

982. Investment Theory
Spring of even-numbered years. 3(3-0)
P: FI 980. R: Open only to Ph.D. students in Business. Market efficiency, stochastic processes, option pricing, efficient set mathematics, intertemporal asset pricing and arbitrage pricing theory.

993. Finance Workshop
Fall. 3(3-0)
P: FI 980. R: Open only to Ph.D. students in Finance. Critical evaluation of original research papers by faculty and students.

999. Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course.
R: Open only to Ph.D. students in Finance and Insurance.

FISHERIES AND WILDLIFE FW

Department of Fisheries and Wildlife College of Agriculture and Natural Resources

100. Introduction to Fisheries and Wildlife
Fall. 1(1-0)

R: Open only to freshmen or sophomores. Fisheries and wildlife history, philosophy and management in the context of conservation ethics.

110. Conservation and Management of Marine Resources
Spring. 3(3-0)

Marine environment, resource distribution, and human impacts on selected marine commercial fisheries. Conflicts in management goals between government and industry. Management goals and techniques in preserving and conserving marine resource biodiversity.

203. Resource Ecology
Fall, Spring. 3(3-0)

Basic concepts of ecology which provide a foundation for examining environmental problems and their solutions.

205. Principles of Fisheries and Wildlife Management
Spring. 3(3-0)

Characteristics of the fish and wildlife resource. Ecological and societal factors influencing the management of fish and wildlife. Management techniques.

207. Great Lakes: Biology and Management
Fall. 3(3-0) Interdepartmental with Resource Development.

Living aquatic resources of the Great Lakes: environmental history, biological resources and their management. Policy issues.

211. Introduction to Gender and Environmental Issues
Spring. 3(3-0) Interdepartmental with Resource Development, Women's Studies, Forestry, and Public Resource Management.

R: Not open to freshmen. The concept of gender. Overview of environment and habitat. Historical gender roles in environmental management. Gender-based theoretical perspectives. Case studies on developing and developed countries. Environmental management with emphasis on fisheries, wildlife and wetlands. Women environmental professionals.

275. Seafood Systems Management
Spring. 3(3-0) Interdepartmental with Food Science and Animal Science.

Domestic and international perspectives on major aquatic foods. Cultural and nutritional value; wild harvest; aquaculture; processing technology; food handling and food safety.

284. Natural History and Conservation in Michigan
Fall. 3(2-3)

R: Not open to freshmen. Identification, habitat requirements, and distribution of Michigan's flora and fauna. Interrelationships which influence natural resource use. Field trips required.

324. Wildlife Biometry
Spring. 3(2-3)

P: MTH 116, ZOL 355. Quantitative techniques to analyze and interpret fisheries and wildlife data.

326. Introduction to Waste Management
Fall. 3(3-0) Interdepartmental with Resource Development. Administered by Resource Development.
P: RD 200, RD 320.

Waste management definitions, techniques, technologies, and strategies. Integrative approach to waste management as an environmental, social, and political subject.

328. Vertebrate Pest Control
Spring. 3(3-0)

P: BS 110. Role of vertebrate animals as agents damaging to human interests. Damage evaluation. Damage control strategies and techniques.

364. Ecosystem Processes
Spring. 3(2-2)

P: CEM 141, FW 324. Concepts of ecosystem structure and function developed from basic scientific laws and relationships.

369. Introduction to Zoo and Aquarium Science
Spring. 3 credits. Interdepartmental with Zoology, Landscape Architecture, and Veterinary Medicine. Administered by Zoology.

P: BS 110. Fundamentals of zoo and aquarium operations including research, interpretation, design, nutrition, captive breeding, conservation, ethics and management.

410. Upland Ecosystem Management
Spring. 4(3-3)

P: FOR 404 or ZOL 250. Analysis and management of upland ecosystems to meet wildlife management and biodiversity objectives. Mitigation of human impact.

412. Wetland Ecosystem Management
Fall. 3(3-0)

P: FW 364 or ZOL 250. R: Completion of Tier I writing requirement. Ecosystem components and processes applied to wetland management. Mitigation of human impact.

413. Wildlife Research and Management Techniques
Fall. 4(2-4)

P: FW 324 C; FW 412 or FW 410 or concurrently or approval of department. concurrently. R: Open only to juniors or seniors or graduate students in the Fisheries and Wildlife major.

