

Department of Environmental and Forest Biology

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www.esf.edu/efb/

Programs in environmental and forest biology provide students with a firm foundation in basic biology, ecosystem dynamics and environmental science. The programs encompass a variety of interconnected disciplines concerned with living systems, and treat not only the form, function and evolution of organisms, but their life requirements, tolerances, and interactions that are central to the stewardship of renewable natural resources and the maintenance of environmental quality.

Modern society places critical importance on natural resources and the quality of our environment has greatly broadened the services that a well-trained biologist can render. The faculty are committed to meet a dynamically changing array of opportunities through coursework enriched by an active program of research and professional experiences. The undergraduate programs, offered as seven distinct majors, prepare students for employment or graduate study in a broad range of disciplines. Graduate students may develop a course of study under the guidance of a major professor and graduate committee within any of several areas of study.

The academic programs stimulate interest in the recognition and understanding of plants, animals, fungi, bacteria and protists and deal with dynamic changes in biological systems in the context of ecology, conservation, physiology, genetics and evolution.

Undergraduate Programs

The Department of Environmental and Forest Biology (EFB) offers seven undergraduate majors. Environmental biology is the broadest major and the degree program to which most students apply. The other six majors are specialized and are recommended only for students with strongly focused educational goals. They are: aquatic and fisheries science, biotechnology, conservation biology, forest health, natural history and interpretation, and wildlife science. For the first year or two the requirements of these programs are similar to those of environmental biology, and internal transfer among them is simple. Full program descriptions follow the discussions of general opportunities provided below.

Pre-health Professions

Degrees in either environmental biology or biotechnology will prepare students for admission to a variety of professional schools in health-related areas, including human and veterinary medicine. A rigorous foundation in the basic biological sciences, calculus, physics and organic chemistry is provided by the core requirements of these majors. Potential electives include certain benchmark courses that admissions committees of professional schools frequently look for, such as comparative vertebrate anatomy and animal physiology. Pre-veterinary students will find strong supporting courses and faculty interest in vertebrate biology, and pre-medical students can pursue such relevant elective subjects as microbiology and environmental toxicology. In addition, ESF students take advantage of Syracuse University's

broad array of relevant courses and the advising, counseling and resources of the Health Professions Advisory Program. Students can earn credit for a variety of internships, such as paid or volunteer work in clinics and other professional settings.

Internships

A variety of internships are available, either in the summer or academic year. These are arranged in cooperation with the student's advisor and may carry course credits under EFB 420 Internship in Environmental and Forest Biology. Agencies actively involved with the internship program include the U.S. Fish and Wildlife Service, New York State Department of Environmental Conservation, Upstate Freshwater Institute, The Nature Conservancy, the National Park Service and the U.S. Geological Survey. Internships also are commonly associated with a local zoo. Field-based internships can, with approval, count toward the three-credit field experience elective required by most EFB degree programs.

Field Experience

Field experience is a vital component of the programs in environmental and forest biology. Each student, except those in biotechnology, is required to attend a three-credit hour integrated course in field biology (EFB 202) at the Cranberry Lake Biological Station in the Adirondack Mountains, normally taken between the freshman and sophomore years. An additional three credits in a field experience elective are required, and this elective can be obtained at Cranberry Lake or through another approved field experience, either that same summer or subsequently. Students are encouraged to participate in as many field and internship experiences as possible during their college career. Additional field station courses beyond the six-credit requirement will be counted as elective credits. The college runs field programs in areas that recently have included Africa, Australia, Costa Rica, Ireland, Russia, and the Caribbean (Dominica). Additional opportunities exist in the School for Field Studies courses, which are offered around the world, as well as in many excellent programs throughout the United States. It is the student's responsibility to obtain current information on the various field stations and to work with an advisor to select courses that meet EFB program requirements and educational needs.

