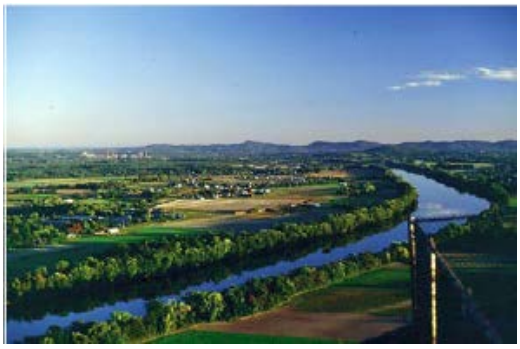
Environmental Conservation Graduate Program
Water, Wetlands and Watersheds Concentration

A. Concentration Description

This concentration leads to both Master of Science (MS) and Doctor of Philosophy (PhD) degrees in Environmental Conservation (ECo) and is designed for students who want scientific training in the multi-disciplinary field of water, wetlands and watershed conservation. The focus of this concentration is broadly on water resources but encompasses specialized training in fields such as wetlands, hydrology, nonpoint source pollution, modeling, ecosystems, water resource management, watershed sciences, economics, climatic impacts, and water-related policy. There are many options for specialized training within this concentration. For example, students may choose to specialize in *wetlands*, where they will gain an understanding of wetland ecology, including hydrology, soils, plants, and wildlife; field methods for wetland delineation and functional assessment; and public policy relating to state and federal wetland regulatory programs. Or, for example, students may choose to specialize in *watershed science and management*, where they will gain an understanding of the science underlying a watershed system and develop technical skills in integrated watershed management. More specifically, students will develop a comprehensive under-standing of the interrelated components of watersheds, including: land cover, hydrology, terrestrial and aquatic ecosystems, socioeconomic processes, pollutant transfer, institutions, communities, and economic growth.



ECo students often conduct research on watersheds, such as this socio-economic and hydrologic study of the Connecticut River

ECo students often conduct research on wetland ecology, such as this study of biodiversity in forested wetlands.

Faculty affiliated with this concentration (see below) have expertise in watershed science, hydrology, water resource management, water economics, wetland delineation, wetland ecology and conservation, modeling and GIS, water quality, forest and wetland hydrology, inland and coastal resources, marine issues, spatial analysis, water policy, aquatic biodiversity, watershed conservation, climate change, land use hydrology, and ecohydrology. A major strength of our program is the unique convergence of Universities, federal and state agencies with water resources focus, which is unmatched in the Northeast. A series of cooperative agreements, memoranda of research understanding and sole-source vendor relationships with state and federal agencies provide a strong base of research funding. These agreements also provide important teaching and research relationships between our program and state and federal natural resource agencies.

ECo students often conduct research on soils, such as this study of hydric soils in forested wetlands.

The research emphasis in this concentration focuses broadly on wetland and watershed science, landuse and hydrology, spatial analysis and remote sensing, climate change impacts, and water resource policy. Wetland research focuses on wetland ecology and biodiversity, functional assessment, remote sensing and mapping, and public policy relating to state and federal wetland regulatory programs. Watershed research focuses on watershed and landscape ecology, ecohydrology, modeling, ecological economics, and resource policy. Landuse and hydrology research focuses on water supply and allocation, water quality management, aquatic toxicology and bioremediation, stormwater management, spatial modeling, and water markets. Through their research projects, graduate students often employ or provide volunteer opportunities for interested undergraduates. Graduate students are encouraged to participate in projects and activities of their colleagues to broaden their experience and to provide and receive ideas and suggestions for improvements.

ECo students often conduct research on climate change impacts, such as this study on desertification in India.

At the MS level, students have the option of pursuing either a professional degree or thesis degree. The *thesis/dissertation degree* leads to the MS or PhD degree and centers on the completion of a major independent research project in addition to a rigorous coursework requirement. The *professional degree* leads to the MS degree and centers around a professional paper based on an internship/practicum that relates to problem-solving in this concentration, in addition to a more substantial coursework requirement. Both degree options provide students a strong foundation in three core topic areas: *environmental science* (biology, ecology, conservation and environmental building systems), 2) *quantitative science* (statistics, GIS and modeling), and 3) *human dimensions* (environmental policies, economics, politics, administration, management and values). The MS thesis degree is intended to prepare students for the option of pursuing a PhD or a career

in conservation science. The MS professional degree is meant to be a terminal degree for students seeking graduate-level training in a field of study and a career as a professional conservation scientist. Overall, the academic requirements of this concentration in combination with the research/practicum experience provide students the professional training for conservation science positions within academia, state and federal resource management agencies, non-governmental conservation organizations, and private industry (e.g., environmental consulting firms). In addition, MS thesis degree students completing this program are well prepared to meet the challenges of any PhD program.