Field and laboratory techniques used in collecting, analyzing, and communicating data on wild animal populations and their habitats. Field trip required.

419. Geographical Information Systems in Natural Resource Management

Spring. 4(2-4) Interdepartmental with Geography; Forestry; Resource Development; Biosystems Engineering; and Park, Recreation and Tourism Resources.

P: GEO 221. The application of geographic information systems, remote sensing, and global positioning systems to integrated planning and management for fish, wildlife, and related resources.

420. Stream Ecology

Fall. 3(3-0) Interdepartmental with Zoology.

P: BS 110, CEM 141, ZOL 355. Biological and environmental factors determining structure and function of stream ecosystems.

424. Population Analysis and Management
Fall. 4(3-3)

P: FW 364. Statistical, ecological and management concepts and methods needed to analyze and interpret demographic data and manage fish and wildlife populations.

431. Comparative Limnology

Summer. 4 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Zoology, and Botany and Plant Pathology. Administered by Zoology.

P: CEM 141 or CEM 151; ZOL 250. R: Not open to students with credit in FW 472.

Physical, chemical, and biological aspects of lakes and streams. Introduction to freshwater biology, and population and community ecology.

434. Human Dimensions of Fisheries and Wildlife Management
Spring. 3(3-0)

P: FW 324. R: Not open to freshmen and sophomores. Completion of Tier I writing requirement. Sociological implications of public policy and planning processes in fisheries and wildlife management resources.

444. Conservation Biology

Fall. 3(3-0) Interdepartmental with Zoology.

P: BS 110. R: Completion of Tier I writing requirement. Ecological theories and methodologies to manage species, communities and genetic diversity on a local and global scale.

462. Invertebrate Fisheries and Wildlife Management
Spring. 4(3-3)

P: ZOL 355. Natural history, conservation and management of selected invertebrate species including commercially important, exotic, non-game, and selected threatened and endangered species.

464. Natural Resource Economics and Social Science (W)

Fall. 3 credits. Interdepartmental with Forestry; Park, Recreation and Tourism Resources; and Resource Development. Administered by Forestry.

P: EC 201 or EC 202. R: Not open to freshmen and sophomores. Completion of Tier I writing requirement. Application of economic and social science principles and techniques to production and consumption of natural resources. Benefit-cost analysis. Regional impact analysis. Social impact assessment.

465. Ecological Risk Assessment

Spring. 3(3-0) Interdepartmental with Resource Development.

P: CEM 143, CEM 161, ZOL 355; FW 324 or STT 200 or STT 201.

Ecotoxicology. Monitoring and modeling the fate of toxins in ecosystems. Dose response relationships. State and federal regulations related to environmental contaminants.