Cranberry Lake Biological Station (CLBS)

www.esf.edu/clbs

The Cranberry Lake Biological Station is located along the south-eastern shoreline of Cranberry Lake, the third largest body of water in the Adirondacks. Its environs are ideally suited for a biology summer program. The surrounding topography is rolling hill and lake country dotted with numerous small ponds, bogs and stream drainages. Because 80 percent of the shoreline is in state ownership, the lake remains pristine, unspoiled by recreational developments and pollution problems. Much of the original forest cover in the region was harvested a century ago; today a rich variety of community types occupies those sites as the vegetation reverts to mature forests. The remaining old-growth forests nearby also provide students with many examples of climax ecosystems, each type reflecting the particular environmental conditions controlling forest development. A wealth of wildlife parallels the variety of cover types. The area provides easy access to a wide range of additional ecosystems, ranging from bog to alpine vegetation.

Facilities include a wireless campus, four classroom-laboratories; a computer cluster; field and laboratory equipment; a dozen

power boats; dining facilities for 120; faculty quarters and cabins; an administration building; 12 cabins housing six to eight students each; a recreation hall; and several smaller, supporting buildings.

The program extends from early June through mid-August, divided into two sessions. Courses are designed to emphasize and effectively utilize the unique nature of this Adirondack setting, and typically involve daily field trips into the surrounding forest, wetland, and aquatic ecosystems.

Information about the summer program, including courses and fees, may be obtained from the Director, Cranberry Lake Biological Station, State University of New York College of Environmental Science and Forestry, Syracuse, N.Y. 13210, or on the Internet at www.esf.edu/clbs.

Bachelor of Science in Aquatic and Fisheries Science

Aquatic and fisheries science is the study of aquatic ecosystems to increase scientific understanding and to apply basic ecological principles to their management, thereby sustaining them for multiple uses. Aquatic ecosystems include wetlands, streams, lakes, estuaries and oceans. Aquatic science professionals study and manage valued natural systems for seafoods, drinking water, recreation, transportation and aesthetics. Aquatic systems and their organisms are sufficiently distinct from terrestrial systems that numerous professional organizations and scientific journals have been founded specifically to foster communication among aquatic science professionals.

At ESF, Wilford E. Dence conducted pioneering studies on aquatic systems in New York in the early 1900s. The present aquatic program at ESF builds on that early tradition with a wide array of aquatic courses. Our program has national and international recognition and includes a balance of applied and basic aquatic science. Students in our program thus have the opportunity to interact with faculty and graduate students involved with diverse studies on aquatic systems.

Undergraduate students considering a career in aquatic and fisheries science need a solid foundation of basic sciences (math, chemistry, physics, statistics) combined with a broad training in organismal biology, ecology and evolution. Upper-division courses focus more specifically on aquatic systems and fishes, including field experience, methods of assessment and principles for management. Students should broaden themselves with studies on the natural history and diversity of various animal and plant groups. Other recommended subjects include communications, ecosystem science, social and economic principles, ecological modeling, and hydrology. ESF's many field stations provide important opportunities for field-oriented studies, both for taking formal courses and for directed independent research. Practical experiences such as a senior synthesis or internship also provide an important complement to formal courses.

Career opportunities for students with a B.S. in aquatic and fisheries science are in the areas of fisheries science, wetland science, limnology, marine biology and oceanography. Jobs are with federal and state agencies, research institutions, private consulting firms and non-governmental organizations, both local and international. The better students will have opportunities to continue with graduate studies, which will broaden career options and lead to positions with greater responsibility and

higher salary. To pursue a career in research and teaching in a university, a Ph.D. is generally required.

Undergraduate Program Requirements

Required Courses (72 credits)

APM	105	Survey of Calculus and Its Applications I Meets the requirements for general education skills and knowledge area. A complete listing of ESF or Syracuse University courses that meet general education standards established by SUNY is listed in Undergraduate Education and on the Internet at www.esf.edu/catalog/GenEd.pdf	G	4
APM	391	Introduction to Probability and Statistics		3
CLL	190	Writing and the Environment (or English with a focus on writing)	G	3
CLL	290	Writing, Humanities and the Environment (or literature with a focus on writing)	G	3
EFB	101/ 102	General Biology I & Laboratory	G	4
EFB	103/ 104	General Biology II & Laboratory		4
EFB	120	The Global Environment & the Evolution of Human Society		3
EFB	132	Orientation Seminar: Environmental Biology <i>Transfer students take ESF 332 Seminar for New Transfer Students (0 credit), and take EFB 202 at their earliest opportunity.</i>		1
EFB	307/ 308	Principles of Genetics and Laboratory		4
EFB	311	Principles of Evolution		3
EFB	320	General Ecology		4
EFB	325	Cell Physiology		3
EFB	424	Limnology		3
EFB	486	Ichthyology		3
EFB	492	Senior Synthesis in Aquatic and Fisheries Science		1
FOR	207	Introduction to Economics	G	3
FCH	150/ 151	General Chemistry I and Laboratory		4
FCH	152/ 153	General Chemistry II and Laboratory		4

