AGRICULTURAL AND APPLIED ECONOMICS (AgEc)

College of Agriculture

231 Classroom Office Building, 625-1222
K. William Easter, 317G Classroom Office Building, 625-7728

AgEc 3610. RESOURCE DEVELOPMENT AND ENVIRONMENTAL ECONOMICS. (3 cr; prereq 1101, 1102 or Econ 1101, 1102 or #) Day class
Basic concepts of resource use including physical and economic classifications; physical and economic feasibility; benefits and costs; external effects; cost sharing; selected resource use problems. Economic areas and units for planning and development; generation of alternative program elements and development of consequences; problems in choosing elements for an optimum resource development program.

AgEc 5600. LAND ECONOMICS. (4 cr for undergrad, 3 cr for grad; prereq 3101, 3102, or Econ 3101, 3102 or #) Day class
Land as a factor of production; land use, classification, and value; sales and rental markets for land; domestic and foreign land policies.

AgEc 5650. ECONOMICS OF NATURAL RESOURCE POLICY. (4 cr for undergrad, 3 cr for grad; prereq 3101 or econ 3101 or AgEc 3610 or #) Joint Day/Extension class
Application of economic analysis, including project evaluation, to current natural resource issues. Emphasis on conservation and resource scarcity, environmental quality, population growth, and resource use issues and their implications for public policy.

AgEc 8264. RESOURCE ECONOMICS. (3 cr; prereq Econ 5162 or ¶Econ 5162 or #) Day class
Economic analysis relevant to resource use and management; concepts of joint production and joint costs; external effects of resource decisions; applications of public finance, welfare economics, capital theory, and discount rates; cost-benefit analysis and other decision-making approaches; investment and management problems related to water resources, outdoor recreation, forestry, and fisheries; economic problems of air pollution and environmental quality.

AgEc 8360. LAND ECONOMICS AND POLICY. (3 cr; offered when demand warrants) Day class

AgEc 8364. SEMINAR: RESOURCE AND ENVIRONMENTAL ECONOMICS. (3 cr; offered when demand warrants) Day class

AGRICULTURAL ENGINEERING (AgEn)

Institute of Technology

213 Agricultural Engineering, 625-7733
J. L. Nieber, 203 Agricultural Engineering, 625-6724
C. J. Clanton, 230 Agricultural Engineering, 625-9218

AgEn 3052. ENGINEERING PRINCIPLES OF SOIL-WATER-PLANT SYSTEMS. (4 cr; prereq IT student, biology, AEM 3016 or ¶AEM 3016; 3 lect and 3 lab hrs per wk) Day class
new Mechanical and hydraulic properties of soil; moisture relations; strength parameters for structural and mechanical design. Soil-machine action in tillage and traction. Energy and water balance in the soil-water-plant system. Plant structure and growth. Engineering and management requirements.

AgEn 5540. WATERSHED ENGINEERING. (4 cr; prereq IT upper division or grad IT major, 3052 or CE 3300, CE 3400; 3 lect and 3 lab hrs per wk) Day class
Application of engineering principles to the management of surface runoff and soil water in agricultural, range and urban lands. Design of facilities for control of surface runoff to mitigate problems of flooding and degradation of surface water quality.

AgEn 5550. WATER MANAGEMENT ENGINEERING. (4 cr; prereq IT upper division or grad IT major, 3052 or CE 3300, CE 3400; 3 lect and 3 lab hrs per wk) Day class
Application of engineering principles to the management of water for production and environmental protection in agricultural systems. Design of facilities to irrigate and drain croplands and to enhance water quality.

AgEn 5910. AGRICULTURAL WASTE MANAGEMENT ENGINEERING. (4 cr; prereq 3052, Chem 1005, CE 3400, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Day class
Sources and characteristics of agricultural wastes including livestock, food processing, and domestic wastes. Physical, biological, chemical, rheological, and microbiological properties. Effects on the environment. Collection, storage, treatment (aerobic and anaerobic), and utilization/disposal. Land application of livestock and food processing wastes, municipal effluents, and sludges. On-site sewage treatment.

AgEn 8500. HYDROLOGIC MODELING—SMALL WATERSHEDS. (4 cr; prereq CE 5405, grad IT major; 3 lect and 1 rec hrs per wk; offered alt yrs) Day class
Study and representation of hydrologic processes by mathematical models; infiltration, overland flow, return flow, evapotranspiration, channel flow, and storage. Time-flow relationships. Linear and nonlinear methods. Frequency relationships. Emphasis on parametric methods.

AgEn 8700. MOISTURE AND HEAT TRANSFER. (3 cr; prereq knowledge of differential equations and #, grad IT major; offered alt yrs) Day class
Mathematical study of transfer of moisture and heat in agricultural crops and soils.

AGRICULTURAL ENGINEERING TECHNOLOGY (AgET)

College of Agriculture

213 Agricultural Engineering, 625-7733
J. L. Nieber, 203 Agricultural Engineering, 625-6724
C. J. Clanton, 230 Agricultural Engineering, 625-9218

AgET 5400. DRAINAGE AND IRRIGATION. (4 cr; prereq Soil 3210; 3 lect and 2 lab hrs per wk) Day class
Soil moisture excesses and deficiencies. Theory and design of tile drainage, surface drainage, and sprinkler irrigation systems. Development of irrigation water supplies. Selection of pumps and power units for drainage and irrigation. Economic feasibility. Legal problems and procedures.

AgET 5410. HYDROLOGY AND WATER QUALITY. (5 cr; prereq Math 1111, Phy 1041, Chem 1004, 1005; 3 lect, 3 lab, and 1 rec hrs per wk) Day class
The hydrologic cycle—precipitation, infiltration, evaporation, surface and subsurface runoff, and groundwater recharge. Flow in streams, flow in aquifers, flow measurement. Soil erosion, sediment transport and deposition. Chemical pollution of surface water and ground water.

ANTHROPOLOGY (Anth)

College of Liberal Arts

215 Ford Hall
E. Ogan, 219 Ford Hall, 625-3424

Anth 5116. CULTURAL ECOLOGY. (4 cr; prereq 1101, 1102 or 5102, one ethnographic area course or #) Day class
The literature of cultural ecology, biological approach to ecosystems and population studies.

Anth 5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT. (4 cr) Joint Day/Extension class
Social-cultural system factors in the development, production, control, distribution and use of energy, water and other key natural resources in the United States and other societies. Social-cultural evolution. Interaction among different societies, growth and no-growth issues, climate warming, emerging global interdependence.

ARCHITECTURE

College of Architecture and Landscape Architecture

110 Architecture, 624-7866
Julia Robinson, 110 Architecture, 624-7866

Arch 3001. ENVIRONMENTAL DESIGN: THEORY AND PROCESS. (4 cr; §LA 3001; soph standing) Day class
Design process, design theory, and interpretation of environments. Exploration of issues and theories at various scales. Lectures, readings, discussions, projects.

Arch 3002. ENVIRONMENTAL DESIGN: PEOPLE AND ENVIRONMENT. (4 cr; §LA 3002; prereq Arch 3001; soph standing) Day class
Interaction of people with the environment. Relations between individuals, groups, culture and environment. The biological, social, and cultural basis is presented for concepts such as home, place, comfort, public and private. Focus on range of scales: rooms, buildings, cities and landscapes. Lectures, readings, discussions, and projects.

Arch 3060. TECHNOS: FORCE, FORM AND ARCHITECTURE. (4 cr; prereq Arch 1021, Arch major, and ¶Arch 3081) Day class
Introduction to fundamental conceptual frameworks that relate science, technology, and building expression to architectural form. Present day to ancient periods. The impact of climate, gravity, and sunlight are examined in four case study houses.

Arch 3064-3065. ENVIRONMENTAL MANAGEMENT AND CONTROL. (4 cr per qtr; prereq Arch major or adult special, 3062, 3083 or #; 4 lect hrs per wk) Day class
Environmental-mechanical considerations including comfort technology, space habitability, climate, psychometrics, control and management systems; waste management including plumbing systems and waste disposal techniques. Electrical systems, energy, power distribution and machinery; lighting systems, physiology of seeing, light sources and control; spatial acoustics, noise barriers, absorption.

BIOLOGY (Biol)

College of Biological Sciences

123 Snyder Hall, 624-2244
Kathleen Peterson, 223 Snyder Hall, 624-9717

Biol 1008. INTRODUCTORY BIOLOGY: AN EVOLUTIONARY APPROACH. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Description of evolution as the unifying principle in biology; organization and change in the biological world and the origin of humans.

Biol 1008H. INTRODUCTORY BIOLOGY: AN EVOLUTIONARY APPROACH. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
For description, see 1008. Intended especially for honors students or their equivalent who plan to major in a life science discipline.

Biol 3051. BIOLOGY AND THE FUTURE OF THE EARTH. (4 cr; A-F or S-N; bioscience students may not apply these credits to the major) JointDay/Extension class limited to 25 Extension students
Nontechnical discussion of current environmental issues including air and water pollution, human population growth, toxic and hazardous wastes,

urbanization, resource economics, biological diversity, energy, health, and environmental ethics.

Biol 5041. ECOLOGY. (4 cr; §5841, prereq Math 1142 or 1211, Biol 1103 or 1106 or 3011 or 3012) Joint Day/Extension class: refer to daytime *Class Schedule*
Growth, structure, and evolution of populations. Pairwise biotic interactions between species, effect on diversity and structure of natural communities. Nutrient dynamics, function, productivity, and temporal stability of ecosystems.

Biol 5841. ECOLOGY. (5 cr; §5041; prereq 1103 or 1106 or 3011 or 3012, Math 1142 or 1221, Δ) Day class
Growth, structure, and evolution of populations. Pairwise biotic interactions between species and their effect on the diversity and structure of natural communities. Nutrient dynamics, function, productivity, and temporal stability of ecosystems. Field work at the Itasca station.

Biol 5951. SOCIAL USES OF BIOLOGY. (4 cr; S-N only; prereq 10 cr sciences) Joint Day/Extension class: refer to daytime *Class Schedule*
Influence of biological science on the quality of human life: agriculture, medicine, occupational health, environmental science, and theories of human nature. Responsibilities and roles of biologists in policy formulation in the scientific and political world.

BUSINESS, GOVERNMENT, AND SOCIETY (BGS)

School of Management

30 Management and Economics, 625-0027
William Seeley, 377 Humphrey Center, 624-1661

BGS 3002. BUSINESS AND SOCIETY. (4 cr; prereq at least 90 cr completed or in progress; may not be taken S-N) Extension class
Examines the strategic and dynamic relations of business and society in a goal-oriented and problem-solving context. Focuses on the interfaces of business institutions with the physical environment, the social milieu, the political process and economic activity. Gives specific attention to the ongoing debate regarding national priorities and the respective roles of the private and public sectors concerning the challenges confronting U.S. society. Includes assessment of the concept, determinants, and indicators of the "quality of life" and the social responsibilities of business.

BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT. (4 cr; prereq jr or sr and at least 90 credits completed or in progress; may not be taken S-N) Day class
Business and its relationship to the natural environment. The use by industry of renewable and nonrenewable resources. Environmental deterioration caused by businesses to air, land, and water. Business solutions to environmental problems. May emphasize energy in some quarters.

BGS 8019. MANAGEMENT TOPICS: BUSINESS, THE PHYSICAL ENVIRONMENT, AND NATURAL RESOURCE ISSUES. (3 cr) Day class
(Same as Mgmt 8019) The impacts of business on the natural environment are very great. These impacts are both national and international in nature. Subsequent social, legal, and economic reactions to these environmental impacts may have consequences not only for an individual firm's profitability and survival, but also for global competitiveness and economic development. Solutions to environmental problems range from moral appeals and voluntary assumption of corporate responsibility to government regulation and government-imposed incentive strategies. This course will examine the reciprocal impacts of the firm and environmental/natural resource issues and will investigate various possible solutions to business-related environmental problems. It will focus on how companies cope with these issues, assessing both the role of internal corporate functions and of corporate external relations and stakeholder management.

BGS 8055. BUSINESS, GOVERNMENT AND MACROECONOMICS. (4 cr) Day class
Roles of government and business in society; alternative systems of economic and political values; social, political, economic, and cultural conflicts affecting the business sector.

BGS 8202. EXTERNAL AFFAIRS MANAGEMENT. (4 cr; prereq MBA 8055, grad mgmt/IR student or # and grad school mgmt approval) Day class
Managing key aspects and issues that face business managers including environmental protection and natural resource issues. Discussion of development of legal framework for environmental control.

CIVIL ENGINEERING (CE)

Institute of Technology

122 Civil and Mineral Engineering, 625-5522
M. Semmens, 150 Civil and Mineral Engineering, 625-9857

CE 5212. TRANSPORTATION PRODUCTIVITY AND ENERGY CONSERVATION. (4 cr; prereq #; offered when feasible) Day class
Measuring transportation productivity and energy consumption; application of control theory for improving transportation productivity; simulation of energy-conservation policies and effect of such policies on transportation ridership and economics through time; transportation use and energy consumption in relation to urban and rural structures; case studies.

CE 5401. WATER RESOURCES ENGINEERING. (4 cr; prereq 3400 or #, IT or grad student; 3 lect and 3 lab hrs per wk) Day class
Introduction to water resources engineering including flow in conduits, pumps, open channels and culverts; introduction to flow measurements, hydraulic structures and systems approach to water resources engineering.

CE 5405. HYDROLOGY AND HYDROLOGIC DESIGN. (4 cr; prereq 5401 or #, IT or grad student; 3 lect and 3 lab hrs per wk) Day class
Hydrologic cycle, precipitation, evaporation, infiltration, runoff analysis, flood routing, statistical procedures in hydrology, urban hydrology, introduction to mathematical models of medium and large watersheds, application of hydrology to design of outlet works and flow control structures.

CE 5425. GROUNDWATER MECHANICS. (4 cr; prereq 3400 or #, IT or grad student) Day class
Basic equations. Shallow confined and unconfined flows, two-dimensional flow in the vertical plane, and transient flow. Flow from rivers and lakes toward wells. Determination of streamlines and pathlines in two and three dimensions. Introduction to containment transport. Elementary computer modeling.

CE 5426. COMPUTER MODELING OF GROUNDWATER FLOW. (4 cr; prereq 3400 or #, IT or grad student) Day class
Principles of Analytic Element Method, Boundary Integral Equation Method, Finite Element Method, Finite Difference Method. Applications of these four methods to field problems using existing computer programs. Derivation and interpretation of basic equations for contaminant transport in groundwater. Implementation of transport mechanisms in the various computer models.

CE 5500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS. (4 cr; prereq 3400 or #, IT or grad student) Day class
Planning and engineering design considerations in developing water supply systems for urban centers. Supply quality, storage, treatment, distribution, and cost analysis.

CE 5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS. (4 cr; prereq 3400 or #, IT or grad student) Day class
Planning and engineering design considerations in developing waste disposal systems for urban centers. Volumes and quality of waste streams, treatment and ultimate disposal of domestic and industrial wastewaters, and storm water runoff. Environmental effects, cost, and political aspects of ultimate disposal.

CE 5505. WATER QUALITY ENGINEERING. (4 cr; prereq IT or grad student or #) Day class
Chemical and physical properties of natural waters, introduction to aquatic biology, and ecological considerations of element cycling of natural carbon, nitrogen, phosphorus, oxygen, and anthropogenic chemical species (pesticides, PCBs, heavy metals). Physical and chemical processes of water treatment.