ECo students often conduct research on water resource issues in other nations, such as this study on water use in Haiti.

B. The MS Professional Degree

Prerequisites

Candidates for an MS professional degree in this concentration will be admitted based on their academic training, work experience, and letters of recommendation. At a minimum, candidates will be expected to possess:

1) a Bachelor's degree in:
   - a natural resources field or environmental sciences; or
   - the biological sciences with an emphasis in ecology; or
   - any field with strong background in mathematics, applied statistics, and policy with some coursework in biological and physical sciences, and professional experience working as a natural resource professional.

Note, prerequisites exist for many of the required courses. Students are expected to have satisfied these prerequisites prior to commencing the program or in addition to the curriculum requirements outlined below.

Requirements

Students in this concentration are expected to meet all of the requirements for a MS degree in ECo, as outlined in the student handbook, including the following:

1) A minimum of 30 credits is required, 21of which must be in the major (defined broadly), 12 of which must be at the 600 level or above; up to 6 graduate credits can be transferred from previous course work from UMass or another university;
2) Successful completion of a comprehensive exam based upon the student's academic training in environmental conservation, encompassing three "core" topic areas (environmental science, quantitative science, and human dimensions) in addition to the required ECo core

courses; and
3) Successful final exam conducted by the committee.

Curriculum

Please check the SPIRE online and department's course offering sheet (https://tinyurl.com/y7pz3uu2)for the current course number listing.

1. **Required Core Courses (1 credit)** (take the following)

ECO 691A	Current research in environmental conservation (1cr)

2. **Core Topic Areas (29 credits)** (including a minimum of one 500-level or above 3-4 credit course in each core topic area below, plus a minimum of three additional courses, as approved by student's committee; note, students may take courses other than those listed here to fulfill the core topic area requirements if they are approved by the students advisory committee; course numbers are subject to change)

a. Environmental Science (take one or more of the following)

NRC 528	Forest & wetland hydrology (fall odd yrs, 3 cr)
NRC 540	Forest resource management (spr even yrs, 4 cr)
NRC 564	Wildlife habitat management (fall, 4cr)
NRC 565	Wildlife population dynamics & management (fall, 4cr)
NRC 571	Fisheries science & management (fall even yrs, 4cr)
NRC 547	Global change ecology (fall, 3cr)
NRC 590	Invasion Ecology (fall, even yrs, 3cr)
NRC 597	Aquatic ecology (spr odd yrs, 3cr)
NRC 597	Ecology of fish (spr even yrs, 4cr)
NRC 597	Watershed science & management (spr, 3cr)
NRC 597	Wetlands assessment & field techniques (spr odd yrs, 2 cr)
NRC 597	Conservation genetics (fall, 4 cr)
ECO 621	Landscape ecology (spr even yrs, 4cr)
ECO 697	Conservation biology (fall odd yrs, 3cr)
ECO 697	Diadromous fisheries ecology & conserv. (fall even yrs, 3cr)
ECO 697	Land use & watershed management (fall even yrs, 3 cr)
ECO 697	Advanced watershed management (spr even yrs, 3 cr)
ECO 697	Predator-prey interactions (fall even yrs, 3cr)
ECO 697	Urban ecology (fall, 4cr)
ECO 697	Applied conservation genetics (fall even yrs, 4cr)
ECO 697	Conservation of aquatic ecosystems (spr odd yrs, 3 cr)
ECO 720	Ecological interactions of fishes (spr odd yrs, 3cr)
ECO 757	Advanced fisheries management (tbd, 3cr)
ECO 768	Wetlands ecology & conservation (fall even yrs, 3 cr)
OEB 797	Environmental evolution (fall, 3 cr)
PLSOIL 566	Soil formation, classification & land use (spr odd yrs, 3 cr)

PLSOIL 597	Wetland plant ID & ecology (fall even yrs, 3cr)
PLSOIL 597	Wetlands delineation (fall odd yrs, 3cr)
CE-ENG 560	Hydrology (fall, 3 cr)

b. Quantitative Science (take one or more of the following)