FCH	210	Elements of Organic Chemistry <i>FCH 221 and 222, taken together, will satisfy the requirement for organic chemistry, but should be substituted only if FCH 223/224 is also planned as elective.</i>	4
PHY	101	Major Concepts of Physics I <i>Physics I also can be satisfied by PHY 211 and PHY 221, taken together. Physics II also can be satisfied by PHY 212 and PHY 222, taken together.</i>	4
APM	106	Survey of Calculus and Its Applications II	4
PHY	102	OR Major Concepts of Physics II	4
FCH	223/ 224	OR Organic Chemistry II with laboratory	4

The summer following the first or second year, students must take:

EFB	202	Ecological Monitoring and Biodiversity Assessment	3
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Electives (54 credits)

General Education Course: American History	G	3
General Education Course: The Arts	G	3
General Education Course: Western Civilization	G	3
General Education Course: Other World Civilizations	G	3
Directed Electives		27
Open Electives		15

Total minimum credits for the degree 126 credits

Directed Electives

At least three upper-division credits must be earned in each of the following subject areas. Lists of acceptable elective courses are available in the student handbook and from the curriculum coordinator.

1. Field Experience Elective
2. Animal Structure and Function
3. Organismal Diversity (three credits from each of two categories)
4. Plants and Microbes
5. Invertebrate and Vertebrate Animals
6. Physical/Chemical Environment
7. Environmental Systems Science
8. Management
9. Analytical Tools
10. Communications

Bachelor of Science in Biotechnology

www.esf.edu/biotech

Biotechnology is the application of biological organisms, cells, or molecules to create products or services for the betterment of humans. The bachelor of science degree in biotechnology prepares students to tackle environmental, natural resource, agricultural and medical problems through training in molecular biology, cell biology, biochemistry, genetic engineering and related biological disciplines. As biotechnology is increasingly used to address such issues, it offers diverse career opportunities. The curriculum emphasizes the basic sciences with a strong foundation in biology, chemistry, calculus, and physics that prepares students for upper-level biology and chemistry courses, but encourages elective breadth in the social sciences, humanities, and environmental studies. The degree program provides sufficient breadth for a student to enter a clinical medical career, or other health profession. Students who complete this major will be qualified to enter the growing biotechnology-related job market or continue their studies in graduate or professional school.

Internships, Independent Research, and Senior Project Synthesis

The biotechnology major features a strong practical experience component. Each student is required to fulfill an internship, which could be in a local, national, or international company, medical unit, or government research laboratory. The objective of this internship is to give students experience working outside a purely academic setting. In addition, each student is required to perform one independent research project in a local, national, or international academic laboratory. The objective of the research requirement is to teach the student to develop and meet a research goal using the scientific method. During the senior year, each student is required to complete a senior project synthesis in which the results from either the internship or independent research—or both—will be organized and presented as a seminar or poster.