CE 5506. ENVIRONMENTAL WATER CHEMISTRY. (4 cr; prereq Chem 1006 or #, IT or grad student; 3 lect and 1 rec hrs per wk) Joint Day/Extension class
Composition of natural waters and wastewater; chemical processes affecting distribution of pollutants and water quality parameters in natural waters; methods of evaluation to determine fate of organic pollutants.

CE 5507. TECHNIQUES OF WATER AND WASTEWATER ANALYSIS. (4 cr; prereq 5500, 5501, 5506 or #, IT upper div student or grad; offered when feasible) Day class
Methods of sampling and examining natural waters and wastewaters; technique used in analysis of general water quality parameters, nutrients, major and minor ions, and natural and synthetic organic matter, with emphasis on modern analytical procedures. Composition of natural waters and wastewater; chemical processes affecting distribution of pollutants and waters; methods of evaluation to determine fate of organic pollutants.

CE 5510. SOLID AND HAZARDOUS WASTE MANAGEMENT. (4 cr) Joint Day/Extension class
Analysis and design of engineered systems for collection, transportation, processing, and disposal of solid and hazardous waste materials. Waste characteristics affecting management options, discussion of relevant regulatory legislation.

CE 5515. WATER AND WASTEWATER MICROBIOLOGY. (4 cr; prereq Chem 1005, Math 1231) Day class
Analysis of role of microbes in environmental degradation and pollution control. Organism growth and selection in wastewater treatment systems. Pathogenic organisms in water supply. System control using microbial based indicators.

CE 5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY. (4 cr; prereq 5501, 5401 or #) Day class
Fate of chemicals in groundwater and soils will be analyzed and modeled. Transport, dispersion, chemical-biological transformations and accumulation will be considered. Models will be used to study in situ clean-up of groundwater and aquifers and simulate time dependent changes in pollutant concentration.

CE 8406. SEMINAR: ADVANCED HYDROLOGY. (1 cr) Day class
Weekly seminar by staff, students, and guest speakers.

CE 8419. WATER RESOURCES SYSTEMS SIMULATION. (4 cr, prereq 5401 or #) Day class
Computer simulation of water resource systems, including hydrology systems stream flow and quality systems, economic systems and sociopolitical systems using deterministic and stochastic approaches.

CE 8425. ADVANCED GROUNDWATER MECHANICS. (4 cr; prereq 5425 or #) Day class
Conforma mapping techniques for two-dimensional steady groundwater flow. The hodograph method. Problems involving a free boundary and horizontal drains. Boundary value problems. Application of boundary integral equation techniques.

CE 8430. LAKE AND RESERVOIR HYDRODYNAMICS. (3 cr; prereq #) Day class
Overview of hydrodynamic phenomena, analysis of density stratification, energy and momentum transfer through a water surface, wind effects of stratification and circulation, standing of progressive waves, stratified flow, density currents, selective withdrawal, mixing.

CE 8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT. (3 cr; prereq 5500, 5501, or #) Day class
Theoretical principles underlying physical and chemical processes for water and wastewater treatment including sedimentation, flotation, adsorption, precipitation, and disinfection.

CE 8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT—PART II. (3 cr; prereq 5500, 5501, 5506 or #) Day class
Theoretical principles, design considerations, and performance of processes not covered in CE 8500. Coagulation flocculation, filtration, membrane processes, gas transfer, sludge dewatering, mixing, and other processes commonly used in water pollution control.

CE 8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT. (3 cr; prereq 5501 or #) Day class
Theoretical principles underlying chemical and biological wastewater treatment processes including aerobic and anaerobic biological processes for carbon and nitrogen removal, aeration, and chemical processes for phosphorus and nitrogen removal.

CE 8505. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS. (4 cr; prereq Chem 5506 or #) Day class
Application of principles of physical chemistry to quantification of chemical processes in aquatic systems. Natural waters as equilibrium and dynamic systems. Ionic equilibria; protolysis, complexation, solubility, and redox equilibria. Precipitation and mineral dissolution kinetics. Aqueous metal species in electrolyte solutions.

CE 8506. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS. (4 cr; prereq 8505 or #) Day class
Natural interactions with rock and soil, precipitation and atmospheric fallout; industrial and domestic sources. Nature of aqueous metals in term of electrolyte

solutions, hydrolysis reactions, complexation, chelation, redox, solubility, and precipitation. Interactions at solid-solution interfaces in terms of phenomenological and general models for adsorption. Hydrodynamic, biological, and chemical factors affecting distribution, transport and removal from aqueous phase. Computer techniques emphasized.

CE 8550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS. (4 cr; prereq #) Day class
Introduction to hydrologic transport and water quality simulation in natural water systems. Mixed cell models, advection, turbulent diffusion and dispersion in one- and two-dimensional systems. Chemical and biological kinetics in water quality models. Applications to temperature, dissolved oxygen, primary productivity, and other water quality management problems in rivers, lakes, and reservoirs. Deterministic versus stochastic models. Water quality dynamics.

CE 8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS. (1-5 cr; prereq 8550) Day class
Case studies of specific aquatic streams and lake systems.

CE 8560. SEMINAR: SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING. (1 cr; prereq #) Day class
Selected environmental engineering topics discussed by students, staff members, and guests.

COMMUNICATION DISORDERS (CDis)

College of Liberal Arts

110 Shevlin Hall, 624-3322
W.D. Ward, 2630 University Ave. S.E., 627-4694

CDis 5704. NOISE AND MAN. (4 cr; prereq 5301 or #) Day class
Temporary and permanent effects of steady, intermittent, and impulse noise on hearing and health. Annoyance and community noise. Noise measurement, reduction, and control; ear defenders and their limitations. Hearing conservation programs; preemployment testing and monitoring audiometry.

CONSERVATION BIOLOGY (CB)

Graduate School

307 Johnston Hall, 625-3490
Francie Cuthbert, 320 Hodson Hall, 624-1756

CB 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES. (3 cr; prereq intro genetics course or #) Day class
Seminar on current conservation biology issues; genetic, demographic, and environmental analysis and management of populations; ecosystem conservation; case studies of species conservation strategies.

ECOLOGY, EVOLUTION, AND BEHAVIOR (EEB)

College of Biological Sciences

109 Zoology, 625-4466
Franklin H. Barnwell, 109 Zoology, 625-4466

EEB 3001. INTRODUCTION TO ECOLOGY. (4 cr; open to jrs and above but not to biology majors) Day class and Extension class
Basic concepts in ecology; the organization, development, and functioning of ecosystems; population growth and regulation. Human impact on ecosystems.

EEB 3101. ECOLOGY FOR ENGINEERS AND PHYSICAL SCIENTISTS. (4 cr; §3001; not open to biology majors; prereq Math 1241) Joint Day/Extension class: refer to daytime *Class Schedule*
Description and analysis of the spatial and temporal interactions between populations in ecosystems; processes affecting populations; transformations of energy and materials in the biosphere. Lectures and recitations.

EEB 5004. DYNAMICS OF GLOBAL CHANGE: QUATERNARY HISTORY OF ECOSYSTEM RESPONSE. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
new Events during the Quaternary Ice Age and earlier in Earth's history illustrate the interconnectedness of the biota, atmosphere, continents and oceans, resulting in a dynamic global ecosystem.

EEB 5008. QUATERNARY ECOLOGY. (4 cr; prereq Biol 5041 or 5841 or #; offered 1992-93) Joint Day/Extension class: refer to daytime *Class Schedule*
Impact of changes in the physical and biological environment during the Quaternary period on plants and animals. Changes in evolutionary rates, geographical distributions, community composition and fluctuations in population sizes. Impact of prehistoric human culture on the environment, including ecosystem-level changes recorded in sedimentary sequences. Recent climatic changes. General principles of analysis and methods of investigation and interpretation.

EEB 5014. ECOLOGY OF PLANT COMMUNITIES. (5 cr; prereq Biol 5041 or 5048 or 5841, 1 qtr statistics or #; offered when feasible) Joint Day/Extension class: refer to daytime *Class Schedule*
Methods of describing, sampling, and classifying plant communities; theory of their structure and development, and of the stability of the interactions among their constituent populations. Field trips to examine local vegetation types; analysis of quantitative data.

EEB 5016. ECOLOGICAL PLANT GEOGRAPHY. (5 cr; prereq Biol 5041 or 5841, PBio 3201 [formerly Bot 3201] or ¶PBio 3201 or #; offered 1992-93) Joint Day/Extension class: refer to daytime *Class Schedule*
Vegetation regions of the world and North America in detail; ecological principles of plant distribution; interpretation of regional and temporal patterns in distribution of vegetation and taxonomic groups. Field trips to floristic regions of Minnesota.

EEB 5051. ANALYSIS OF POPULATIONS. (4 cr; prereq Biol 5041 or 5841 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Factors involved in the regulation, growth, and general dynamics of populations. Data needed to describe populations, population growth, population models, and regulatory mechanisms.

EEB 5122. PLANT/ANIMAL INTERACTIONS. (4 cr; prereq Biol 1106 or 3011, 1103 or 3012 plus 10 credits in biological sciences or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Herbivority, pollination, seed dispersal. Implications of interaction for plants and animals at organismal, population, and community levels. Coevolution.

EEB 5129. MAMMALOGY. (5 cr; §FW 5129; prereq Biol 1106 or 3011 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Recent families and orders of mammals of the world and of genera and species of mammals of North America, with emphasis on morphology, evolution, and zoogeographic history.

EEB 5132. HERPETOLOGY. (5 cr; prereq Biol 1106 or 3011 or #; not offered 1991-92) Joint Day/Extension class: refer to daytime *Class Schedule*
Distribution, classification, and evolution of amphibians and reptiles of the world. Physiological, morphological, and behavioral aspects of adaptive trends. Laboratory and lecture.

EEB 5134. INTRODUCTION TO ORNITHOLOGY. (5 cr; prereq Biol 1106 or 3011) Joint Day/Extension class: refer to daytime *Class Schedule*
Laboratory and field course in structure, classification, distribution, migration, habits, habitats, and identification of birds. Weekend trips scheduled.

EEB 5136. ICHTHYOLOGY. (4 cr; prereq 15 cr incl Biol 1106 or 3011) Joint Day/Extension class: refer to daytime *Class Schedule*
Biology of fishes including development, systematics, anatomy, physiology, and ecology.

EEB 5601. LIMNOLOGY. (4 cr; §Geo 5601; prereq Chem 1005 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Description and analysis of the events in lakes, reservoirs, and ponds, beginning with their origins and progressing through their physics, chemistry, and biology. Interrelationships of these parameters and effects of civilization on lakes.

EEB 5606. ECOLOGY OF FISHES. (3 cr; prereq Biol 1106 or 3011, EEB 5136 plus 10 cr in the biological sciences; offered when feasible) Joint Day/Extension class: refer to daytime *Class Schedule*
Ecological requirements of fishes with emphasis on nongame species, habitat, food, interactions among species, and behavioral, anatomical, and physiological adaptations. Fishes in the aquatic ecosystem with emphasis on fresh waters.

EEB 5607. ECOLOGY OF ANIMAL PLANKTON. (4 cr; prereq Biol 5041 or 5841, EEB 5601 or #; not offered 1991-92) Joint Day/Extension class: refer to daytime *Class Schedule*
Biology of animal plankton, including distribution of zooplankton in lakes, ecosystem functions such as grazing and remineralization, determination of production, physiological responses to contaminated environments, and important aspects of behavior.

EEB 5608. ECOSYSTEMS: FORM AND FUNCTION. (3 cr; prereq 5601 or Biol 5041 or 5841 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*
Nature and development of terrestrial wetland and aquatic ecosystems. Analysis of energy flow and element cycling in relation to environmental controls, self-regulation, natural and human disturbances.

EEB 5613. ASSESSING THE ECOLOGICAL EFFECTS OF POLLUTION. (4 cr; prereq Biol 5041 or 5841 or equiv, Chem 3301, 3302; not offered 1991-92) Joint Day/Extension class: refer to daytime *Class Schedule*
Assessment of effects upon species and ecosystems, methodological problems, initial phases of investigating a new pollutant, problems of prediction.

EEB 5621. LIMNOLOGY LABORATORY. (2 cr; §Geol 5621; prereq EEB 5601 or Geol 5601 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Principal techniques for obtaining information about environmental conditions in lakes and streams. Procedures for measuring the abundance and population dynamics of aquatic organisms, with special emphasis on plankton, field instruments, sampling devices, chemical analyses, microscopy and analysis of data. One Saturday field trip.

COURSES OFFERED AT LAKE ITASCA FORESTRY AND BIOLOGICAL STATION

EEB 5814. PLANT COMMUNITY ECOLOGY. (5 cr; limited to 20 students; prereq course in ecology; not offered 1991-92; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
Communities represented in Itasca Park and vicinity, with emphasis on vegetation. Patterns of distribution of the communities, their interaction with the environment, and their dynamic relationships. Methods of community description and analysis.

EEB 5817. VERTEBRATE ECOLOGY. (5 cr; prereq course in ecology, Δ; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
Field studies on populations and their relationships to local environments; habitat analysis and ecological research methods. All students will work as a team investigating factors influencing the distribution and abundance of selected vertebrates in various habitats. This is a research-oriented course supplemented with lectures and field trips.

EEB 5834. FIELD ORNITHOLOGY. (5 cr; prereq course in general biology including study of zoology; Δ; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
Emphasis on the breeding season, biology, behavioral ecology of birds in the Itasca region. Field trips taken to a variety of habitats to learn bird identification and observe and practice techniques for conducting field studies. Laboratory sessions investigate family distinctions and species identification. Individual field projects. Designed primarily for students with fisheries and wildlife management interests. (Lab charge required)

ECONOMICS (Econ)

College of Liberal Arts

1035 Management and Economics, 625-6353
Director of Undergraduate Programs, 1035 Management and Economics, 625-6353

Econ 5611. RESOURCE AND ENVIRONMENTAL ECONOMICS. (4 cr; prereq 3101 or equiv, 1 qtr calculus) Day class
Exhaustible resources and the theory of optimal depletion. Renewable resources and the theory of optimal use. Will resource scarcity limit growth? Natural resources and natural environments. Environmental pollution and economic efficiency.

ELEMENTARY EDUCATION (Elem)

College of Education

125 Peik Hall, 625-6372
Pat Williamson, 125 Peik Hall, 625-4044

Elem 5348. WORKSHOP: OUTDOOR SCIENCE EDUCATION. (3 cr; prereq elementary teaching experience, A-F only) Joint Day/Extension class
Classroom and fieldwork activities dealing with models, materials, and methods in the outdoor setting; consideration of broad topics such as ecological relationships, cyclic processes, and change as well as more specific topics such as rocks and minerals, plants and animals, and stargazing.

ENTOMOLOGY (Ent)

College of Agriculture

219 Hodson Hall, 624-3636
David W. Ragsdale, 416 Hodson Hall, 624-3636

Ent 1005. ECONOMIC ENTOMOLOGY. (4 cr; prereq Biol 1009 or #) Day class
Brief introduction to structure and classification of insects; management of insect populations; life histories, habits, and recognition of insect pests of livestock, orchards, field crops, vegetables, and ornamentals.

Ent 3005. INTRODUCTORY ENTOMOLOGY. (5 cr; prereq Biol 1009 or equiv) Day class
General morphology, life histories, habits, and classification of insects.