**Descriptions — Fisheries and Wildlife
of
Courses**

- 466. Natural Resources Planning and Policy**
Spring. 3 credits. Interdepartmental with Forestry; Park, Recreation and Tourism Resources; and Resource Development. Administered by Forestry.
R: Open only to seniors and graduate students in Forestry; Fisheries and Wildlife; Park, Recreation and Tourism Resources; and Resource Development. Approval of department; application required.
Scientific, environmental, social, and institutional factors affecting planning and policy-making. Focus on ecosystem-based planning and policy issues through development of a multiple-use plan. Case studies.
- 471. Ichthyology**
Fall. 4(3-3)
P: ZOL 328. R: Completion of Tier I writing requirement.
Fish morphology, physiology. Development, behavior, evolution and ecology. World fishes with emphasis on freshwater fishes.
- 472. Limnology**
Fall. 3(3-0) Interdepartmental with Zoology.
P: CEM 141, ZOL 250. R: Not open to students with credit in ZOL 431.
Ecology of lakes with emphasis on interacting physical, chemical, and biological factors affecting their structure and function.
- 474. Fishery and Limnological Techniques**
Fall. 3(1-6) Interdepartmental with Zoology.
P: FW 472 or concurrently.
Field and laboratory investigations of physical, chemical, and biological parameters of lakes and streams. Field trips required.
- 475. Aquaculture**
Spring. 3(3-0)
P: ANS 313 or FW 364 or ZOL 250.
Propagation and rearing of aquatic organisms used for food, bait and recreational fisheries management. Culture principles and techniques for important aquatic species. Commercial potential.
- 477. Pest Management I: Pesticides in Management Systems**
Fall. 3(3-0) Interdepartmental with Entomology, Horticulture, and Crop and Soil Sciences. Administered by Entomology.
P: CEM 143; BOT 405 or CSS 402, ENT 404 or ENT 470 or FW 328.
Chemistry, efficient use, and environmental fate of pesticides. Legal and social aspects of pesticide use.
- 478. Pest Management II: Biological Components of Management Systems (W)**
Spring of odd-numbered years. 3 credits. Interdepartmental with Entomology, Horticulture, Crop and Soil Sciences, and Forestry. Administered by Entomology.
P: ENT 404 or ENT 470 or BOT 405 or CSS 402 or FW 328. R: Completion of Tier I writing requirement.
Principles of host plant resistance and biological control and their relationship to the design of agroecosystems. Classification of insect biological control agents.
- 479. Fisheries Management**
Spring. 3(2-2)
P: FW 424, FW 471, FW 474.
Manipulation of aquatic populations and their habitats to achieve societal goals for fishery resources. Management of human impact and biotic diversity.
- 484. Environmental Education**
Spring. 3(3-0)
P: AEE 101 or PRR 320 or RD 201 or TE 150. R: Not open to freshmen and sophomores.
Methods, materials and theory for teaching environmental education in formal and nonformal educational settings.
- 489. Capstone: Seminar in Zoo and Aquarium Science**
Fall, Spring. 1 credit. A student may earn a maximum of 3 credits in all enrollments for this course. Interdepartmental with Zoology and Park, Recreation and Tourism Resources. Administered by Zoology.
R: Approval of department.
Scientific writing and oral presentations related to zoo and aquarium studies.
- 490. Independent Study in Fisheries and Wildlife**
Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course.
P: BS 110. R: Not open to freshmen and sophomores. Approval of department; application required.
Supervised individual research and study in fisheries and wildlife.
- 491. Special Topics in Fisheries and Wildlife**
Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course.
R: Not open to freshmen and sophomores. Approval of department; application required.
Selected topics of current interest and importance in fisheries and wildlife.
- 498. Capstone: Internship in Zoo and Aquarium Science**
Fall, Spring, Summer. 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. Interdepartmental with Zoology and Landscape Architecture. Administered by Zoology.
R: Open only to juniors or seniors. Approval of department.
Experience in applying zoological experience in a zoo or aquarium setting outside the university.
- 810. Human Dimensions Research in Fisheries and Wildlife**
Fall of even-numbered years. 3(3-0)
Methods of surveying, educating and involving the public to achieve fish and wildlife management goals. Review of human dimensions research and current case studies.
- 811. Fisheries and Wildlife Laws and Regulation**
Fall of odd-numbered years. 3(3-0)
R: Open only to graduate students or to seniors with approval of department.
Legal and regulatory systems related to fisheries and wildlife management. State, federal and international laws, policies and agencies. Nongovernmental organizations. Conservation of biodiversity and endangered species.
- 814. Environmental Chemodynamics**
Spring of even-numbered years. 4(4-0)
Chemical and environmental factors controlling the distribution of organic and inorganic chemicals in air, water and soil. Monitoring.
- 817. Ecology and Evolution in Aquatic Systems**
Summer. 4 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Zoology, and Botany and Plant Pathology. Administered by Zoology.
P: ZOL 250 or ZOL 431.
Experimental field studies of population and community ecology of freshwater lakes and streams. Emphasis on interactions among species and between biotic and abiotic factors.
- 824. Analysis of Wildlife Populations**
Spring of even-numbered years. 3(2-3)
Statistical and ecological concepts, methods and computer techniques needed to analyze and interpret demographic data from fish and wildlife studies.
- 826. Ecology and Management of Waterfowl**
Fall of even-numbered years. 3(2-3)
P: FW 412, FW 424.
Physiological, behavioral, and population characteristics of waterfowl. Current issues and management.
- 828. Conservation and Genetics**
Fall of odd-numbered years. 3(3-0)
P: ZOL 341 or CSS 350 or ANS 314.
Population genetic principles applied to ecology and management of fish and wildlife.
- 831. Aquatic Toxicology**
Spring of odd-numbered years. 4(3-2)
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, Human Medicine, Natural Science, Osteopathic Medicine, and Veterinary Medicine.
Techniques for assessing acute and chronic effects of toxicants on biochemical, physiological, organismal, population, community and ecosystem levels of organization.
- 852. Systems Modeling and Simulation**
Fall of even-numbered years. 3(3-0) Interdepartmental with Forestry, Resource Development, and Biosystems Engineering.
P: STT 422 or STT 442 or STT 464 or GEO 463.
General systems theory and concepts. Modeling and simulation methods. Applications of systems approach and techniques to natural resource management, and to ecological and agricultural research.
- 853. Applied Systems Modeling and Simulation for Natural Resource Management**
Spring of odd-numbered years. 3(2-2) Interdepartmental with Forestry, Resource Development, Biosystems Engineering, and Zoology.
P: FW 820 or BE 486 or ZOL 851 or approval of department. R: Open only to seniors and graduate students.
Mathematical models for evaluating resource management strategies. Stochastic and deterministic simulation for optimization. System control structures. Team modelling approach.
- 860. Wildlife Nutrition**
Fall of odd-numbered years. 3(2-2)
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, and Natural Science.
Nutritional ecology of wild species. Techniques for analyzing and improving nutritional qualities.
- 872. Fishery Habitat Analysis and Management**
Spring of odd-numbered years. 3(3-0)
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, and Natural Science.
Fish habitat use. Analysis and manipulation of habitats to enhance fish production in freshwater ecosystems.
- 875. Advanced Aquaculture**
Fall of odd-numbered years. 3(3-0)
P: FW 475. R: Open only to seniors and graduate students.
Adaptations and responses of aquatic organisms to environmental change in aquaculture systems. Research methods and applications for aquaculture planning and management decisions.