Undergraduate Program Requirements Required Courses (79 credits)

APM	105	Survey of Calculus and Its Applications I <i>Meets the requirements for general education skills and knowledge area. A complete listing of ESF or Syracuse University courses that meet general education standards established by SUNY is listed in Undergraduate Education and on the Internet at www.esf.edu/catalog/GenEd.pdf</i>	G	4
APM	106	Survey of Calculus and Its Applications II		4
BTC	132	Orientation Seminar: Biotechnology		1
BTC	401	Molecular Biology Techniques		3
BTC	497	Research Problem Design and Professional Development		1
BTC	498	Research Problems in Biotechnology		3

BTC	499	Senior Project Synthesis		1
CLL	190	Writing and the Environment (or English with a focus on writing)	G	3
CLL	290	Writing, Humanities and the Environment (or literature with a focus on writing)	G	3
EFB	101/2	General Biology I & Lab	G	4
EFB	103/4	General Biology II & Lab		4
EFB	303	Introductory Environmental Microbiology		4
EFB	307/308	Principles of Genetics and Laboratory		4
EFB	320	General Ecology		4
EFB	325	Cell Physiology		3
FCH	150/151	General Chemistry I and Laboratory		4
FCH	152/153	General Chemistry II and Laboratory		4
FCH	221/222	Organic Chemistry I and Laboratory		4
FCH	223/224	Organic Chemistry II and Laboratory		4
FCH	530	Biochemistry I		3
FCH	532	Biochemistry II		3
PHY	101	Major Concepts of Physics I <i>Physics I also can be satisfied by PHY 211 and PHY 221, taken together. Physics II also can be satisfied by PHY 212 and PHY 222, taken together.</i>		4
PHY	102	Major Concepts of Physics II <i>Physics I also can be satisfied by PHY 211 and PHY 221, taken together. Physics II also can be satisfied by PHY 212 and PHY 222, taken together.</i>		4

The summer following the third year, students must take:

BTC	420	Internship in Biotechnology		3
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Electives (44 credits)

General Education Course: American History	G	3
General Education Course: Social Sciences	G	3
General Education Course: The Arts	G	3
General Education Course: Western Civilization	G	3
General Education Course: Other World Civilizations	G	3

Directed Electives		9
Open Electives		20

Total minimum credits for the degree 123 credits

Directed and Open Electives

Nine credits of coursework related to biotechnology must be selected from a list of approved subjects, obtainable in the student handbook or from the curriculum coordinator. Twenty credits of open electives can be selected without subject constraints, with the help of a faculty advisor.

Bachelor of Science in Conservation Biology

Conservation biology is the application of science to conserve the earth's imperiled species and ecosystems. The field is a relatively young one that is growing rapidly in response to the biodiversity crisis, perhaps the most critical environmental issue of our time. Conservation biologists view all of nature's diversity as important and having inherent value. This diversity spans the biological hierarchy and includes variation at the level of genes, populations, communities, ecosystems, and biomes.

A focus on biological diversity and an intrinsic valuation of nature is what distinguishes conservation biology from wildlife management (with its somewhat more utilitarian perspective and a focus on populations of birds and large mammals) and from general environmental biology (with a broad focus on environmental issues). Conservation biologists seek ways to integrate biological perspectives with social, economic, legislative and political ones to achieve conservation goals.

The courses associated with this major reflect the interdisciplinary and holistic nature of conservation biology. After obtaining a foundation in basic science communication, and general education subjects, students learn the evolutionary and ecological forces that have generated the patterns of biodiversity around us, through courses in organismal biology, evolutionary and systematic biology, population biology, ecology and ecosystem science.

An introductory course in conservation biology and one in problem solving in conservation biology familiarize students with the dimensions of the current biodiversity crisis and the management tools available to mitigate for it. These, in combination with a selection of advanced courses in conservation biology, a senior synthesis and an internship or research experience in conservation biology, cover the breadth of biological, social, political, and economic aspects of the biodiversity crisis.

The program prepares students for employment in a variety of government agencies at the municipal level (for example, as land use planners), state level (such as with the New York Department of Environmental Conservation or State Heritage Programs), federal level (such as with the U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Forest Service, or National Park Service), and occasionally at the international level (such as with the United Nations Environment Programme). Many private conservation agencies such as The Nature Conservancy preferentially hire broadly trained conservation biologists. Ecological consulting firms are an increasingly important source of employment for conservation biologists. Training in conservation biology also provides a strong basis for postgraduate education and rewarding careers in research, teaching and environmental education.