Ent 5040. INSECT ECOLOGY. (3 cr; prereq Biol 5041 or EBB 5122 or #) Day class
Synthetic analysis of the causes of insect diversity and of fluctuations in insect abundance. Focus on abiotic, biotic and evolutionary mechanisms influencing insect populations and communities.

Ent 5210. INSECT PEST MANAGEMENT. (4 cr; prereq 1005 or #) Day class
Management of insect, mite, and weed populations through integration of various methods and techniques.

Ent 5250. FOREST ENTOMOLOGY. (4 cr; prereq any two courses among the forestry, zoological, botanical, biological and/or agricultural sciences) Day class
Lectures and laboratory concerning ecology and population management of forest insects, with heavy emphasis on tree factors and biological control.

Ent 5280. LIVESTOCK ENTOMOLOGY. (3 cr) Day class
Biology and management of arthropods that affect livestock production systems.

Ent 5320. ECOLOGY OF AGRICULTURE. (4 cr; prereq two 3000 or above level courses in agronomy, horticulture or animal science, and two 3000 or above level courses in entomology, plant pathology or soil science or #) Day class
Ecological perspective on post-industrial agriculture. Discussions on the origins of agriculture and comparison of the function and ecology of contemporary and extinct agricultural systems.

Ent 5600. FIELD ENTOMOLOGY. (5 cr; prereq introductory biology; offered SSI at Itasca) Day class
Insect fauna in various natural habitats of the park and surrounding areas. Includes field trips and collection and identification of insects, as well as studies of general morphology, life histories, and habitats of local species.

Ent 5610. AQUATIC ENTOMOLOGY. (5 cr; prereq 3005 or 5600 or equiv or #; given at Itasca) Day class
Identification and biology of aquatic and littoral insects in all stages.

Ent 8240. COLLOQUIUM IN INSECT ECOLOGY. (3 cr; prereq 5040 or #) Day class
Dispersal, distribution, abundance, natural control and related problems.

ENVIRONMENTAL AND OCCUPATIONAL HEALTH (PubH)

School of Public Health

1155 Mayo Memorial Building, 626-0900
Kathryn Buxton, 1260 Mayo, 626-0900

PubH 5151. ENVIRONMENTAL HEALTH. (3 cr; prereq #)
Extension class
Methods for promoting human health and comfort by controlling environment.

PubH 5152. ENVIRONMENTAL HEALTH. (2 cr) Day class
General principles of environmental health relating to macro and micro environments and products consumed or used by people.

PubH 5153. CASE STUDIES IN ENVIRONMENTAL HEALTH. (2 cr; prereq EH student and concurrent registration in PubH 5152 or #) Day class
Current applications of environmental health principles and practices. Relation of past didactic work to real-life problems encountered by environmental health professionals.

PubH 5155. ISSUES IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH. (2 cr; prereq PH or grad student, or #) Day class
The field, the current issues, and the principles and methods of environmental and occupational health protection. Independent field visits to observe, review and analyze environmental/occupational health programs is required.

PubH 5158. HEALTH RISK EVALUATION. (3 cr; prereq EH majors or #) Day class
General principles of health risk assessment and management; environmental pollutants; public domain and workplace, legislation and regulations.

PubH 5171. ENVIRONMENTAL MICROBIOLOGY. (4 cr; prereq MicB 3103 or #) Day class
Survival, dissemination, monitoring, and significance of microorganisms in the environment; application of principles to environmental health problems.

PubH 5181. AIR POLLUTION. (4 cr; prereq 2 yrs chemistry, calculus, general physics or #) Day class
Overview of current air pollution problems; sources; chemistry of air pollutants and polluted atmospheres; potential human health effects; air pollution control technology; laws regulating air pollution.

PubH 5184. AIR ANALYSIS. (3 cr; prereq 5211, #) Day class
Laboratory and field exercises involving air flow calibration, dynamic calibration of field equipment for analysis of air contaminants, respirable mass sampling, dust counting and sizing, and instrumentation for measuring physical environmental stresses.

PubH 5185. FIELD INSTRUMENTATION. (1 cr; prereq 5211) Day class
Laboratory experience with the instruments used by industrial hygienists in the performance of field evaluations of occupational exposures to toxic agents. Sampling strategy.

PubH 5186. ENVIRONMENTAL CHEMISTRY. (3 cr; prereq general chemistry and organic chemistry or #) Day class
Chemistry of atmosphere, water and soil; environmental behavior and fate of pollutants.

PubH 5201. RADIATION PROTECTION AND MEASUREMENT. (2 cr) Day class
Ionizing radiation sources, detection and measurement, protection principles, health implications.

PubH 5202. RADIATION LABORATORY. (1 cr; prereq 5201 or concurrent with 5201) Day class
Laboratory for 5201.

PubH 5211. INDUSTRIAL HYGIENE ENGINEERING. (3 cr)
Joint Day/Extension class: refer to daytime *Class Schedule*
Concepts and techniques used in occupational health; emphasis on evaluation of potential hazards and preventive techniques.

PubH 5215. APPLIED OCCUPATIONAL TOXICOLOGY. (3 cr; prereq 5261 or #) Day class
Basic toxicology and physiology with emphasis on environmental contaminants. Inhalation toxicology of the work environment and air pollution.

PubH 5218. FIELD PROBLEMS IN OCCUPATIONAL HEALTH. (3 cr; prereq 5211, #) Day class
Guided evaluation of potential occupational health problems; recommendations and design criteria for correction if indicated.

PubH 5233. BIOLOGICAL SAFETY. (2 cr; prereq #) Day class
Topics include: assessment of risk; primary barriers, laboratory design criteria, safety devices and equipment; personnel practices; sterilization and decontamination; laboratory animals; and shipping and disposal of biohazardous agents.

PubH 5239. MICROBIOLOGY OF THE HUMAN ENVIRONMENT: SEMINAR. (1 cr; prereq #) Day class
Topics of current research interest on infectious disease and injury prevention through environmental intervention.

PubH 5242. ENVIRONMENTAL HEALTH ASPECTS OF GROUNDWATER SYSTEMS. (2 cr) Day class
Groundwater geology, quality, and treatment; well design, contruction and maintenance; special references to public and environmental health problems.

PubH 5243. WATER AND HEALTH. (3 cr) Day class
Occurrences, health effects, and treatment of physical, chemical and biological agents in transmission of waterborne diseases.

PubH 5253. INTRODUCTION TO HAZARDOUS WASTE MANAGEMENT. (3 cr) Joint Day/Extension class
Review of roles of public and private sectors as generators, disposers and regulators of hazardous wastes. Includes definitions, sources, transportation, handling, treatment, recovery, disposal, and public health implications.

PubH 5254. HAZARDOUS WASTE MANAGEMENT. (1 cr) Day class
Overview of problems and possible solutions. Technical, political, social, economic and regulatory factors are included.
Summer—Graduate Occupational Health and Safety Institute.

PubH 5261. GENERAL ENVIRONMENTAL TOXICOLOGY. (3 cr) Joint Day/Extension class
Application of basic biochemical, anatomical, and physiological principles to environmental toxicology; assessment of potential health hazards; approaches to solution of toxic problems.

PubH 5262. METABOLISM AND DISTRIBUTION OF XENOBIOTICS. (3 cr; prereq 5261 or #) Day class
In-depth examination of mechanisms and regulation of zenobiotic metabolism; kinetic models for distribution of toxicant and metabolites; receptor-mediated toxicity.

PubH 5266. RISK ASSESSMENT AND MANAGEMENT. (1 cr) Day class
General principles and practices, including data extrapolation techniques, model selection, public preference analysis, contextural analysis and equity analysis.

PubH 5267. ENVIRONMENTAL AND OCCUPATIONAL TOXICOLOGY. (3 cr; not open to students with subspecialty in toxicology) Day class
Basic principles of toxicology (absorption, distribution, metabolism, excretion, and site of action); tissue specificity of chemical injury.
Summer—Graduate Occupational Health and Safety Institute.

PubH 5268. SEMINAR: TOXICOLOGY AND HUMAN POPULATIONS. (1 cr) Day class
Students present data from the literature pertaining to the scientific evaluation of epidemiological studies that deal with human exposure to toxic agents.

PubH 8185. ANALYSIS OF TOXICANTS. (3 cr; prereq #) Day class
Application of principles of analytical chemistry to analysis of toxic chemicals in tissues and fluids, environment, workplace, and environmental health research: survey of instrumental methods (gas and liquid chromatography, mass spectrometry, and atomic and molecular spectroscopy); interpretation of results; analytical quality control.

EXTRACTIVE METALLURGICAL ENGINEERING (MetE)

Institute of Technology

Civil and Mineral Engineering

M. T. Hepworth, 122 Civil and Mineral Engineering, 625-5522

MetE 5800. MINERAL PROCESSING I. (4 cr; prereq IT upper division; 4 lect hrs per week) Day class
Introduction to unit operations of mineral and waste processing. Size reduction, classification, separation, and auxiliary operations. Application of physical and chemical principles to mineral and waste processing problems.

MetE 5801. MINERAL PROCESSING II. (4 cr; prereq IT upper division; 3 lect and 3 lab hrs per week) Day class
Chemical, physical, and engineering aspects of flotation, thickening and filtration.

MetE 5901. PRINCIPLES OF METALS EXTRACTION. (4 cr; prereq IT upper division; 3 lect and 1 rec hrs per week) Day class
Overall evaluation of: a)pyrometallurgical, hydrometallurgical, and electrometallurgical extraction of metals from their concentrates, e.g., extraction of Cu, Ni, Pb, Zn, Mg, A., Ti, ironmaking and steelmaking; and b) metal melting and recycling.

FISHERIES AND WILDLIFE (FW)

College of Natural Resources

200 Hodson Hall, 624-3600

Ira Adelman, 204 Hodson Hall, 624-3600

FW 1001. ORIENTATION IN FISHERIES AND WILDLIFE. (1 cr; S-N only) Joint Day/Extension class: refer to daytime *Class Schedule*
Survey of technical requirements and training of fishery and wildlife technicians and scientists; introduction to fields of work, problems and career outlets.

FW 1002. WILDLIFE: ECOLOGY, VALUES AND HUMAN IMPACT. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Controversial issues imvolving specific wildlife management principles and techniques. Designed for students without natural science background who are interested in wildlife management issues.

FW 1101. ETHICS AND VALUES IN RESOURCE MANAGEMENT. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Coverage of various aesthetic, economic and ecological values of wildlife and fisheries resources. Class discussions will be directed at understanding the process and ethics of resource management.

FW 3052. INTRODUCTION TO FISHERIES AND WILDLIFE. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Introduction to general ecological principles applied to management of fish and wildlife populations and their habitats; survey of legislation, agencies and policy affecting vertebrate populations; natural history of important Minnesota game and nongame vertebrates.

FW 3167. TECHNIQUES OF FOREST WILDLIFE MANAGEMENT. (2 cr; offered at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*
Biology and management of important forest wildlife species; methods of evaluating forest wildlife populations and habitats.

FW 3600. FISHERIES AND WILDLIFE FIELD TECHNIQUES. (5 cr; FW 3052; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
An introduction to a variety of field techniques and skills; planning and implementing field projects; data collection and analysis using microcomputers; written reports and a field journal.

FW 5129. MAMMALOGY. (5 cr; §EBB 5129; prereq Biol 1106 or 3001 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Recent families and orders of mammals of the world and genera and species of mammals of North America, with emphasis on morphology, evolution, and zoogeographic history.

FW 5455. AQUACULTURE. (3 cr; prereq Biol 1009, 1103, 1106 or equiv, Chem 1001-2 or 1004-5 or equiv or #; offered alt yrs) Joint Day/Extension class: refer to daytime *Class Schedule*
Role of aquaculture in resource management and world food production; institutional and economic considerations; principles of husbandry of aquatic organisms; interactions between fish metabolism and water quality; nutrition and energetics; fish health and genetics.

FW 5459. PHYSIOLOGY AND BEHAVIOR OF FISH. (4 cr; prereq EEB 5136 or EEB 5156 or FW 5455 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Relationships between the physiology of fishes, their behavior and the aquatic environment. Includes examination of ionic and osmotic balance, gas exchange, locomotion, orientation and migration, reproduction, endocrinology, growth and stress.

FW 5460. POLLUTION IMPACTS ON AQUATIC SYSTEMS. (3 cr; prereq Bio 5041, EEB 5601 and Chem 1004, 1005, 3301, 3305 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Pollution assessment approaches, biological effects, fate and flow of contaminants in aquatic systems, and major types of pollutants will be described.

FW 5570. AVIAN CONSERVATION AND MANAGEMENT. (4 cr; prereq grad or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Current problems in avian conservation and management, with emphasis on non-game, wetland, and game birds.

FW 5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS. (5 cr; prereq Math 1142 or 1211 and PubH 5450 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*
Conceptual models of populations, description of population characteristics and computer-assisted estimation of population parameters for the purpose of management. Competency in microcomputer word processing and spreadsheet data entry required.

FW 5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS. (4 cr; prereq 5601 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Ecological analysis of environmental factors as they influence distribution, abundance, and productivity of terrestrial and aquatic vertebrates. Emphasis is placed on those factors which humans do or can influence. Three or four all-afternoon and/or Saturday morning field trips.

FW 5604. FISHERY AND WILDLIFE MANAGEMENT. (4 cr; prereq FW 5601 or #) Day/Extension class: refer to daytime *Class Schedule*
Basic understanding of fisheries and wildlife management with an emphasis on managed species of interest. Introduction to tactics and strategies of fisheries and wildlife management. Understanding of the role of strategic planning in directing and redirecting management actions and familiarity with the tools of fisheries and wildlife management and assessment of their efficacy.

FW 5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION. (4 cr; prereq Biol 5041) Day class
new Hands-on experience with GIS as a tool for understanding analysis and management of ecological systems. Students will learn ARC-INFO and apply it to problems in fisheries, wildlife, and biological conservation.

FOREST RESOURCES (FR)

College of Natural Resources

115 Green Hall, 624-3400
Alan Ek, 204 Green Hall, 624-3400

FR 1001. FOREST RESOURCES ORIENTATION. (1 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Information about curricula offerings, areas of emphasis, CLE requirements, and summer job and internship programs.

FR 1100. DENDROLOGY. (4 cr; prereq Biol 1103) Joint Day/Extension class: refer to daytime *Class Schedule*
new Identification, nomenclature, classification, and distribution of about 200 important forest trees. Preparation and use of keys, systems of natural classification, and field and lab methods of identification.

FR 1200. INTRODUCTION TO FOREST RESOURCES. (3 cr)
Joint Day/Extension class: refer to daytime *Class Schedule*
Multiple forest resources and their management. History, policy, and current issues in forest resources. Lectures and laboratory.

FR 1201. CONSERVATION OF NATURAL RESOURCES. (3 cr)
Joint Day/Extension class: refer to daytime *Class Schedule*
Development of thought on natural resource conservation in the United States. Renewable resources and their management problems; resource conservation and environmental management related to basic ecological principles.

FR 1202. FARM AND SMALL WOODLANDS FORESTRY. (3 cr for non-forestry majors, 2 cr for majors [3 cr with paper]; prereq for majors 1100 or ¶1100) Joint Day/Extension class: refer to daytime *Class Schedule*
Status and problems of the small woodland owner. Factors influencing tree growth. Cutting practices for and marketing products of small woodlands. Establishment and care of plantations, shelterbelts, and windbreaks. Field trips.