876. Applied Limnology
Spring of even-numbered years. 3(3-0)
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, and Natural Science.
 Applied aquatic ecology. Quantitative relationships between physical, chemical, and biological parameters in polluted and unpolluted lakes.

877. Fish Population Dynamics
Fall of even-numbered years. 3(2-2)
R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Natural Science.
 Quantitative analysis of fish populations. Evaluation, causes, and impacts of the rates of change in survival, growth, reproduction, and recruitment for fish populations and their yield.

878. Dynamics of Trace Contaminants in Aquatic Systems
Spring of even-numbered years. 3(3-0)
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, Human Medicine, Natural Science, Osteopathic Medicine, and Veterinary Medicine.
 Chemical and environmental parameters controlling movement and disposition of trace contaminants in aquatic environments. Fate models.

879. Advanced Limnology
Spring of odd-numbered years. 3(3-0)
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, and Natural Science.
 Physical, chemical, and biological processes affecting productivity of aquatic ecosystems.

891. Advanced Topics
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 10 credits in all enrollments for this course.
 In depth study of advanced topics in fisheries and wildlife.

892. Biodiversity
Spring. 2(2-0) A student may earn a maximum of 4 credits in all enrollments for this course. Interdepartmental with Zoology. Administered by Zoology. P: ZOL 250.
 Status of world biota and factors in the decline and extinction of major groups of plants and animals. Theory and design of natural reserves. Assessment and ecological meaning of diversity. Management for global and local diversity.

893. Seminar in Fisheries and Wildlife
Fall, Spring. 1(1-0) A student may earn a maximum of 7 credits in all enrollments for this course.
 Study and research in advanced problems and current development in fisheries and wildlife.

897. Community and Ecosystem Ecology
Spring. 4(4-0) Interdepartmental with Zoology, and Botany and Plant Pathology. Administered by Zoology.
 Structure and function of natural communities and ecosystems. Community analysis along environmental gradients. Succession, food web analysis, energy flow, nutrient cycling, and effects of human activities on ecosystems.

898. Master's Research
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 10 credits in all enrollments for this course.
R: Open only to graduate students in Fisheries and Wildlife.
 Master's degree Plan B research paper.

899. Master's Thesis Research
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 99 credits in all enrollments for this course.
R: Open only to graduate students in Fisheries and Wildlife.

943. Techniques of Analyzing Unbalanced Research Data
Spring. 4(4-0) Interdepartmental with Animal Science, Forestry, Crop and Soil Sciences, and Horticulture. Administered by Animal Science.
P: STT 464. R: Open only to graduate students in the College of Agriculture and Natural Resources.
 Linear model techniques to analyze research data characterized by missing and unequal number of observations in classes. Simultaneous consideration of multiple factors. Estimable comparisons. Hypothesis testing. Computational strategies. Variance and covariance components. Breeding values.