Undergraduate Program Requirements

Required Courses (62 credits)

APM	105	Survey of Calculus and Its Applications I <i>Meets the requirements for general education skills and knowledge area. A complete listing of ESF or Syracuse University courses that meet general education standards established by SUNY is listed in Undergraduate Education and on the Internet at www.esf.edu/catalog/GenEd.pdf</i>	G	4
APM	391	Introduction to Probability and Statistics		3
CLL	190	Writing and the Environment (or English with a focus on writing)	G	3
CLL	290	Writing, Humanities and the Environment (or literature with a focus on writing)	G	3
EFB	101/102	General Biology I & Laboratory	G	4
EFB	103/104	General Biology II & Laboratory		4
EFB	120	The Global Environment & the Evolution of Human Society	G	3
EFB	132	Orientation Seminar: Environmental Biology <i>Transfer students take ESF 332 Seminar for New Transfer Students (0 credit), and take EFB 202 at their earliest opportunity.</i>		1
EFB	200	Physics of Life <i>Physics also can be satisfied by PHY101 or by PHY 211 and PHY 221, taken together.</i>		3
EFB	307/308	Principles of Genetics and Laboratory		4
EFB	311	Principles of Evolution		3
EFB	320	General Ecology		4
EFB	413	Introduction to Conservation Biology		3
EFB	414	Senior Synthesis in Conservation Biology		3
EFB	419	Problem Solving in Conservation Biology		3
EFB	420	Internship in Environmental and Forest Biology		3
EFB	498	OR Research Problems in Environmental and Forest Biology		
FCH	150/151	General Chemistry I and Laboratory		4

FCH	152/153	General Chemistry II and Laboratory		4
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The summer following the first or second year, students must take:

EFB	202	Ecological Monitoring and Biodiversity Assessment		3
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Electives (64 credits)

General Education Course: American History	G	3
General Education Course: The Arts	G	3
General Education Course: Western Civilization	G	3
General Education Course: Other World Civilizations	G	3
Directed Electives		30
Open Electives		22

Total minimum credits for the degree 126 credits

Directed Electives

Thirty credit hours of upper-division elective courses must be distributed among the following subject areas, as indicated. Lists of acceptable courses can be obtained from the student handbook or from the curriculum coordinator.

- Field Experience Elective (3 credits)
- Organismal Diversity (12 credits, at least one course in three of the following four categories)
- Diversity of Microorganisms
- Diversity of Plants
- Diversity of Invertebrate Animals
- Diversity of Vertebrate Animals
- Applied Conservation Biology (6 credits)
- Human Dimensions (3 credits)
- Communications and Interpretation (3 credits)
- Technical Skills (3 credits)

Bachelor of Science in Environmental Biology

The curriculum for the bachelor of science degree in environmental biology is built around a core of required courses that provides a general education, a background in the principles of biological and physical science, and an orientation to natural resources and other environmental concerns. From this common foundation, the large number of elective credits allows each student to develop a unique plan of study, with the help of an assigned advisor who is expert in the student's general area of interest. In keeping with the hands-on, field orientation of our curriculum, students also must complete six credit hours of field experience.

With appropriate electives, students who complete the degree program will meet requirements for a wide range of federal, state, municipal and private-sector positions that call for training in biological sciences. (Students interested in federal and state positions should review civil service publications and become familiar with specific course requirements early enough to make

timely elective choices.) General subject requirements for graduate study in virtually any area of biology also will be met.

Environmental biology is the broadest of the seven biology majors at ESF, covering topics from molecules to ecosystems to regional landscapes, but nearly all the courses in the specialized areas are also available as electives. Sufficient elective space exists to allow completion of a minor during the four-year program. In choosing electives, some students sample from the widest spectrum of classes in environmental biology; this is common for those wishing to enter graduate school for further, career-oriented education. Other students focus their electives to some extent, depending on their interests and their educational and career goals.

Through a joint degree program with Syracuse University, students pursuing the B.S. in environmental biology can couple a strong program in basic biological sciences with necessary education courses required to qualify for certification as biology teachers in grades 7-12 under New York regulations. See Coordinated Programs with Syracuse University.