FR 1203. INTRODUCTION TO MINNESOTA'S NATURAL RESOURCES. (3 cr; §1201; for non-forestry students) Joint Day/Extension class: refer to daytime *Class Schedule*
Ecological, social, and economic implications of Minnesota's soil, water, forest, wildlife, and other resources are studied in field exercise and group discussions at nature centers and natural areas. Environmental teaching techniques for the elementary indoor classroom.

FR 3100. IMPORTANT FOREST PLANTS. (1 or 2 cr; prereq Biol 1103; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
Identification of forest plants as related to forest types.

FR 3101. FIELD FOREST ECOLOGY. (3 cr; prereq Chem 1001 or Chem 1004; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
Field examination of succession, soils, silvical characteristics, tree classification, stand structure, and the ecology of regeneration.

FR 3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS. (2 cr; prereq Phys 1001, Phys 1005 or #)
Joint Day/Extension class: refer to daytime *Class Schedule*
Fundamentals of meteorology and climatology as applied to wildland resource management.

FR 3104. FOREST ECOLOGY. (3 cr; prereq Itasca session) Joint Day/Extension class: refer to daytime *Class Schedule*
Ecological concepts and principles as a basis for silvicultural practice. The forest as an ecosystem.

FR 3106. IMPORTANT PLANTS: FISHERIES AND WILDLIFE HABITATS. (1 cr; prereq FW 3600 or ¶3600; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
new Field identification of important plants in fisheries and a wildlife habitat.

FR 3110. COLLOQUIUM IN NATURAL RESOURCES. (1-4 cr)
Joint Day/Extension class: refer to daytime *Class Schedule*
new Selected topics in natural resources.

FR 3201. FIELD FOREST MEASUREMENTS. (1 cr; prereq Math 1008; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
Introduction to land survey, tree and stand measurement, and basic forest sampling techniques.

FR 3225. DIRECTED STUDY EXPERIENCE. (1-5 cr; prereq #)
Joint Day/Extension class: refer to daytime *Class Schedule*
Opportunity to pursue experiences not available under independent study or extra credit registration. The student develops, in consultation with the adviser for the project, a prospectus, and completes progress reports on his or her project.

FR 3250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES. (2 cr; also offered as FR 5200) Joint Day/Extension class: refer to daytime *Class Schedule*
International perspective on important resource issues, including integration of natural resource, social, and economic considerations. Overviews of issues and case studies.

FR 3300. ELEMENTS OF SURVEYING. (2 cr; prereq Math 1008 or high school trigonometry; given at Cloquet Forestry Center 1 week prior to fall quarter) Joint Day/Extension class: refer to daytime *Class Schedule*
Basic concepts of elementary plane surveying for use in natural resource assessment. Introduction to public land and boundary surveys and geographic information systems. Lectures and labs.

FR 5100. SILVICULTURE. (3 cr; prereq Itasca session, 1100) Joint Day/Extension class: refer to daytime *Class Schedule*
Introduction to silvics, forest regeneration and site preparation techniques, intermediate silvicultural practices, and silvicultural systems.

FR 5101. FIELD SILVICULTURE. (3 cr; prereq 5100; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*
Regeneration surveys, plantation inspection, site preparation, and reforestation prescription. Practice in marking for thinning and determining effect on stands. Compartment examination and prescription. Written and oral reports.

FR 5103. ADVANCED FOREST TREE BIOLOGY. (3 cr; prereq FR 3104) Joint Day/Extension class: refer to daytime *Class Schedule*
Current applications and research in forest tree biology.

FR 5104. FOREST ECOLOGY. (3 cr; prereq one course in biology or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Ecological concepts and principles as a basis for conservation and management of forest ecosystems.

FR 5106. SENIOR SILVICULTURE SEMINAR. (2 cr [3 cr with research paper]; prereq senior, FR 5100, or #; A-N only) Joint Day/Extension class: refer to daytime *Class Schedule*
Students prepare, present, and critique seminars on silvicultural topic of interest. Guest speakers.

FR 5110. FORESTRY APPLICATIONS OF MICROCOMPUTERS. (3 cr; prereq Stat 3011 and AgEt 3030 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*
Use of microcomputer software to solve forestry problems, applications programming, working of hardware components. Hands-on access to microcomputers as well as lectures.

FR 5114. FOREST HYDROLOGY. (3 cr; prereq Itasca session, 3103, Geo 1001 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Introduction to the hydrologic cycle and hydrologic processes. Effects of forest management activities on water yield, storm flow, and water quality.

FR 5115. FOREST HYDROLOGY, FIELD APPLICATIONS. (2 cr; prereq 5114 or #; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*
Use of hydrologic instrumentation to measure precipitation, streamflow, infiltration capacity, soil moisture, air temperature, evaporation, and selected water quality constituents. Collection and interpretation of hydrologic information to evaluate forest-use impacts on water quantity and quality.

FR 5120. INTRODUCTORY TREE PHYSIOLOGY AND GENETICS. (4 cr; prereq Chem 1001 or 1004, 10 cr Biol) Joint Day/Extension class: refer to daytime *Class Schedule*
Genetic variation in forest trees, underlying causes, use. Tree growth, nutrition, and water relation. Environmental and internal regulation of growth. Plant biochemistry and photo-chemistry. Physiology related to silviculturally and ecologically significant phenomena.

FR 5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS. (2 cr; prereq 1122, 5100; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*
Field examination of forest soils and their relationship to site productivity and forest management.

FR 5130. GEOGRAPHIC INFORMATION SYSTEMS IN NATURAL RESOURCE ANALYSIS. (2 cr; prereq grad or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Provides an introduction to the application of geographic information systems (GIS) to natural resource and regional planning studies. Theory and technical points covered, emphasis on applications. Hands-on experience on microcom-

puter. Case study is performed, including map digitizing, data processing, and generation of map products.

FR 5140. APPLICATION OF SILVICULTURE IN NORTH AMERICAN FOREST TYPES. (3 cr; prereq FR 5100 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Current regeneration methods and intermediate stand treatments. Economic and biological principles. Primarily lectures. Student presentations, discussion of current literature, and field trips may also be included, depending on enrollment.

FR 5152. FOREST GENETICS. (3 cr; prereq sr or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Genetic variation of forest tree species and underlying principles; application of plant breeding principles to forestry.

FR 5153. ADVANCED FOREST HYDROLOGY. (4 cr; prereq 3220, 5114 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Current hydrologic problems in the management of forested watersheds. Analytical methods to evaluate effects of vegetation management on the quantity and quality of runoff. Lecture and laboratory.

FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS. (3 cr; prereq grad only; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
Plant identification, plant dynamics, land survey, tree measurement.

FR 5200. AERIAL PHOTO INTERPRETATION. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Types, characteristics, procurement, preparation, viewing, and interpretation of color, black-and-white, and color infrared aerial photographs; basic aerial photography; introduction to mapping; applications to resource surveys.

FR 5212. NATURAL RESOURCES INVENTORY. (3 cr; prereq Itasca session, AgET 3030 or equiv computer programming course with FORTRAN or BASIC language, Math 1142 or Math 1211, Stat 3011 or Stat 5021) Joint Day/Extension class: refer to daytime *Class Schedule*
Measurement of stand variables, forest products, forest growth and yield. Elementary statistics. Sampling methods for estimating characteristics of natural resources and resources use for management decision making. Lecture and laboratory.

FR 5215. FOREST FIRE MANAGEMENT. (2 cr; prereq FR 1100, Itasca session, 3103, 5100, or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Concepts, principles, and techniques of fire control and use in wildland management.

FR 5220. REMOTE SENSING, FOREST RESOURCES INVENTORY. (4 cr; prereq FR 5200, 5212; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*
Use of aerial photographs in property boundary location; interpretation and classification of forest vegetation types. Application of sampling methods for estimating natural resources and resource use for management decision making.

FR 5221. PLANT MOLECULAR EVOLUTION. (3 cr; prereq Biol 5003 or GCB 3022 or GCB 5022; equiv to PBiol 5221) Joint Day/Extension class: refer to daytime *Class Schedule*
Experimental molecular techniques applicable to evolutionary studies. Molecular methods of quantifying genetic diversity. Statistical methods for phylogenetic reconstruction. Application of RFLPs to the study of morphological evolution. Evolution of organellar genomes. Evolution of multigene families. Role of transposable elements in plant evolution. DNA sequence evolution. Molecular aspects of development as related to plant evolution.

FR 5226. FOREST ECONOMICS AND PLANNING. (5 cr; prereq FR 5212, AgEc 1030 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Conduct and interpretation of economic analysis, forest planning concepts, principles and techniques of forest regulation.

FR 5231. RANGE MANAGEMENT. (3 cr; prereq Biol 1103 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Important range plants; range livestock; range management methods and improvements; public grazing land administration; relationship of livestock grazing to wildlife, forest, watershed, and recreation management on public and private range lands.

FR 5232. MANAGEMENT OF RECREATIONAL LANDS. (4 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*
Recreational use of the forest and associated land and water. Policy problems arising form recreational demands.

FR 5233. PRINCIPLES OF OUTDOOR RECREATION PLANNING. (4 cr; prereq 5232 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
For advanced students associated with design, management, and planning of recreational facilities. Planning and design principles related to recreational land use and development; parks campsites, water areas, highways, summer and winter recreational facilities.

FR 5236. FOREST RECREATION PLANNING. (1 cr; prereq 5232; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*
Recreation area and site planning, examples and managerial concerns. Field work and presentation.

FR 5240. NATURAL RESOURCE POLICY AND ADMINISTRATION. (3 cr; prereq sr in forestry or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Basic concepts of political and administrative processes in development of natural resource policies and programs. Policy processes, agenda setting, political decision rules, strategies for achieving agreement, participants in policy development, public means of implementing policies and case examples.

FR 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES. (3 cr; prereq FR 5240 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Advanced concepts of political and administrative processes important to the development of natural resource policies and programs. Issue creation and agenda setting theories, incremental decision-making styles, role of analysis and analytical information, actions of major policy participants (e.g., courts, legislatures, interest groups, media), program planning, budgeting and staffing, and evaluation of natural resource case studies.

FR 5248. HARVESTING AND ENGINEERING. (3 cr; prereq CE 3100; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*
An introduction to harvesting systems, relationship to forest management, and preparation and administration of timber sales. Fundamentals of location, construction, and maintenance of forest roads.

FR 5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES. (2 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
International perspective on important resource issues, including integration of natural resource, social, and economic considerations. Overviews of issues and case studies. Term paper, other requirements.

FR 5257. RECREATION LAND POLICY. (3 cr; prereq 5232 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Policy issues affecting the use and management of lands devoted entirely or in part to recreational objectives.

FR 5259. ANALYSIS OF OUTDOOR RECREATION BEHAVIOR. (3 cr; prereq 5232, RRM major or grad student or #; offered alt years beginning 1992) Joint Day/Extension class: refer to daytime *Class Schedule*
Development of environmental framework for understanding recreation behavior. Contributions of several disciplines, current cultural trends, management implications.

FR 5262. REMOTE SENSING OF NATURAL RESOURCES. (4 cr; offered alt yrs beginning 1993) Joint Day/Extension class: refer to daytime *Class Schedule*
Introduction to remote sensing for natural resource inventories, land use analyses, and environmental monitoring activities; photographic, thermal, multispectral, and radar sensing procedures; airborne and satellite systems; visual and computer-assisted analysis techniques; oriented toward an interdisciplinary audience.

FR 5264. QUANTITATIVE TECHNIQUES IN FOREST MANAGEMENT. (3 cr; prereq FR 5212, 5226 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Forestry applications of quantitative techniques in allocation and other decision-making problems. Mathematical programming, simulation, and other techniques.

FR 5401. SENIOR TOPICS. (ar cr; prereq sr in forestry or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Independent study in a field of interest to the student. Work must be planned with a forestry faculty member.

FR 5403. FUNDAMENTALS OF NATURAL RESOURCE EDUCATION. (3 cr) Joint Day/Extension class
Intended for elementary school teachers. Study of soil, water, forest, and wildlife resources of Minnesota and the biological principles and ecological implications of management.

FR 5406. FORESTRY WORKSHOP FOR TEACHERS. (3 cr)
Joint Day/Extension class: refer to daytime *Class Schedule*
Forest ecosystems and forest management studied in lecture and laboratory sessions conducted in a forest environment. In field exercises, techniques and materials are developed for teaching principles of forestry in indoor and outdoor classrooms. Tours to forest and wildlife research and management units and utilization locations, and discussions of contemporary forestry issues by guest lecturers. Offered at Cloquet Forestry Center (1 week) in June.

FR 5408. FORESTRY IN THE URBAN ENVIRONMENT. (3 cr; prereq student teacher, teacher or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Study of forest ecosystems and forest management in lecture and laboratory sessions. Field exercises emphasize techniques and materials useful for teaching principles of forestry in indoor and outdoor classrooms; forest areas in the Twin Cities used for field exercises. Special uses and problems of the urban forest. Discussions and presentations by guest lecturers on contemporary forestry issues.

FR 5412. ADVANCED REMOTE SENSING. (4 cr; prereq FR 5262 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Working knowledge of quantitative remote sensing. Both theoretical basis and practical aspects, including energy-matter interactions, radiation measurements and sensors, and digital analysis.

FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
new Water quality management practices and policies in rapidly changing societies; emphasis on developing countries.

FR 5500. URBAN FOREST MANAGEMENT. (3 cr; prereq 5100 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Discussion and development of basic concepts. Introduction to terminology and principles of urban tree inventory, propagation, and care; management case studies; equipment operation and costs.

FR 5700. COLLOQUIUM IN FOREST BIOLOGY. (1-2 cr; prereq varies with topic or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Colloquium on specialized topics in forest biology, silviculture, and related resource management.

FR 8100. RESEARCH PROBLEMS: SILVICULTURE. (ar cr) Day class

FR 8101. RESEARCH PROBLEMS: FOREST TREE PHYSIOLOGY. (ar cr) Day class

FR 8102. RESEARCH PROBLEMS: FOREST TREE GENETICS. (ar cr) Day class

FR 8103. RESEARCH PROBLEMS: FOREST HYDROLOGY. (ar cr) Day class

FR 8105. ADVANCED FIELD SILVICULTURE. (3 cr; prereq FR 5101, #) Day class
Selected current problems and research in silviculture. Plant-soil relationships with particular reference to forest soils. Methods of forest soil investigations in the field and laboratory.

FR 8106. TOPICS IN SILVICULTURE—FOREST SOILS. (ar cr; prereq FR 5100 and 5 cr in soils or #) Day class

FR 8108. FOUNDATIONS OF RENEWABLE RESOURCES RESEARCH.
(3 cr) Day class

FR 8200. RESEARCH PROBLEMS: FOREST MANAGEMENT. (ar cr) Day class

FR 8201. RESEARCH PROBLEMS: FOREST ECONOMICS. (ar cr) Day class

FR 8202. RESEARCH PROBLEMS: FOREST MEASUREMENTS. (ar cr) Day class

FR 8203. RESEARCH PROBLEMS: FOREST RECREATION. (ar cr) Day class

FR 8204. RESEARCH PROBLEMS: FOREST POLICY. (ar cr) Day class

FR 8205. RESEARCH PROBLEMS: REMOTE SENSING. (ar cr) Day class

FR 8206. ADVANCED MANAGEMENT OF RECREATIONAL LANDS. (3 cr; prereq FR 5233, EBB 3004 or #) Day class
Relationship of people as recreationists to the natural environment. Principles of manipulation of plant and animal communities for outdoor recreation objectives. Lectures, readings, discussions, reports, field trips.