NRC 577	Ecosystem modeling & simulation (fall odd yrs, 3cr)
NRC 587	Digital remote sensing (spr odd yrs, 3cr)
NRC 585	Introduction to GIS (both, 3cr)
ECO 632	Multivariate statistics for environmental cons. (spr odd yrs, 4cr)
ECO 592B	Readings in GIS (fall odd yrs, 3cr)
ECO 697	Cartography (Fall, 1 cr)
ECO 697	Applied Biostatistics. (spr, 4cr)
ECO 697SA	Advanced Biostatistics. (tbd, 4cr)
ECO 697	Advanced statistics for environmental cons. (fall even yrs, 4cr)
ECO 697	Analysis of environmental data - lab (fall, 2cr)
ECO 777	Advanced systems ecology (spr even yrs, 3cr)
GEO-SCI 595A	Advanced GIS (spr, 3 cr)
CE-ENG 577	Surface water quality modeling (spr, 3 cr)
CE-ENG 662	Water resources systems analysis (spr, 3 cr)
REGIONPL 625	Quantitative methods in planning (fall, 3 cr)
PLSOIL 661	Intermediate biometry (fall, 3 cr)

c. Human Dimensions (take one or more of the following courses)

NRC 590TP	Adapting to climate change (spr odd yrs, 3 cr)
NRC 597	Ecological economics & sustainability (spr odd yrs, 3 cr)
NRC 576	Water resources management and policy (fall even yrs, 3 cr)
ECO 690E	Environmental conflict & collaborative policy (spr odd years, 3 cr)
ECO 690P	Public Engagement and Communication (spr even yrs, 3 cr)
ECO 697	Federal environmental law & regulation (spr even yrs, 3cr)
ECO 697	Human dimensions of natural res. cons. (tbd, 3cr)
ECO 697	Natural resources policy & administration (tbd, 3cr)
ECO 697EC	Environmental Social Sciences (spr odd years, 1 cr)
ENVDES 574	City planning (fall, 3 cr)
GEO-SCI 666	Water resource policy (tbd, 3 cr)
POLSCI 784	Environmental policy (tbd, 3 cr)
REGIONPL 553	Resource policy & planning (spr even yrs, 3 cr)
REGIONPL 575	Environmental law & resource management (tbd, 3 cr)
RES-ECON 720	Environmental & resource economics (fall even yrs, 3 cr)
RES-ECON 721	Advanced natural resource economics (fall, 3 cr)

C. The MS Thesis Degree

Prerequisites

Candidates for an MS thesis degree in this concentration will be admitted based on their academic training, work experience, and letters of recommendation. At a minimum, candidates will be expected to possess:

1) a Bachelor's degree in:
   - a natural resources field or environmental sciences; or
   - the biological sciences with an emphasis in ecology; or
   - any field with strong background in mathematics, applied statistics, and policy with some coursework in biological and physical sciences, and professional experience working as a natural resources professional.

Note, prerequisites exist for many of the required courses. Students are expected to have satisfied these prerequisites prior to commencing the program or in addition to the curriculum requirements outlined below. To better understand specific requirements, it is very helpful to contact a prospective advisor before applying to the program.

Requirements

Students in this concentration are expected to meet <u>all</u> the requirements for an MS degree in ECo, as outlined in the student handbook, including the following:

1) A minimum of 30 credits is required, 21of which must be in the major (defined broadly), minimum of 6 of which must be at the 600 level or above, and at least 6 of which must be a thesis specific to this concentration and approved by the student's advisory committee;
2) Successful completion of a comprehensive assessment based upon the student's academic training in environmental conservation, encompassing three "core" topic areas (environmental science, quantitative science, and human dimensions) in addition to the required ECo core courses;
3) Successful final defense of the thesis; and
4) A minimum of <u>one</u> publishable-quality scientific paper resulting from the thesis research project.

Curriculum

Please check the SPIRE online and department's course offering sheet (https://tinyurl.com/y7pz3uu2)for the current course number listing.

1. **Required Core Courses (7 credits)** (take all of the following)

ECO 601	Research concepts (fall, 3cr)
ECO 602	Analysis of environmental data - lecture (fall, 3cr)
ECO 691A	Current research in environmental conservation (1cr)

2. **Core Topic Areas (17 credits)** (including a minimum of <u>one</u> 500-level or above 3-4 credit course in each core topic area below, as approved by the students advisory committee; note, students may take courses other than those listed here to fulfill the core topic area requirements if they are approved by the students advisory committee and the Graduate Concentration Coordinator; course numbers are subject to change)

a. Environmental Science (take one or more of the following)