Undergraduate Program Requirements

Required Courses (61 credits)

Courses			Credits	
APM	105	Survey of Calculus and Its Applications I <i>Meets the requirements for general education skills and knowledge area. A complete listing of ESF or Syracuse University courses that meet general education standards established by SUNY is listed in Undergraduate Education and on the Internet at www.esf.edu/catalog/GenEd.pdf</i>	G	4
APM	391	Introduction to Probability and Statistics		3
CLL	190	Writing and the Environment (or English with a focus on writing)	G	3
CLL	290	Writing, Humanities and the Environment (or literature with a focus on writing)	G	3
EFB	101/102	General Biology I & Laboratory	G	4
EFB	103/104	General Biology II & Laboratory		4
EFB	120	The Global Environment & the Evolution of Human Society	G	3
EFB	132	Orientation Seminar: <i>Environmental Biology Transfer students take ESF 332 Seminar for New Transfer Students (0 credit), and take EFB 202 at their earliest opportunity.</i>		1

EFB	200	Physics of Life <i>Physics also can be satisfied by PHY 101 or by PHY 211 and PHY 221, taken together; if elected, Physics II can be satisfied by either PHY 102 or PHY 212/222.</i>		3
EFB	307/308	Principles of Genetics and Laboratory		4
EFB	311	Principles of Evolution		3
EFB	320	General Ecology		4
EFB	325	Cell Physiology		3
FCH	150/151	General Chemistry I and Laboratory		4
FCH	152/153	General Chemistry II and Laboratory		4
FCH	210	Elements of Organic Chemistry <i>FCH 221 and 222, taken together, will satisfy the requirement for organic chemistry, but should be substituted only if FCH 223/224 is also planned as elective.</i>		4
APM	106	Survey of Calculus and Its Applications II		4
PHY	102	OR Major Concepts of Physics II		4
FCH	223/224	OR Organic Chemistry II with laboratory		4

The summer following the first or second year, students must take:

EFB	202	Ecological Monitoring and Biodiversity Assessment		3
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Electives (65 credits)

General Education Course: American History	G	3
General Education Course: The Arts	G	3
General Education Course: Western Civilization	G	3
General Education Course: Other World Civilizations	G	3
Directed Electives		25
Open Electives		28

Total minimum credits for the degree 126 credits

Directed Electives

At least 25 upper-division credits must be earned in biological coursework. Among these, the following subject distribution requirements must be met. Lists of acceptable elective courses are available in the student handbook and from the curriculum coordinator.

- Field Experience Elective (3 credits)

- Organismal Structure and Function (3 credits)
- Organismal Diversity (3 credits from each of three of the following four categories)
 - Diversity of Microorganisms
 - Diversity of Plants
 - Diversity of Invertebrate Animals
 - Diversity of Vertebrate Animals

Bachelor of Science in Forest Health

Forest health is a multidisciplinary and collaborative field of study that involves the understanding, monitoring, and protection of the world's forest resources. A solid foundation in forest health requires expertise in many disciplines including, but not limited to, plant pathology, entomology, ecology, dendrology, mycology, silviculture, and forest management. At ESF, we have provided academic training in these areas for decades, but only recently have they been merged into an academic major.

The forest health major prepares biology-oriented students for employment in positions that deal with maintaining the health of forest resources. The major is distinct from those in the Department of Forest and Natural Resources Management and its forest ecosystem science major, which provides skills and preparation in forest management. Employers today have expressed a need for a deeper understanding of the science behind the trees. Positions requiring a forest health background are found in federal and state agencies, nonprofit organizations, and the private sector. With good performance, the forest health major prepares students for graduate study in preparation for higher-level positions, such as forest pathologist, entomologist, or mycologist.

The curriculum provides a solid foundation in mathematics and the physical sciences (chemistry, physics) followed by courses focusing on forest trees and their requirements, the basic ecological principles that shape forest ecosystems, and the management of these ecosystems. Other required courses introduce students to the identification and impact of biological agents of disease and physical damage, and to the methods by which these are monitored. The flexibility of the major will permit students to pursue more intensive training in integral forest health specialties, such as forest pathology and forest entomology, or to obtain even broader knowledge in related fields such as forestry, micro-biology, mycology, conservation biology, and ecology. Field experience is an important element of the program and is integral to several required courses and many of the directed electives. Two of the requirements are field courses at the Cranberry Lake Biological Station.