FR 8207. ECONOMIC ANALYSIS OF FORESTRY PROJECTS. (3 cr; prereq #) Day class
Public and private forestry projects; analysis of commercial profitability and application of benefit-cost analysis; preparation of feasibility studies; case studies.

FR 8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES. (3 cr) Day class
Identification and analysis of major international, national, and state issues of importance to natural resource management. Review of literature, case studies, and guest speakers.

FR 8213. TOPICS IN WILDLAND HYDROLOGY. (3 cr; prereq 5114, CE 5405 or #; offered alt yrs) Day class
Lecture and discussion of current literature on the water resources of wildlands (non-urban, non-agricultural lands).

GENERAL COLLEGE (GC)

340 Appleby Hall, 625-5529
Jay Hatch, 340 Appleby Hall, 625-9346

GC 1111. SCIENCE IN CONTEXT: WEATHER AND CLIMATE. (5 cr; 5 lect, 1 lab hrs per wk) Day class and Extension class
new Weather patterns; interactions among atmosphere, oceans, land surfaces, and earth motion. Storms, seasonal change, climatic change, fair weather, air pollution, and distribution of moisture and energy from theoretical and applied viewpoints. Scientific principles applied to analyzing and forecasting weather, interpreting climates and climatic change, and understanding individuals' interaction with atmospheric environment.

GC 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS. (5 cr) Day class and Extension class
new Concepts of ecology (organization of ecosystems, material cycling, energy flow and production, population dynamics, and community interactions) needed to understand proximate and ultimate causes of environmental problems such as world hunger, endangered species, deforestation, solid and hazardous wastes, global climate change, acid rain, and cultural eutrophication. Frameworks and methodologies for critically evaluating impacts and proposing interventions.

GC 1171. PHYSICAL GEOLOGY. 5 cr; 5 lect, 2 or more lab hrs per wk) Day class
new Description and development of common land features—valleys, mountains, rivers, lakes. Processes responsible for their origin and change. Types of surface materials. Movements inside earth and their effects on its surface. Self-paced laboratory: mineral and rock analysis, topographic map reading, landform identification, landscape interpretation.

GENETICS AND CELL BIOLOGY (GCB)

College of Biological Sciences

250 Biological Sciences Center, 624-3003
Kathleen Peterson, 233 Snyder Hall, 624-9717

GCB 3002. HUMAN GENETICS, SOCIAL AFFAIRS. (3 cr [4 cr with paper], §3022 or §Biol 1101, §Biol 5003; for students in programs not directly related to biological sciences) Extension class
Human genetics; study of individuals, families, populations, and races with respect to differences in intelligence, behavior, disease, and other matters of social concern.

GEOGRAPHY (Geog)

College of Liberal Arts

414 Social Sciences, 625-6080
R. Skaggs, 568 Social Sciences, 625-6643

Geog 1401. PHYSICAL GEOGRAPHY. (5 cr; §NSci 1501) Joint Day/Extension class: refer to daytime *Class Schedule*
Distribution patterns of climate, relief, vegetation, and soils, regional differences in problems of physical development.

Geog 1425. INTRODUCTION TO METEOROLOGY. (4 cr; §Soil 1262) Joint Day/Extension class: refer to daytime *Class Schedule*
(Same as Soil 1262) The atmosphere and its behavior. Atmospheric composition, structure, stability, and motion; precipitation processes, air masses, fronts, cyclones and anticyclones; general weather patterns, meteorological instruments and observation; plotting and analysis of maps; forecasting.

Geog 3343. LAND USE AND STATE GOVERNMENT. (4 cr; prereq 3344) Joint Day/Extension class: refer to daytime *Class Schedule*
How individuals choose to use land in the United States; the state's role in such choices. Descriptions of American landscapes as outcomes of decisions.

Geog 3344. LAND USE AND THE FEDERAL GOVERNMENT. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Analysis of how individuals choose to use land in the United States, emphasizing the statutory and regulatory framework for decisions. Description of American landscapes as outcomes of decisions.

Geog 3345. ENERGY AND MINERALS. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Sources, production, circulation, and consumption of power, metals, and nonmetallic minerals. Problems of exhaustion, substitution, pollution, costs, trade, and policy. National and local case studies.

Geog 3421. CLIMATOLOGY. (4 cr; prereq 1401 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
World distribution of climatic elements; methods of arranging climatic data; climatic classifications and world distributions of climatic types; general circulation; climatic change and climatic fluctuations.

Geog 3431. INTRODUCTION TO PLANT AND ANIMAL GEOGRAPHY. (4 cr; not open to biology majors) Joint Day/Extension class: refer to daytime *Class Schedule*
World distribution of plants and animals; biological and ecological background; the geographical picture; the paleoecological record.

Geog 3441. LANDFORM GEOGRAPHY. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
The role of landforms in the distribution of resources; processes of landform origin and change; map interpretation of landforms; complex environmental history of the Quaternary period and its contribution to a complicated pattern of landforms, with emphasis on North America.

Geog 3451. GEOGRAPHY OF SOILS. (4 cr; §Soil 5512) Joint Day/Extension class: refer to daytime *Class Schedule*
Distributions of soil-forming processes and soil types; soil differences in small areas; soil constraints on human activities in different places; regional differences in soil problems and management techniques—farming, forestry, construction, agri-business, suburbanization, homesteading.

Geog 5344. HISTORICAL GEOGRAPHY OF RESOURCE USE IN THE UNITED STATES. (4 cr; prereq 3101 or 3344 or grad) Joint Day/Extension class: refer to daytime *Class Schedule*
Selected topics in the development of the American landscape; how resources have been used.

Geog 5424. APPLIED CLIMATOLOGY. (3 cr; §Soils 5424; prereq Geog 3421 or Soils 5420 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Application of climatic principles and data to selected problems in environmental management and agriculture.

Geog 5444. GEOGRAPHY OF WATER RESOURCES. (4 cr; prereq two courses in physical geography or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Distributional aspects of the magnitude, quality, and dynamics of water resources. Aesthetic, recreational, and material production uses of water; consequences of human actions in the hydrosphere, especially in fresh water.

Geog 8340. SEMINAR: LAND USE PLANNING. (3 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

Geog 8344. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA. (1 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

Geog 8345. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA. (3 cr; prereq 8344) Joint Day/Extension class: refer to daytime *Class Schedule*

Geog 8420. SEMINAR: CLIMATOLOGY. (1-3 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*
Detailed study of selected topics. Topics vary from year to year; examples include modeling, climatic variability, predictability, severe local storms, drought, and energy balance.

GEOLOGY AND GEOPHYSICS (Geo)

Newton Horace Winchell School of Earth Sciences

Institute of Technology
106 Pillsbury Hall, 624-1333
H.O. Pfannkuch, 2D Pillsbury Hall, 624-1620

Geo 1001. THE DYNAMIC EARTH: AN INTRODUCTION TO GEOLOGY. (4 cr; 4 lect hrs) Day class and Extension class
A nonmathematical introduction to earth, its internal structure; processes that shape its surface; theory of plate tectonics; action of streams, glaciers, waves, wind, and groundwater; limnology; fossil fuels and mineral deposits; environmental geology; planetary geology; and the geology of Minnesota.

Geo 1005. GEOLOGIC PERSPECTIVES ON ENERGY. (4 cr; 4 lect hrs per wk) Day class and Extension class
Introduction to the geologic aspects of energy resources, conventional and unconventional. History of energy use, distribution and amounts of known and potential reserves, environmental aspects and implications of U.S. consumption patterns.

Geo 1012. INTRODUCTION TO COMPARATIVE PLANETOLOGY. (4 cr) Day class
A nonmathematical introduction to comparative planetology. Topics include the origin and evolution of the solar system, composition, structure, and dynamics of planetary interiors, planetary surfaces, oceans and atmospheres; plate tectonics, the origin of the elements, climate, Earth resources, the biosphere, the life cycle of stars, vulcanism, and measurement of geologic time.

Geo 1021. INTRODUCTION TO GEOLOGY LAB: GEOLOGY OF MINNESOTA. (1 cr; prereq 1001 or ¶1001 or #; one 2-hr lab) Day class and Extension class
Ten laboratory exercises based on the geology of Minnesota. These labs will introduce students to the bedrock, glacial history, topography, mineral resources, and environmental geology of the state through the use of appropriate minerals, rocks, topographic and geologic maps.

Geo 1111. INTRODUCTORY PHYSICAL GEOLOGY. (5 cr; prereq high school or college chemistry or #; 3 lect hrs, 1 rec hr, and two 2-hr labs per wk) Day class
For prospective majors and others desiring a more intensive course.

Geo 1601. OCEANOGRAPHY. (4 cr; 3 lect and 1 lab hrs per wk) Day class
How various processes in the ocean interact; analogies between the oceans and Lake Superior and smaller lakes in Minnesota. Topics include marine biology, waves, tides, chemical oceanography, marine geology and human interaction

with the sea. Lab work includes study of live marine invertebrates and manipulation of oceanographic data.

Geo 3401. INTRODUCTORY MINERALOGY. (5 cr; §5004, 5404; prereq 1001 or 1111 or #, 1 term college chemistry, Math 1221; 3 lect and 6 lab hrs per wk) Day class
Crystallography, crystal chemistry, and crystal physics. Physical and chemical properties, crystal structures, and chemical equilibria of the major mineral groups. Laboratory includes crystallographic, polarizing microscope, X-ray powder diffraction exercises, and hand specimen mineral identification.

Geo 5004. MINERALOGY. (4 cr; §3401; not open to geology, geophysics, and geological or mineral engineering majors; prereq Math 1221, 1 term college chemistry, and #; 3 lect and 6 lab hrs per wk; offered when demand warrants) Day class
For description, see 3401.

Geo 5108. ADVANCED ENVIRONMENTAL GEOLOGY. (4 cr; prereq geology core courses 1111 through 5201 or equiv or #) Day class and Extension class
Human impact on the geological environment and the effect of geology; geologic processes on human life from the point of view of ecosystems and biogeochemical cycles. Geologic limits to resources and carrying capacity of the earth. Land use planning, environmental impact assessment, ecogeologic world models. Field project.

Geo 5201. STRUCTURAL GEOLOGY. (5 cr; prereq 3401; 3102; IT: upper division major in Geo, Geophys, GeoE, MinE; CLA: jr or sr GEO major; or #) Day class
Primary and secondary structures of rocks, mechanics and modes of deformation, introduction to field methods in geology. Field trips.

Geo 5251. GEOMORPHOLOGY. (4 cr [5 cr with term project]; prereq 1001, Math 1111 or #; 3 lect, 2 lab hrs per wk; lab often used for field trips; offered when demand warrants) Day class
Study of the origin, development, and continuing evolution of landforms in various environments. Environmental implications are emphasized. Topics include weathering, slope and shore processes, fluvial erosion and deposition, wind action, tectonics, and impact phenomena.

Geo 5261. GLACIAL GEOLOGY. (4 cr [5 cr with term paper or map lab]; prereq 1002 or 3112; offered when demand warrants) Day class
Formation and characteristics of modern glaciers; erosional and depositional features of Pleistocene glaciers; history of Quaternary environmental changes in glaciated and nonglaciated areas. Field trips.

Geo 5601. LIMNOLOGY. (4 cr; §EBB 5601; prereq Chem 1005 or equiv) Day class
Description and analysis of events occurring in lakes, reservoirs, and ponds, beginning with their origins and progressing through study of their physics, chemistry, and biology. Emphasis on interrelationships of these parameters and on effects of civilization on lakes.

Geo 5611. GROUNDWATER GEOLOGY. (4 cr; prereq 1001 or 1111, Math 1231, 1 qtr physics and chemistry or #) Day class
Origin, occurrence, and movement of groundwater viewed in the context of the hydrologic cycle. Characteristics of aquifer systems. Exploratory investigations. Hydrogeologic units and boundaries of regional systems. Analysis of surface water groundwater interaction, recharge. Quality and chemistry of groundwater supplies. Contaminant hydrology.

Geo 8262. QUATERNARY PALEOECOLOGY AND CLIMATE. (4 cr; prereq 5261 or #; offered when demand warrants) Day class
Principles of stratigraphic pollen analysis. Pleistocene and Holocene vegetation and climatic history as interpreted from pollen diagrams from different parts of the world. Paleoclimatic interpretation of ocean-sediment cores.

Geo 8602. ADVANCED LIMNOLOGY. (3 cr; prereq 5601 or equiv, #) Day class
Detailed study of selected problems in limnology using current and classical literature. Term paper required.

Geo 8612. ANALYTICAL GEOHYDROLOGY. (3 cr; [4 cr with term paper]; prereq Math 3221, CE 3400 or #; offered when demand warrants) Day class
Microphysics of flow through porous media; geological factors in aquifer performance; equations for groundwater flow; analysis of pumping tests; potential theory in groundwater flow; computer and analog models of aquifers; groundwater basin analysis; contaminant fate and transport through aquifers.

Geo 8617. TRANSPORT PHENOMENA IN NATURAL POROUS MEDIA. (2 or 3 cr; prereq CE 3400 or Chem 5520 or equiv or #; 2 lect hrs per wk and term project ar; offered when demand warrants) Day class
Microscopic flow parameters, momentum, mass and energy transport through porous media, rate processes, coupled processes and nonequilibrium thermodynamics, geologic controls of natural flow systems in porous media and aquifers.

HISTORY OF SCIENCE AND TECHNOLOGY (HSci)

Babbage Institute for History of Information Processing

103 Walter Library, 624-5050
Arthur Norberg, 103 Walter Library, 624-5050

HSci 3331/5331. TECHNOLOGY IN AMERICAN CULTURE. (4 cr) Day class
Technology in America with emphasis on its impact on society and culture. Traces the growth of American technology in its cultural and intellectual context from colonial period to present.

HUMANITIES (Hum)

College of Liberal Arts

314 Ford Hall, 624-5553
W. John Archer, 358 Ford Hall, 624-3830

Hum 3366. LANDSCAPE AND IDEOLOGY, 1600-1875. (4 cr; §Hum 3663) Day class
The cultural construction of "nature" as concept and as environment. From Puritan "garden in the wilderness" to 18th-century "natural" landscape garden and 19th-century transcendentalism. Attention to the role of agriculture, religion, philosophy, aesthetics, property relations, travel, and exploration.

INTERDEPARTMENTAL STUDY (ID)

College of Liberal Arts

225 Johnston Hall, 624-5701
Mary Lymer, 225 Johnston Hall, 624-5701

ID 3970. DIRECTED STUDIES. (3-15 cr per qtr; prereq OSLO [Office for Special Learning Opportunities] approval, Δ) Day class
Individual readings and research on topics that cross departmental lines.

ID 5525-5526. GARBAGE, GOVERNMENT, AND THE GLOBE. (4 cr winter, 4 cr spring) Extension class
A rigorous analysis of how garbage—yours, mine, ours—affects not only our economy, politics, environment, and health but also the lives of untold future generations of humans and other species. The problem of garbage does not lend itself to narrow disciplinary approaches, but calls for cooperation among many fields. Reflecting this need for boundary crossing, this two-quarter course offers an interdisciplinary approach to learning about messy, real-world problems. Faculty from the Institute of Technology, the Carlson School of Management, and the Colleges of Agriculture, Biological Sciences, and Liberal Arts join students in examining topics such as the movement of toxic materials through the environment; the management of solid wastes, especially those generated by incinerators, power plants, municipal water treatment plants, etc.; the philosophic grounding of environmental exploitation in the ethics of humanism; the physical, chemical, and biological aspects of soils in environmental planning and conservation decisions; and the effect of environmental problems on economic competitiveness and domestic and international corporate operations. The sequence will include lectures, exams, major project, films, visiting speakers, and field trips. Students must enroll in both quarters. Enrollment is by application only; contact Susan Henderson in 202 Wesbrook Hall (625-6361). No prerequisite for 5525; 5525 for 5526.