NRC 528	Forest & wetland hydrology (fall odd yrs, 3 cr)
NRC 540	Forest resource management (spr even yrs, 4 cr)
NRC 564	Wildlife habitat management (fall, 4cr)
NRC 565	Wildlife population dynamics & management (fall, 4cr)
NRC 571	Fisheries science & management (fall even yrs, 4cr)
NRC 547	Global change ecology (fall, 3cr)
NRC 590	Invasion Ecology (fall, even yrs, 3cr)
NRC 597	Aquatic ecology (spr odd yrs, 3cr)
NRC 597	Ecology of fish (spr even yrs, 4cr)
NRC 597	Watershed science & management (spr, 3cr)
NRC 597	Wetlands assessment & field techniques (spr odd yrs, 2 cr)
NRC 597	Conservation genetics (fall, 4 cr)
ECO 621	Landscape ecology (spr even yrs, 4cr)
ECO 697	Conservation biology (fall odd yrs, 3cr)
ECO 697	Diadromous fisheries ecology & conserv. (fall even yrs, 3cr)
ECO 697	Land use & watershed management (fall even yrs, 3 cr)
ECO 697	Advanced watershed management (spr even yrs, 3 cr)
ECO 697	Predator-prey interactions (fall even yrs, 3cr)
ECO 697	Urban ecology (fall, 4cr)
ECO 697	Applied conservation genetics (fall even yrs, 4cr)
ECO 697	Conservation of aquatic ecosystems (spr odd yrs, 3 cr)
ECO 720	Ecological interactions of fishes (spr odd yrs, 3cr)
ECO 757	Advanced fisheries management (tbd, 3cr)
ECO 768	Wetlands ecology & conservation (fall even yrs, 3 cr)
OEB 797	Environmental evolution (fall, 3 cr)
PLSOIL 566	Soil formation, classification & land use (spr odd yrs, 3 cr)
PLSOIL 597	Wetland plant ID & ecology (fall even yrs, 3cr)
PLSOIL 597	Wetlands delineation (fall odd yrs, 3cr)
CE-ENG 560	Hydrology (fall, 3 cr)

b. Quantitative Science (take one or more of the following)

NRC 577	Ecosystem modeling & simulation (fall odd yrs, 3cr)
NRC 587	Digital remote sensing (spr odd yrs, 3cr)
NRC 585	Introduction to GIS (both, 3cr)
ECO 632	Multivariate statistics for environmental cons. (spr odd yrs, 4cr)
ECO 592B	Readings in GIS (fall odd yrs, 3cr)
ECO 697	Cartography (Fall, 1 cr)

ECO 697	Applied Biostatistics. (spr, 4cr)
ECO 697SA	Advanced Biostatistics. (tbd, 4cr)
ECO 697	Advanced statistics for environmental cons. (fall even yrs, 4cr)
ECO 697	Analysis of environmental data - lab (fall, 2cr)
ECO 777	Advanced systems ecology (spr even yrs, 3cr)
GEO-SCI 595A	Advanced GIS (spr, 3 cr)
CE-ENG 577	Surface water quality modeling (spr, 3 cr)
CE-ENG 662	Water resources systems analysis (spr, 3 cr)
REGIONPL 625	Quantitative methods in planning (fall, 3 cr)
PLSOIL 661	Intermediate biometry (fall, 3 cr)

c. Human Dimensions (take one or more of the following courses)

NRC 590TP	Adapting to climate change (spr odd yrs, 3 cr)
NRC 597	Ecological economics & sustainability (spr odd yrs, 3 cr)
NRC 576	Water resources management and policy (fall even yrs, 3 cr)
ECO 690E	Environmental conflict & collaborative policy (spr odd years, 3 cr)
ECO 690P	Public Engagement and Communication (spr even yrs, 3 cr)
ECO 697	Federal environmental law & regulation (spr even yrs, 3cr)
ECO 697	Human dimensions of natural res. cons. (tbd, 3cr)
ECO 697	Natural resources policy & administration (tbd, 3cr)
ECO 697EC	Environmental Social Sciences (spr odd years, 1 cr)
REGIONPL 553	Resource policy & planning (spr even yrs, 3 cr)
REGIONPL 575	Environmental law & resource management (tbd, 3 cr)
RES-ECON 720	Environmental & resource economics (fall even yrs, 3 cr)
RES-ECON 721	Advanced natural resource economics (fall, 3 cr)
GEO-SCI 666	Water resource policy (tbd, 3 cr)
POLSCI 784	Environmental policy (tbd, 3 cr)

3. Thesis (minimum 6 credits)

ECO 699	Thesis

D. The PhD Degree

Prerequisites

Candidates for a PhD degree in this concentration will be admitted based on their academic training, work experience, and letters of recommendation as evaluated by the faculty sponsor. At a minimum, candidates will be expected to possess:

1) a Bachelor's degree in:
   - a natural resources field or environmental sciences; or
   - the biological sciences with an emphasis in ecology; or

- any field with strong background in mathematics, applied statistics, and policy with some coursework in and the biological and physical sciences, and professional experience working as a natural resource professional.