976. Multivariate Methods in Agriculture and Natural Resources
Spring. 4(4-0) Interdepartmental with Forestry and Animal Science. Administered by Forestry.
P: STT 422, MTH 314. R: Open only to graduate students in the College of Agriculture and Natural Resources and in the Interdepartmental Graduate Specializations in Ecology and Evolutionary Biology.
 Application of multivariate methods to research problems. Hotelling's T-test, profile analysis, discriminant analysis, canonical correlation, principal components, principal coordinates, correspondence analysis, and cluster analysis.

999. Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course.
R: Open only to Doctoral level graduate students in Fisheries and Wildlife.

FOOD ENGINEERING FE

**Department of Agricultural Engineering
 College of Agriculture and Natural Resources
 College of Engineering**

329. Fundamentals of Food Engineering
Spring. 3(3-0) Interdepartmental with Food Science.
P: FSC 211, MTH 124, PHY 231. R: Not open to freshmen and sophomores.
 Unit operations in food industry: fluid mechanics, heat transfer, rate processes, refrigeration, freezing, and dehydration. Thermal process calculations.

FOOD SCIENCE FSC

**Department of Food Science and Human Nutrition
 College of Agriculture and Natural Resources
 College of Human Ecology**

150. Introduction to Nutrition and Food Science
Fall, Spring, Summer. 3(3-0) Interdepartmental with Human Nutrition and Foods. Administered by Human Nutrition and Foods.
 Nutrition needs in life stages from a human ecological perspective. Domestic and international factors affecting the availability of a safe, nutritious food supply. Relationships of food choices to health and disease.

211. Principles of Food Science
Fall. 3(3-0)
P: CEM 141.
 Scientific principles, historical perspective and current status of technology related to food composition, safety, toxicology, processing, preservation and distribution.

275. Seafood Systems Management
Spring. 3(3-0) Interdepartmental with Animal Science and Fisheries and Wildlife. Administered by Fisheries and Wildlife.
 Domestic and international perspectives on major aquatic foods. Cultural and nutritional value; wild harvest; aquaculture; processing technology; food handling and food safety.

329. Fundamentals of Food Engineering
Spring. 3(3-0) Interdepartmental with Food Engineering. Administered by Food Engineering.
P: FSC 211, MTH 124, PHY 231. R: Not open to freshmen and sophomores.
 Unit operations in food industry: fluid mechanics, heat transfer, rate processes, refrigeration, freezing, and dehydration. Thermal process calculations.

330. Food Processing: Fruits and Vegetables
Fall. 2(3-3)
P: MTH 116, FSC 211. R: Not open to freshmen.
 Fruit and vegetable composition and quality indices. Harvest and post harvest technology. Preservation systems: canning, freezing and specialized techniques. Offered first half of semester.

331. Food Processing: Cereals
Fall. 2(3-3)
P: MTH 116, FSC 211. R: Not open to freshmen.
 Classification and composition of cereals. Milling processes. Cereal product manufacture. Offered second half of semester.

332. Food Processing: Dairy Foods
Spring. 2(1-3)
P: MTH 116, FSC 211. R: Not open to freshmen.
 Fluid milk. Principles and technology in manufacturing dairy products. Marketing, distribution and regulations of dairy foods. Offered first half of semester.

333. Food Processing: Meat, Poultry and Fishery Products
Spring. 2(1-3)
P: FSC 211, MTH 116. R: Not open to freshmen.
 Manufacturing practices and principles of fresh, frozen, and cured meats, eggs, and processed products. Product formulation and quality control. Offered second half of semester.

401. Food Chemistry
Fall. 3(3-0)
P: FSC 211, CEM 251. R: Not open to freshmen and sophomores. Not open to students with credit in HNF 300.
 Organic and biological reactions of food constituents. Chemical changes in foods during processing and storage affecting texture, color, flavor, stability and nutritive qualities.

402. Food Chemistry Laboratory
Fall. 1 credit.
P: FSC 401 or concurrently. R: Open only to majors in Food Science, Foods: Technology and Management, and Food Engineering. Completion of Tier 1 writing requirement.
 Chemical changes in food constituents which affect stability of food products and properties such as color, flavor and texture.