JOURNALISM AND MASS COMMUNICATION (Jour)

College of Liberal Arts

111 Murphy Hall, 625-9824
P. Tichenor, 35 Murphy Hall, 625-6893

Jour 5133. INTERPRETIVE REPORTING ABOUT SCIENCE. (4 cr; prereq 3121 or #, Δ; offered 1992-93) Day class
Role of journalistic communication in science; scientist-journalist relationships; communicating results of scientific investigations to public, specialized audiences, industry.

LANDSCAPE ARCHITECTURE (LA)

College of Architecture and Landscape Architecture

205 North Hall, 625-8285
David Pitt, 205 North Hall, 625-7099

LA 1021. HISTORY OF ENVIRONMENTAL DEVELOPMENT: ARCHITECTURE. (4 cr; Arch 1021; 4 lect hrs per wk) Day class and Extension class
Introduction to the philosophy and principles of architecture and landscape architecture as an art; survey of environmental history from the ancient periods through the medieval age.

LA 1022. HISTORY OF ENVIRONMENTAL DEVELOPMENT: LANDSCAPE ARCHITECTURE. (4 cr; Arch 1022; prereq 1021; 4 lect hrs per wk) Day class and Extension class
Continuation of 1021 from the Renaissance through the modern eras; focuses on forces and individuals that shaped the form of architecture and landscape architecture in the 19th and 20th centuries in America and Europe.

LA 1023. HISTORY OF ENVIRONMENTAL DEVELOPMENT: PLANNING. (4 cr; Arch 1023; prereq 1022; 4 lect hrs per wk) Day class and Extension class
Introduction to urban planning. Survey of the rise and history of cities as centers of civilization. Collaboration among various disciplines for creating better urban environment and improving the quality of human life in cities.

LA 1031. INTRODUCTION TO LANDSCAPE ARCHITECTURE. (4 cr; 4 lect hrs per wk) Joint Day/Extension class
Design potential of materials of the landscape; exercises in assessment of land developments and detail landscapes; the role of landscape architecture in shaping the natural and cultural environment; brief historical review of site developments.

LA 3001. ENVIRONMENTAL DESIGN: PEOPLE AND ENVIRONMENT. (4 cr; Arch 3001) Day class
Interaction of people with the environment, using natural and social sciences and the arts as background for readings, lectures, discussions, and workshop sessions.

LA 3002. ENVIRONMENTAL DESIGN: TOOLS AND PROCESSES. (4 cr; Arch 3002; prereq 3001) Day class
Nature and the effects of various tools and processes of environmental change, ranging from buildings and landscapes to economic policies, climate, and myths. Readings, lectures, discussions, and workshop sessions.

LA 5105. RECREATIONAL PLANNING AND DESIGN. (6 cr; prereq 5010; 2 lect and 12 lab hrs per wk) Day class
Analysis, development, and presentation of landscape design solutions for diverse, recreational land uses.

LA 5107. REGIONAL LANDSCAPE DESIGN. (6 cr; prereq senior or grad or #) Day class
Emphasis on large-scale land areas. Analyzing development potential and evolving solutions for integration of such divergent land use patterns as agricultural, residential, commercial, industrial and recreational.

LA 5119. PLANTING DESIGN: ECOLOGICAL PRINCIPLES/ LAND USE CONCEPTS AND IMPLEMENTATION. (4 cr; prereq 3092 or #) Day class; summer session Extension class
new Lectures, presentations, field trips, readings, and projects related to principles and practices of using plant materials in an ecologically sound and environmentally sensitive manner. Principles derived from prairie, north woods, riverine, and wetland environments. Integrating naturalized materials in environnments of various scales. Historic and modern land use planting concepts. Planting implementation skills.

LA 5562. INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS. (4 cr; prereq jr, sr, or grad major in Geog or LA or #) Day class
Basic concepts of geographic information systems structure. Theory and applications for landscape location and resource analysis, and regional planning. Location principles, data structure, and variable attributes.

LA 8330. CONCEPTS OF LANDSCAPE EVALUATION. (2 cr; prereq 8108, MLA student or #) Day class
Studies in philosophical bases for and wide-ranging approaches to evaluating qualitative aspects of landscape. Emphasis on aesthetic factors.

LA 8390. DESIGNING THE LONG-TERM LANDSCAPE. (2 cr; prereq MLA student or #) Day class
Problems of designing landscapes that must sustain their integrity over generations or centuries. Survey of historical examples. Design theory, principles, and strategies.

LAW SCHOOL (Law)

285 Law Building, 625-1000
Daniel Sarber, 350 Law, 625-1022

Law 5215. ENVIRONMENTAL LAW. (3 cr) Day class
Legal aspects of major environmental problems with emphasis upon pervasive issues that reappear in various regulatory contexts: e.g., the degree to which environmental quality should be protected; who should bear the cost enhancing environmental quality; the allocation of responsibilities among courts, legislatures, and administrative agencies; the role of citizens' groups and environmental litigation.

Law 5885. ADVANCED ENVIRONMENTAL LAW. (2 cr; Law 5215) Day class
new This seminar will provide in-depth coverage of current issues in environmental law, with visiting lectures by environmental law specialists. Among the topics covered will be hazardous waste disposal, water pollution, and toxic torts. Student papers will analyze current controversial issues in environmental law. Satisfies senior writing requirement.

MECHANICAL ENGINEERING (ME)

Institute of Technology

125 Mechanical Engineering, 625-0705
B.Y. Liu, 130 Mechanical Engineering, 625-6574

ME 5603. THERMAL ENVIRONMENTAL ENGINEERING. (4 cr; prereq 3303 and 5342 or equiv, IT student or grad; 4 lect hrs per wk; offered 1992-93 and alt yrs) Joint Day/Extension class
Thermodynamic properties of moist air; h-W diagram for moist air; solar radiation; heat and water vapor transmission in structures; effects of thermal environments upon people, processes, and materials; thermal loads, thermal environmental control systems.

ME 5609. AIR POLLUTION. (4 cr; prereq 3303 or #, IT student or grad; 4 lect hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*
Air pollution sources, atmospheric transport, transformations and fate. Air pollution meteorology, dispersion, and models. Basic chemistry of secondary pollutant formation, aerosol growth, air pollutant visibility relationships. Standards and regulations.

ME 5712. SOLAR ENERGY UTILIZATION. (4 cr; prereq 5342 or #, IT student or grad; 4 lect hrs per wk; offered when feasible) Joint Day/Extension class
History and potential of solar energy utilization; availability of solar radiation on clear and cloudy days; incident radiation on horizontal, vertical, and inclined surfaces; flat-plate and concentrating solar collectors; heating and cooling with solar energy; power generation; review of current research.

MICROBIOLOGY (MicB)

College of Biological Sciences, College of Liberal Arts, and Medical School

1460 Mayo Memorial Building, 624-6190
Palmer Rogers, 925 Mayo Memorial Building, 624-7140

MicB 3103. GENERAL MICROBIOLOGY. (5 cr; §5105, §Biol 5013, §VPB 3103; prereq soph with C avg in courses prereq to major sequence, or jr with 10 cr chemistry and 5 cr biological sciences or #; offered 1992-93) Extension class
Morphology, physiology, taxonomy, and ecology of bacteria. Applications of fundamental principles. Lab.

MicB 5352. APPLIED MICROBIOLOGY. (4 cr; prereq 5321 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Microbial adaptation to various environments; role of microorganisms in the earth's biogeochemical cycles. Application of microbial systems to industrial processes; basic principles of fermentation technology; microbial bioconversions and product formation. Biodegradation of chemicals.

MicB 5611. MICROBIAL ECOLOGY. (3 cr; prereq 3103 or 5105 of Biol 5013 or Soil 5610 or #; §Soil 5605) Joint Day/Extension class: refer to daytime *Class Schedule*
new Interrelationship of microorganisms with terrestrial, aquatic and organismal environments; survey of bacterial, fungal and algal components of ecosystems; evolution and structure of microbial communities; population interactions within ecosystems; quantitative and habitat ecology; biogeochemical cycling; and biotechnological approaches to the study of microbial ecology.

NATURAL RESOURCES AND ENVIRONMENTAL STUDIES (NRES)

College of Natural Resources and College of Agriculture

John V. Bell, 135 Natural Resources Building, 624-6768
Terrence H. Cooper, 439 Borlaug Hall, 625-7747

NRES 1001. ORIENTATION TO NATURAL RESOURCES AND ENVIRONMENTAL STUDIES. (1 cr; S-N only) Day class
Information about NRES major. Discussions with faculty adviser. Employment information. Current topics in NRES. Information about facilities. Discussions with alumni.

NRES 1010. ISSUES IN THE ENVIRONMENT. (3 cr) Day class
Interdisciplinary offerings exploring five areas of environmental concern: aspects of environmental design providing maximum compatibility of human beings with their environment, sources of water pollution and their control, disposal and control of solid wastes from agriculture, minimization of pesticide pollution of the environment, and managed use of forest resources to maintain environmental quality. A televised course involving twenty taped lectures and ten discussion periods.

NRES 1040. NATURAL RESOURCES AS RAW MATERIALS. (2 cr) Day class
Role of natural resources as raw materials for industry and economic development. Environmental and economic trade-offs associated with raw material gathering, processing, and use. Implications of processing technologies, energy consideration.

NRES 3001. COLLOQUIUM IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES. (1 cr) Day class
Round table discussions of current topics in Natural Resources and Environmental Studies.

NRES 3050. EXPERIENCE AND TRAINING IN A FIELD SETTING. (1-4 cr; prereq jr or sr standing) Day class
Students are required to obtain professional experience in a field setting by attending field sessions, completing a Professional Experience Program, or volunteering for various natural resource and/or environmental programs through local, state or federal agencies. Approval by an adviser required.

NRES 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT. (3 cr; §3060, §5060) Joint Day/Extension class
new Water quality issues and concerns in the broader context of natural resource management. Global and ecological perspectives toward understanding the management of surface and groundwater resources.

NRES 3225. NRES DIRECTED STUDY EXPERIENCE. (1-5 cr ar, prereq fresh or soph) Day class
new Opportunity to pursue experiences not available under independent study or extra credit registration. The student develops, in consultation with the advisor for the project, a prospectus and completes progress reports and a final report on his or her project.

NRES 5099. PROBLEM SOLVING IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES I. (2 cr; prereq sr standing or #, 5099, 5100 †) Day class
Designed to help students identify and analyze natural resources and environmental problems. Identify a problem and develop a working plan for a solution. Students participate as a team.

NRES 5100. PROBLEM SOLVING IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES II. (3 cr; prereq 5099, 5100 †) Day class
Development of a solution to the problem identified in 5099. Discussions reflect diverse aspects of the problem and assignments. Oral and written presentation. Students participate as a team.

NRES 5210. SURVEY, MEASUREMENT, AND MODELLING METHODS FOR NATURAL RESOURCES I. (3 cr; prereq Math 1142, Stat 3011 and computer competency) Day class
Introduction to survey design, measurement concepts, and modelling methods useful in the study of natural resources and environmental issues. Emphasis on data collection and analysis.

NRES 5220. SURVEY MEASUREMENT AND MODELLING METHODS FOR NATURAL RESOURCES II. (4 cr; prereq 5212 or NRES 5210 or equiv and computer programming) Joint Day/Extension class: refer to daytime *Class Schedule*
new Advanced survey design, mmeasurement concepts, and modelling methods for study of natural resources annd environmental problems.

NRES 5225. NRES DIRECTED STUDY EXPERIENCE. (1-5 cr ar; prereq jr, sr, or grad) Day class
new Opportunity to pursue experiences not available under independent study or extra credit registration. The student develops, in consultation with the advisor for the project, a prospectus and completes progress reports and a final report on his or her project.

NRES 5600. PRINCIPLES OF WASTE MANAGEMENT. (4 cr; prereq Soil 1020 or 3125, and 1 course in chemistry and in biology) Day class
new Understanding the issues, problems and solutions in remediating the waste stream generated by today's society. Topics include waste stream dynamics, MSW (municipal solid waste) and yard waste composting, WTE (waste to energy) incineration operation, ash disposal, recycling, landfill requirements, and requirements for direct land disposal, regulatory trends, and case studies.

PHYSICS (Phys)

Institute of Technology

148 Physics, 624-7375
K. Maversberger, 42 Physics, 624-6305

Phys 1071. INTRODUCTORY METEOROLOGY. (4 cr; prereq high school algebra; 4 lect hrs per wk; offered when feasible) Day class
Physics of atmospheric processes. Clouds, fronts, and cyclones. Weather forecasting. Human influence on the atmosphere.

Phys 1075. INTRODUCTORY METEOROLOGY LABORATORY. (1 cr; S-N only; prereq 1071 or ¶1071; 2 lab hrs per wk; offered when feasible) Day class
Field experiments offered in conjunction with 1071.

Phys 5461. PHYSICS AND CHEMISTRY OF THE EARTH'S UPPER ATMOSPHERE. (4 cr; prereq general physics and calculus; offered when feasible) Day class
Survey of atmosphere above 15 km; physics and chemistry of the stratosphere, mesosphere, and thermosphere; temperature and density profiles; major and minor constituents and their distributions; aspects of pollutants; reactions and rates; global variation of constituents; the energy budget of the atmosphere.

PLANT BIOLOGY (PBio)

College of Biological Sciences

220 Biological Sciences Center, 625-1234
Thomas Soulen, 220 Biological Sciences, 625-1234

PBio 1009. MINNESOTA PLANT LIFE. (4 cr; suitable for nonmajors) Joint Day/Extension class: refer to daytime *Class Schedule*
Identification of the more characteristic and conspicuous Minnesota plants, including many lower forms, with discussion of their basic distinctions, life cycles, habitat requirements, distribution, vegetation types, and ecological relations. Lectures, demonstrations, six field trips.

PBio 1012. PLANTS USEFUL TO HUMANS. (4 cr; for majors or nonmajors) Day class and Extension class
Roles that plants play and have played in human biological and cultural development. Lectures and demonstrations.

PBio 3201. INTRODUCTORY PLANT SYSTEMATICS. (4 cr; prereq Biol 1103 or 3012) Day class
Systematics of the flowering plants of the world. The ecology, geography, origins, and evolution of the flowering plants; family characteristics; floral structure, function and evolution; pollination biology; methods of phylogenetic reconstruction; molecular evolution; taxonomic terms; methods of collection and identification. Two field trips.

PBio 5103. ALGAE, FUNGI, AND BRYOPHYTES. (5 cr; prereq Biol 1103 or 3012; offered when feasible) Day class
Characteristics of groups, evolutionary relationships, life cycles, comparative morphology (including ultrastructure), comparative nutrition. Laboratory emphasizes living material and isolation of algae and fungi into culture.