*Note, students wishing to pursue a PhD with only a BS degree can choose to obtain a MS degree along the way toward completion of Ph.D. degree requirements. MS is not a requirement.

The 81,000 acre Quabbin Reservation is located just a few miles from campus.

Requirements

Students in this concentration are expected to meet all the requirements for a PhD degree in ECo, as outlined in the student handbook, including the following:

1) A minimum of 10 dissertation credits is required, based on a research project specific to this concentration and approved by the student's advisory committee; no other course credits are required other than those determined by the student's advisory committee;
2) Complete two consecutive, full time semester residency
3) Successful completion of a comprehensive exam based upon the student's academic training in environmental conservation, encompassing three "core" topic areas (environmental science, quantitative science, and human dimensions);
4) Successful final defense of the dissertation; and
5) A minimum of three publishable-quality scientific papers resulting from the dissertation research project.

E. Resources & Facilities

There are excellent opportunities for students to study water resource issues at local, regional, national, and international settings. Nearby, rivers, lakes, wetlands, and coastal areas provide excellent field opportunities to learn through interaction and research. The nearby Quabbin reservoir provides an excellent and accessible water supply system critical for the Boston metropolitan area. The Connecticut River watershed provides unique opportunities to study watershed systems and hydrology across four New England states. Faculty also conduct water resource research projects in several foreign countries in Asia, Africa and Latin America. At the university, students have access to several water and soil labs and department labs equipped with latest modeling and analysis software for conducting GIS, remote sensing, statistical analysis, and simulation experiments. The department is equipped with labs for fish analysis and conservation genetics. Two University forests (totaling 2,000 acres), the 800-acre Swift River Wildlife Management Area of the Massachusetts Division of Fisheries and Wildlife, and the 81,000-acre Quabbin Reservation of the Massachusetts Department of Conservation and Recreation offer unique field study areas close to campus. The University of Massachusetts also maintains the Nantucket Field Station and the Marine Station at Gloucester. The Conte Anadromous Fish

Research Center in Turners Falls offers excellent, modern facilities for both lab and field study of migratory fish behavior, ecology and physiology. Cooperation with the National Marine Fisheries Service allows graduate students to participate in research cruises in the Northwest Atlantic, as well as use facilities at the NMFS Woods Hole Laboratory. As members of the Five College School of Marine Science Program, students have access to research laboratories at Woods Hole and Waquoit Bay on Cape Cod. Further, concentration faculty conduct research in a variety of sites outside Massachusetts, and in water systems throughout the world.

F. Matriculation & Financial Aid

This program typically takes a full-time MS professional degree student 2-4 semesters to complete, a full-time MS thesis degree student 3-5 semesters to complete, and a full-time PhD student 8-10 semesters to complete, including the completion of a practicum/thesis/dissertation. However, some students may be able to complete the degree in less time and some take longer depending on their academic preparedness and the dictates of the practicum or thesis/dissertation research project.

Funding opportunities are limited, yet financial assistance is provided to our MS *thesis* and PhD students through teaching or research assistantships (at Graduate Employee Organization bargained wage rates), University fellowships, or hourly wages. Tuition is waived during semesters in which at least a 10-hour assistantship or fellowship is awarded, but the student is responsible for most fees. Research assistantships are available through faculty members who have grant-supported research, and many faculty only accept students if they can provide grant-supported assistantships. Limited University fellowships are awarded by the Graduate School in open competition for those (including foreign applicants) who are endorsed by the Department.

Funding opportunities are more limited for students in the MS *professional* degree option. Some teaching assistantships and University fellowships may be available, or internship institutions may be able to provide some assistance, but most professional degree students are self-funded. Again, tuition is waived during semesters in which at least a 10-hour assistantship or fellowship is awarded (or the equivalent from an internship employer), but the student is responsible for most fees.

G. Concentration Coordinator & Faculty Affiliates

The following on-campus faculty (both regular and adjuncts) and professional staff, including the Graduate Concentration Coordinator, are principally affiliated with this concentration and regularly serve in the role of the student's advisory committee chair or member and instructor for core courses; other faculty and staff are occasionally involved in this concentration. See Departmental website for information about the faculty and staff (http://eco.umass.edu/index.php/people/).

Graduate Concentration Coordinator:
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