PBio 5183. WATER, MINERALS, AND TRANSLOCATION. (4 cr; §PlPh 5183; prereq 5131 or equiv) Day class
Membrane phenomena and osmotic properties of cells. Uptake, movement, and loss of water in plants; effects of external factors. Translocation of organic substances. Absorption, distribution, and function of inorganic elements.

PBio 5231. INTRODUCTION TO THE ALGAE. (5 cr; prereq 10 cr in plant biology or biology or #; offered when feasible) Day class
Structure, reproduction, and life histories of major algal divisions.

PLANT PATHOLOGY (PlPa)

College of Agriculture

495 Borlaug Hall, 625-8200
Philip Larsen, 495 Borlaug Hall, 625-8200

PlPa 5002. INTRODUCTORY PLANT PATHOLOGY. (5 cr; prereq 14 cr plant sciences or #) Day class
Introductory course in plant diseases. Lectures, laboratory and special problems.

PlPa 5007. AIR POLLUTANTS AND THEIR EFFECTS ON PLANTS. (3 cr; prereq 20 cr biology incl biochemistry) Day class
Sources, types, and forms of air pollution; air pollution and changing climate; impacts of air pollution on crops and forests; acidic rain; methods of studying air pollution effects on plants including diagnosis; air quality regulations and policies.

PlPa 5050. FOREST PATHOLOGY. (4 cr; prereq 10 cr plant sciences or forestry) Day class
Diseases of forest and shade trees; wood decay. Symptoms, etiology and control. Lectures, laboratory, and field work.

PlPa 5102. FUNGAL ECOLOGY. (3 cr; prereq 5 cr botany) Day class
Emphasis on ecological studies and identification of fungi. Lectures include topics on fungal symbioses, morphology, coevolution and applicable ecological theory. Student teams will determine species richness in an aquatic, grassland, and forest habitat.

PlPa 5105. INTRODUCTION TO THE STUDY OF FUNGI. (4 cr; prereq 9 cr botany or Biol 1002 or #) Day class
Structure, habits, classification, and identification of fungi.

PlPa 5106. MYCOLOGY: ASCOMYCETES - FUNGI IMPERFECTI. (4 cr; prereq 5105 or equiv or MicB 3103 or #; offered alt yrs) Day class
Lectures and laboratory exercises in taxonomy, identification, life histories, genetics, and ecology of fungi.

PlPa 5107. MYCOLOGY: BASIDIOMYCETES. (4 cr; prereq 5105 or equiv or MicB 3103 or #; offered alt yrs) Day class
Lectures and laboratory exercises in taxonomy, identification, life histories, genetics, and ecology of fungi.

PlPa 8003. PLANT DISEASE THEORY III, POPULATIONS. (4 cr; prereq 5005, 5006, 5007 or #, and 8001, 8002) Day class
Disease in populations of plants; agroecosystems, natural ecosystems, and interrelatedness of plant disease over large geographic areas. This course introduces elements of population genetics, epidemiology, and geopathology.

PlPa 8111. FUNGAL GENETICS. (4 cr; prereq Genetics 3022) Day class
Attributes of the genetics of fungi using classical approaches, including mendelian and quantitative traits, ecological and population genetics, incompatibility systems, tetrad analysis, treterokaryosis, somatic recombination, plasmids, genetics of parasitism, and moecular genetics techniques.

POLITICAL SCIENCE (Pol)

College of Liberal Arts

1414 Social Sciences, 624-4144
Terence Ball, 1414 Social Sciences, 624-0083

Pol 5523. THE POLITICS OF THE REGULATORY PROCESS. (4 cr; prereq 1001 or equiv or #) Day class
Operations of regulatory agencies considered in context of political and legal environment. Principles of federal administrative law, informal procedures, interest group activity, philosophy of regulation, politics and processes of deregulation.

PUBLIC AFFAIRS (PA)

Hubert H. Humphrey Institute of Public Affairs

300 Humphrey Center, 625-9505
D.E. Abrahamson, 243 Humphrey Center, 625-2338

PA 5601. LAND USE. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Physical, spatial basis for community and regional development. Private sector development processes. Public regulatory frameworks, guidance and interventional strategies. Integration of physical, social and economic factors in land use policy, planning and decision-making. Graduate status or written permission.

PA 5622. MANAGING URBAN GROWTH AND CHANGE. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Integrated systems of controls and incentives to manage land development at state, metropolitan, and local government levels. Traditional planning and land use devices, tax and fee techniques, environmental regulations and innovative controls.

PA 5701, 5702. TECHNOLOGY PLANNING I AND II. (3 cr each) Joint Day/Extension class: refer to daytime *Class Schedule*
Relationship of science and technology to ideological bases of our society; identification of technology's significance to the policy process; analysis of our society's institutions for governing its technologies.

PA 5711. ENERGY POLICY I. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Possible energy supply systems and ways energy is consumed; relatively non-technical description of physical systems, environmental and social impacts, regulatory frameworks, resource base, and relationship to energy policy options.

PA 5712. ENERGY POLICY II. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Energy policy options including political, economic, environmental, and other considerations.

PA 5721. ENVIRONMENTAL POLICY I. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Systems in the natural and physical environment. Environmental impacts of technological innovation. Associated social controversy. Legislative, judicial, regulatory responses.

PA 5722. ENVIRONMENTAL POLICY II. (3 cr, offered 1992-93) Joint Day/Extension class: refer to daytime *Class Schedule*
Relationship of science and technology to ideological bases of our society; identification of technology's bases of our society, identification of technology's significance to the policy process analysis of our society's institutions for governing its technologies.

PA 5791. SCIENCE, TECHNOLOGY POLICY (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
new Ways in which science and technology in the closing decades of the 20th century directly affect the global economic, political, and social environment. How the dynamics of technological development and specific advances in science and technology affect relations among nations in such matters as autonomy, national security, distribution of power, cultural identity and international cooperation. Various approaches to determining national policy and negotiating international agreements in areas affected by science and technology.

PA 5792. TOPICS IN ENVIRONMENT AND ENERGY POLICY. (3 cr) Day class
new Description not yet available. For information, contact Karen Schuster, 154 Humphrey Center, 625-3497.

PA 8691-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Advanced analysis of selected topics in land use and human settlements such as large scale planned communities, agricultural preservation, historical preservation, infrastructure planning and programming, urban transportation policy.

PA 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY. (3 cr, offered 1992-93) Joint Day/Extension class: refer to daytime *Class Schedule*
Topics in technology, energy, and environment, such as hazardous waste, energy efficiency, nuclear technologies, or atmospheric carbon dioxide.

RECREATION, PARK, AND LEISURE STUDIES (Rec)

College of Education

203 Cooke Hall, 625-5300
Leo H. McAvoy, 209 Cooke Hall, 625-5887

Rec 5160. CONSERVATION OF PARK RESOURCES. (3 cr; prereq 1520 or 5100 or Δ) Joint Day/Extension class limited to 10 Extension students
Environmental considerations in relation to recreation and leisure services; environmental and visitor management in park areas.

Rec 5250. FINANCING LEISURE SERVICES. (3 cr; prereq 3550 or Δ) Day class
Methods and techniques of financing operations and capital improvements in public park and recreation agencies and nonpublic community leisure services; sources of revenue budgeting procedures.

Rec 5300. FOUNDATIONS OF OUTDOOR EDUCATION. (3 cr; prereq sr, 1520 or 5100 or #) Day class
Investigation of the philosophical, historical, and educational foundations of outdoor education.

Rec 5310. PROGRAMMING IN OUTDOOR EDUCATION. (4 cr; prereq 5300 or #) Joint Day/Extension class limited to 10 Extension students
Methods, materials and settings for outdoor education and environmental interpretation programs.

Rec 5350. WILDERNESS OUTDOOR RECREATION PROGRAMMING. (4 cr; prereq 3150 or #) Day class
Exploration of leisure and educational resources of wilderness and management of wilderness-based outdoor recreation and outdoor education programs.

RHETORIC (Rhet)

College of Agriculture

202 Haecker Hall, 624-3445

Rhet 1310. HUMANITIES: THE LAND IN AMERICAN EXPERIENCE. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
American attitudes toward the land from colonial times to the present as expressed in social history, literature, and fine arts. Social thought and the relationship between farm and city, wilderness and countryside. The changing appearance of America.

Rhet 3375. HUMANITIES: AGRICULTURAL HERITAGE. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
Examination and analysis of significant events or periods affecting rural agriculture peoples as expressed in historical, cultural, and literary documents. Understanding of major values, attitudes, and philosophies related to agricultuial change and development.

SOCIOLOGY (Soc)

College of Liberal Arts

909 Social Sciences, 624-4300
Robert Kennedy, 1125 Social Sciences, 624-1615

Soc 3551. WORLD POPULATION PROBLEMS. (4 cr) Day class
Population growth and natural resources, population dynamics, fertility and mortality in less developed and industrialized nations, population forecasts, policies to reduce fertility.

SOIL SCIENCE (Soil)

College of Agriculture

439 Borlaug Hall
Russell S. Adams, Jr., 439 Borlaug Hall, 625-4229

Soil 1020. THE SOIL RESOURCE. (5 cr; §3125) Fall: Extension class; Winter: Day class
Introduction to the physical, chemical, and biological aspects of soils. Use of the soil classification system to understand the use of soil survey information for land-use planning. Concepts of soil fertility for understanding plant growth requirements. Introduction to urban soils and their management. Understanding soil's role in environmental planning and conservation decisions.

Soil 1262. INTRODUCTION TO METEOROLOGY. (4 cr) Day class
(Same as Geog 1425) Pre-calculus introductions to nature of atmosphere and its behavior. Atmospheric composition, structure, stability, and motion; precipitation processes, air masses, fronts, cyclones and anticyclones; general weather patterns; meteorological instruments and observations; plotting and analysis of maps; forecasting.

Soil 1500. BIOTECHNOLOGY: BASIC CONCEPTS AND APPLICATIONS. (3 cr; prereq H.S. biology and H.S. chemistry or #) Day class
new Introduction to biotechnology for students interested in this field as part of a liberal education, as well as those contemplating careers in the sciences. Genetic engineering, application of biotechnology to microbes, plants and animals, and legal and ethical issues are discussed.

Soil 3118. SEMINAR: SOIL AND WATER POLLUTION AND PUBLIC POLICY. (1 cr; [may be repeated for max 3 cr]; S-N only) Extension class
Speakers from the University, the public, and state and federal agencies address a current rural soil and water environmental issue, with emphasis on policies and pertinent technical concerns. A new topic is examined each time offered.

Soil 3125. BASIC SOIL SCIENCE. (5 cr; prereq Chem 1001 or 1004) Day class
Basic physical, chemical, and microbiological properties of soil. Soil genesis, classification, and principles of soil fertility. Lectures and laboratory.

Soil 3220. SOIL CONSERVATION AND LAND USE MANAGEMENT. (4 cr; prereq Soil 1020/3125 or #) Day class
new Soil erosion and land degradation processes on rural and urban landscapes. Technical, historical, economic, social, and international considerations of soil conservation. Land-use management practices for soil conservation and methods of natural resource assessment. Lectures, field trips, and computer lab.

Soil 5240. MICROCLIMATOLOGY (SOILS). (5 cr; prereq Math 1111, 10 cr physics or #) Day class
Meteorology and climatology in relation to the soil-atmosphere interface, with emphasis on the microclimate, physical processes taking place within the microclimate, modification of the microclimate, description of meteorological instruments, and use of weather data.

Soil 5340. ORGANIC AND PESTICIDAL RESIDUES. (5 cr; prereq 1122, sr or #) Day class
The fate of crop residues, animal wastes, sewage materials, petroleum hydrocarbons, detergents, and pesticides in soils with emphasis on the chemical, physical, and biological factors of the soil that influence decomposition or persistence.

Soil 5424. APPLIED CLIMATOLOGY. (3 cr; prereq 5140 or Geog 3421 or #) Day class
Intended for advanced undergraduates and beginning graduate students who have a background in the principles of climatology or microclimatology. Sources of climatic data, methods of analysis, and selected set of specific applications that focus on agricultural and environmental management problems.

Soil 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION. (3 cr; prereq 1122 or #) Day class
Formation, properties, and management of peatlands important to crop, forestry, and energy production in this state and worldwide. Lecture.

Soil 5560. INTERPRETATION OF LAND RESOURCES. (3 cr; prereq 3520 or #) Joint Day/Extension class
Techniques used in preparing soil maps of varying scales. Information available from soil maps and accompanying reports evaluated for use in agriculture, engineering, waste treatment, forestry, and land planning. How soil survey information can be used to the fullest extent in land resource interpretation.

Soil 5605. MICROBIAL ECOLOGY. (3 cr; prereq MicB 5105 or Biol 5013 or Soil 5610 or #; §MicB 5611) Day class
new Interrelationship of microorganisms with terrestrial, aquatic and organismal environments; survey of bacterial, fungal and algal components of ecosystems; evolution and structure of microbial communities; population interactions within ecosystems; quantitative and habitat ecology; biogeochemical cycling; and biotechnological approaches to the study of microbial ecology.

Soil 5610. SOIL BIOLOGY. (4 cr; prereq 1020/3125 and PlPa 1001 or #) Day class
The soil environment and its biological population. Role of living organisms in the soil-plant environment and cyclic transformations of agronomic interest (carbon, nitrogen, and mineral substances). Effect of soil microflora on soil fertility and plant nutrition. Lectures and laboratory.

UNIVERSITY COLLEGE (UC)

317 Walter Library, 624-2022
Susan Stonefield, 7 Wulling Hall, 624-2004

UC 3075. INDEPENDENT STUDY. (3-15 cr; prereq Δ) Day class
UC 3075 is an undergraduate directed study listing available to students who wish to pursue learning projects that go beyond the scope of any single department or college of the University. Projects are either interdisciplinary in nature or are monitored by faculty from departments that do not have an appropriate undergraduate directed study registration. Students design their own learning projects, working closely with appropriate faculty who also supervise and evaluate the project. May be taken for 1 to 15 degree credits.

VETERINARY BIOLOGY (VB)

College of Veterinary Medicine

295K Animal Science/Veterinary Medicine Building, 624-2700
Patrick T. Redig, Gabbert Raptor Center , 624-4969

VB 5330. WILD BIRD MEDICINE. (2 cr; prereq regis vet med, 3rd or 4th year or DVM grad student or #) Day class
Brief summary of important aspects of clinical avian anatomy and physiology and pathology. Survey of diseases common to wild birds and surgical repair of common injuries and fractures.

PART III. SPECIAL CENTERS AND LIBRARIES

CENTERS

JAMES FORD BELL MUSEUM OF NATURAL HISTORY

College of Biological Sciences
Elmer C. Birney, Director, 10 Church Street S.E., University of Minnesota, Minneapolis, MN 55455; 624-4112

The museum features exhibits of Minnesota wildlife, the Touch and See Room, and the Jacques Gallery of natural history art. It also houses extensive research collections of birds, mammals, reptiles, amphibians, and fish. Public education programs on natural history are offered throughout the year. The Natural History Library, located in the museum, emphasizes collections in vertebrate zoology, behavior, and basic ecology.

CENTER FOR POPULATION ANALYSIS AND POLICY

James W. Vaupel, Director, 257 Humphrey Center, 301 19th Ave. S., University of Minnesota, Minneapolis, MN 55455; 625-9821

The Center for Population Analysis and Policy (CPOP) is an international interdisciplinary population research center founded in 1987. In addition to some fifty faculty members from a broad range of disciplines at the University of Minnesota, CPOP's research involves participants from across the United States and Europe, as well as the U.S.S.R. and China. Some of CPOP's current activities include offering weekly research seminars, sponsoring conferences, and developing a graduate program in population sciences.

CENTER FOR URBAN AND REGIONAL AFFAIRS

Thomas M. Scott, Director, 330 Humphrey Center, 301 19th Ave. S., University of Minnesota, Minneapolis, MN 55455; 625-1551

The regents established the Center for Urban and Regional Affairs (CURA) to help make the University more responsive to the needs of the larger community and to increase the constructive interaction between faculty and students, on the one hand, and between the University and those dealing directly with major public problems, on the other hand.

Specific projects of the center are selected from several broad problem areas reflecting major concerns in this region: economic development and employment, environment, housing, human services, land use management, planning and public affairs, and the diffusion of information about these topics. These problems cut across a wide and changing array of disciplines.

CURA's role is to help coordinate and stimulate projects in these problem areas. It works with the faculty and students of all academic units of the University. All CURA programs are pilot, experimental, or short term projects. The goal is to probe and evaluate, complete short-term projects, discard unsuccessful ones, and help build successful ones into the appropriate part of the academic structure. It confines itself to projects for which there is currently no other practical administrative home.

The center also publishes a newsletter, the *CURA Reporter*. Information about both the newsletter and the center may be obtained from the CURA office.

DEPARTMENT OF PROFESSIONAL DEVELOPMENT AND CONFERENCE SERVICES

Nolte Center for Continuing Education
Steven Weiland, Director, 215 Nolte Center for Continuing Education, 315 Pillsbury Drive S.E., University of Minnesota, Minneapolis, MN 55455; 625-8040

The Department of Professional Development and Conference Services (PDCS), with support from the University of Minnesota academic faculty, assists groups in developing and presenting noncredit continuing education programs.

The department has a professional staff to assist interested parties in planning, publicizing, administration, and evaluation of continuing education programs. PDCS occasionally sponsors programs for the general public in the fields of environment, urban problems, and planning. For further information contact the director.

GRAY FRESHWATER BIOLOGICAL INSTITUTE

College of Biological Sciences
Steven J. Eisenreich, Interim Director, P.O. Box 100, County Roads 15 and 19, Navarre, MN 55392; 471-8476

The Gray Freshwater Biological Institute is a research facility where faculty and staff members, postdoctoral fellows, and students from several disciplines (microbiology, biochemistry, limnology, biogeochemistry, environmental chemistry) conduct basic and applied research dealing with problems of aquatic systems.

LAKE ITASCA FORESTRY AND BIOLOGICAL STATION

College of Biological Sciences
Administrative Office: Donald B. Siniff, Director, 305 Zoology, 318 Church Street S.E., Minneapolis, MN 55455; 625-9165

Located at the headwaters of the Mississippi River in northern Minnesota, the field station is an ecological area where three plant regions of the United States meet. Fifty square miles of protected forest provide unique opportunities for study of varied ecosystems and of the fauna and flora with southern, northern, and western origins. Diverse lakes and wetlands provide unusual field advantages for aquatic studies. For a list of courses held at the Station, see the entry for Lake Itasca in Part I, "Courses Listed by Subject Area."

LIMNOLOGICAL RESEARCH CENTER

Newton Horace Winchell School of Earth Sciences
Institute of Technology
Kerry Kelts, Director, 220 Pillsbury Hall, 310 Pillsbury Drive S.E., University of Minnesota, Minneapolis, MN 55455; 624-7005

This center conducts research on lakes from four perspectives: a) lakes as archives of changing environment and climate, b) lakes as models of biological, ecological, physical and biogeochemical processes, c) lakes as geological features in Earth history, d) lakes as natural resources. Studies of lake history are made through analyses of microfossils, sediment components, and geochemical signatures. Research activities are global in scope.

Evening seminars for current problems are held in Fall for limnology, and Spring for paleoenvironment. Courses and degree programs are coordinated through the Department of Geology and the Department of Ecology, Evolution, and Behavior, and a Quatenary Paleoecology minor. The center participates in a Research Training Group for paleorecords of global change.

MINNESOTA GEOLOGICAL SURVEY

Newton Horace Winchell School of Earth Sciences
Institute of Technology
Priscilla Grew, Director, 2642 University Avenue, St. Paul, MN 55114; 627-4780

The Minnesota Geological Survey is engaged in a number of activities related to the environment and planning. These include developing a database of waterwell logs and groundwater data for the state of Minnesota and preparing county atlases containing geological, hydrogeological, and resource information useful for environmental planning and management.

Undergraduate and graduate students are employed by the survey as aides and research assistants. Whenever possible their work forms part of the research for a master's thesis or Ph.D. dissertation. The Minnesota Geological Survey is a potential source of employment and research support in geologically related aspects of the environment and planning.

The Minnesota Geological Survey maintains an inventory of topographic and geologic maps of the state, as well as publications on the state's geology and resources. For further information, call 627-4780.

MINNESOTA LANDSCAPE ARBORETUM

Department of Horticultural Science
College of Agriculture
Peter Olin, Director, P.O. Box 39, Chanhassen, MN 55317; 443-2460

Established in 1958, the Arboretum covers 905 acres of rolling hills with native woods, marshes, a prairie, formal display gardens, and a variety of plant collections. Its programs include the Andersen Horticultural Library with 9,500 non-circulating volumes and a plant locator database with sources for more than 40,000 commercially grown plants, the Research Department which develops cold-hardy fruit and landscape plants, the Horticultural Research Center which has introduced more than 70 cold-hardy fruit varieties, and many informal classes and workshops for children and adults on horticulture, landscape design, and related areas.

MINNESOTA PUBLIC INTEREST RESEARCH GROUP

Heather Cusick, Executive Director, 2512 Delaware Street S.E., Minneapolis, MN 55414 (campus office, 235 Coffman Union); 627-4035

MPIRG is a nonprofit, nonpartisan organization representing Minnesota college students and working for constructive social change to benefit all Minnesotans. MPIRG activities related to environmental issues include work on energy policy, clean air, recycling, wilderness protection, and alternative modes of transportation.

MPIRG is funded by nearly 30,000 students on nine Minnesota college and university campuses who pay a special fee for its support. It is directed by a board of elected student representatives from the participating institutions. The board holds open meetings at least once a month. All matters of organizational business—from hiring staff, to allocating $400,000 annual budget, to selecting projects for the organization—are handled by the board. Any enrolled, fee-paying student may seek election to the board. Annual elections are held in the spring.

MPIRG employs a full-time staff of twelve people including attorneys, researchers, organizers and support staff. MPIRG publishes *Statewatch* two times a year. MPIRG sponsors coursework on advocacy—on campus, in communities, and with the legislature. It also provides numerous internships involving research, organizing, and legislative work. Students work with MPIRG staff in coordinated programs that involve publication of research findings and recommendations for public action, active representation before government agencies, law reform through legislative action, and, where necessary, legal action through courts.

ST. ANTHONY FALLS HYDRAULIC LABORATORY

Civil and Mineral Engineering
Institute of Technology
Roger Arndt, Director, Mississippi River at 3rd Avenue S.E., Minneapolis, MN 55414; 627-4012 or 627-4010

The St. Anthony Falls Hydraulic Laboratory's focus is on fluid mechanics and water resources engineering and its relationship to the fields of water resources development, including water quality dynamics and hydropower. The Laboratory conducts research on the flow of water in streams, rivers, estuaries, lakes, and man-made pipes, channels, and reservoirs. Transport of sediment, heat, and dissolved substances, as well as natural and artificial water storage, drainage, runoff, and other hydrological processes are part of the research program. The related fields of low speed aerodynamics and wind engineering are also studied.

In its fifty-year history the laboratory staff, comprised of Civil and Mineral Engineering Department faculty, civil service employees, and graduate and undergraduate students, has conducted hundreds of studies on water-related projects locally, nationally, and internationally. Extensive documentation is available through reports and films of the research studies in the Lorenz G. Straub Memorial Library.

The laboratory provides academic and financial assistance to graduate and undergraduate students interested in water resources engineering and related programs.

UNDERGROUND SPACE CENTER

Civil and Mineral Engineering
Institute of Technology
Raymond L. Sterling, Director, 790 Civil and Mineral Engineering Building, 500 Pillsbury Drive S.E., University of Minnesota, Minneapolis, MN 55455; 624-0066

The Underground Space Center is a division of the Department of Civil and Mineral Engineering. The center was founded in November 1977 by the Minnesota Legislature in response to the growing interest in many aspects of underground space utilization.

The goals of the center are to: serve as a focal point for planning and coordination of underground space use; carry out research in areas affecting underground space use; provide an information and referral service for all aspects of underground space utilization; and serve as a focal point for international cooperation or research and information transfer.

During the past fourteen years, research at the Underground Space Center has been conducted on a wide range of topics. Major research areas have included: planning of underground space; legal and regulatory issues; habitability of underground space; life safety in underground buildings; underground storage of food and energy; earth sheltered building technology; subsurface heat transfer; foundation construction and energy use; geomechanics; frost heave action in soils; and energy conservation retrofits to existing buildings.

The Underground Space Center offers two courses on earth-sheltered building design and underground construction engineering; these courses are listed under the Civil Engineering Department's class schedule. Energy use, planning, security, environment, building design, underground excavation, landscaping,

building codes, financing and psychological considerations are topics, studies and discussions in these courses.

WATER RESOURCES RESEARCH CENTER

Patrick Brezonik, Director, Rm 302, 1518 Cleveland Ave. N., St. Paul, MN 55108; 624-9282

The Water Resources Research Center (WRRC) was established in the Graduate School in 1964. The center has responsibility for promoting water resources research at the University of Minnesota and at state and private colleges with funds provided by the Federal Water Resources Research Act of 1964 (most recently re-authorized in 1984). The WRRC also promotes coordination and cooperation among the water research programs of University departments and centers and state and federal agencies throughout the state. The WRRC supports water research activities of faculty primarily through an open competitive grant proposal mechanism. Both fundamental and applied research is supported on physical, biological, economic, social, and political aspects of water resources. Projects generally are related to pressing water issues in the state, such as groundwater contamination, effects of atmospheric contaminants on surface waters, nonpoint source pollution, and impacts of climate change on Minnesota's water resources. Training of scientists for work in water resources fields is an important function of the WRRC. The majority of funds on most projects awarded by the Center are used directly for graduate research assistantships and/or for undergraduate support. In addition, some opportunities exist for student employment on projects conducted directly by the Center.

The center assists in recruiting students and in guiding them into appropriate programs of study. The center has been helpful in developing new courses in various areas of water resources and a new graduate minor program in water resources.

The WRRC publishes and distributes a quarterly newsletter called *Minnegram* as well as other informative publications to people throughout the state. The results of research projects are published in technical reports and theses, which the center distributes to scientists and water managers throughout the state and nation. To provide an opportunity for professional people and students working in water resources fields to meet and exchange information, the WRRC organizes and sponsors symposia and conferences on specific water issues. In addition, in cooperation with the Minnesota Environmental Quality Board and other state agencies, the Center sponsors a biannual conference on water resources issues and problems in the state.

LIBRARIES

UNIVERSITY LIBRARIES—TWIN CITIES

The research collections that support the courses and programs in the environment are found throughout the nineteen libraries which comprise the University Libraries. The six major library units and their respective environmentally-related collections are:

Bio-Medical Library—East Bank (Diehl Hall)

Contains environmentally-related materials in the fields of health sciences, including microbiology, pharmacology, environmental health, and genetics.

Humanities and Social Sciences—East Bank (Walter Library)

Contains environmentally-related collections in education, sport, recreation and psychology.

Humanities and Social Sciences—West Bank (Wilson Library)

Contains environmentally-related collections in a broad range of social sciences and humanities, including economics, political science, sociology, anthropology, philosophy, and history. The Map Library and the Business Reference Service are also located in Wilson. The Government Publications Library (409 Wilson Library) serves as the official U.S. Regional Depository for the State of Minnesota. It houses all federal depository documents and also has holdings of non-depository federal, municipal, and regional documents, with emphasis on the Twin Cities area.

Law Library—West Bank (Law Building)

Contains environmental law materials.

St. Paul Libraries—St. Paul Campus

Besides the St. Paul Central Library with its collections on agriculture and home economics, five libraries on the St. Paul Campus contain environmentally-related material in the fields of biochemistry, forestry, wildlife, vegetation, and veterinary medicine. These libraries are:

Biochemistry Library	(406 Biological Sciences Center)
Entomology, Fisheries and Wildlife Library	(375 Hodson Hall)
Forestry Library	(203 Green Hall)
Plant Pathology Library	(395 Borlaug Hall)
Veterinary Medical Library	(450 Veterinary Science)
Science and Technology/East Bank	(Walter Library)

Collections on chemistry, engineering, geology, mines and metallurgy, and physics contain environmentally-related information ranging from urban design to water pollution to environmental geology. There is a separate Architecture Library (160 Architecture).

In addition to strong collections, the University Libraries offer a full range of reference and research services including specialized reference assistance and computerized data base literature searching. Inquire at any library.

NON-UNIVERSITY LIBRARIES

Environmental Conservation Library (ECOL)

Bill Johnston, Librarian, Minneapolis Public Library, 300 Nicollet Mall, Minneapolis, MN 55401; 372-6570

ECOL, a special collection within the Minneapolis Public Library, brings together materials from various subject fields that relate to the physical, environmental, and human impact on planet earth. ECOL has books, periodicals, newsletters, pamphlets, bibliographies, posters, and government documents relating to such topics as air and water pollution, solid waste, wildlife, conservation of natural resources, land use planning, environmental law, energy resources, and environmental education. ECOL was designated by the Minnesota Legislature as a state center for environmental information and receives publications of many state agencies, including environmental impact statements. ECOL serves as the local public document room for U.S. Nuclear Regulatory Commission materials relating to nuclear power plants in Minnesota. A newsletter, *ECOL News*, is published twice a year and is free to the public.

A large collection of full documents and articles on microfiche are available for use and loan. Entitled Envirofiche, they are keyed to the abstract journal *Environment Abstracts*.

Minnesota Department of Health Library

Diane Jordan, Librarian, 717 Delaware Street S.E., Minneapolis, MN 55440; 623-5090

This collection has been developed with the needs of public health professionals in mind and is a specialized library with technical, as opposed to popular, literature. It is a reference collection only and extends no loan privileges except through interlibrary loan. The library subscribes to some 200 periodicals.

Minnesota Department of Public Service Library, Energy Division (formerly Minnesota Energy and Economic Development Library)

Galina Mogilyansky, Librarian, 900 American Center Building, 150 East Kellogg Boulevard, St. Paul, MN 55101; 296-7952

This research library has a noncirculating collection, although some items may be borrowed through the MINITEX system. The collection contains United States and Minnesota statistics of energy use, Department of Energy reports, and approximately 100 periodicals. There is strong emphasis on energy conservation reports. The library has environmental information on electric power, nuclear power, solar energy, and coal development.

The library also has a collection on economic development issues including trade, high technology, and location of industry, with materials discussing Minnesota and U.S. business conditions.

Minnesota Pollution Control Agency Library

Kathy Malec and Helena Peskova, Librarians, 520 Lafayette Road, St. Paul, MN 55155; 296-7719 or 296-6623

This collection has been developed with the needs of professional pollution control engineers in mind. It is essentially a technical library with few subprofessional materials. The library extends reference services.