Undergraduate Program Requirements

Required Courses (79 credits)

APM	391	Introduction to Probability and Statistics <i>Meets the requirements for general education skills and knowledge area. A complete listing of ESF or Syracuse University courses that meet general education standards established by SUNY is listed in Undergraduate Education and on the Internet at www.esf.edu/catalog/GenEd.pdf</i>	G	3
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CLL	190	Writing and the Environment (or English with a focus on writing)	G	3
CLL	290	Writing, Humanities and the Environment (or literature with a focus on writing)	G	3
EFB	101/2	General Biology I & Lab	G	4
EFB	103/4	General Biology II & Lab		4
EFB	120	The Global Environment & the Evolution of Human Society	G	3
EFB	132	Orientation Seminar: Environmental Biology <i>Transfer students take ESF 332 Seminar for New Transfer Students (0 credit), and take EFB 202 at their earliest opportunity.</i>		1
EFB	200	Physics of Life <i>Physics also can be satisfied by PHY 101 or by PHY 211 and PHY 221, taken together</i>		3
EFB	303	Introduction to Environmental Microbiology		4
EFB	307/308	Principles of Genetics and Laboratory		4
EFB	311	Principles of Evolution		3
EFB	320	General Ecology		4
EFB	336	Dendrology		3
EFB	340	Forest and Shade Tree Pathology		3
EFB EFB	351 352	Principles of Forest Entomology OR Elements of Entomology		3
EFB EFB	420 498	Internship in Environmental and Forest Biology OR Research Problems in Environmental and Forest Biology		3
EFB	439	Forest Health Monitoring		3
EFB	494	Senior Synthesis in Forest Health		1
FCH	150/151	General Chemistry I and Laboratory		4
FCH	152/153	General Chemistry II and Laboratory		4
FCH	210	Elements of Organic Chemistry <i>FCH 221 and 222, taken together, will satisfy the requirement for organic chemistry, but should be substituted only if FCH 223/224 is also planned as elective.</i>		4

FOR	321	Forest Ecology and Silviculture	3
FOR	345	Introduction to Soils	3

The summer following the first or second year, students must take:

EFB	202	Ecological Monitoring and Biodiversity Assessment	3
EFB	345	Forest Health (CLBS)	3

Electives (47 credits)

General Education Course: American History	G	3
General Education Course: The Arts	G	3
General Education Course: Western Civilization	G	3
General Education Course: Other World Civilizations	G	3
Directed Electives		15
Open Electives		20

Total minimum credits for the degree 126 credits

Directed Electives

Fifteen credit hours of electives related to forest health are required distributed among five (of seven) topic areas: forest protection and conservation biology; forestry/wood products; technology; ecology and environmental science; biodiversity; mathematics and physical sciences; and anatomy and physiology. A list of approved courses can be found in the student handbook or obtained from the curriculum coordinator.

Bachelor of Science in Natural History and Interpretation

Natural history is the description of nature and differs from ecology in placing less emphasis on quantification and more on careful observation. The overarching goal is to elucidate patterns and relationships in the natural world and assimilate this information into human affairs. It uses traditional and modern tools, often with an aesthetic component, to differentiate the natural world, and focuses on identification, life history, distribution, abundance and interrelationships among and between individuals, populations and species. The field has a long and distinguished history including figures such as Darwin, Wallace and E. O. Wilson who are recognized for their seminal contributions to biology and ecology. Following a meteoric rise in popularity during the 19th century, natural history declined as new experimental and quantitative approaches came to dominate biology. In recent years, however, both the recognition of the role of biology in an holistic view of the planet, and the increasing emphasis on the value of education as the key to a sustainable future, have brought about a resurgence of interest in natural history and, crucially, its interpretation. Interpretation is defined as a communications process that reveals meanings and relationships about natural, cultural, historical and recreational resources. While interpretation may be viewed as a process to communicate any subject matter, historically it has

always been linked with natural history. The methods of interpretation were forged by naturalists.

The courses associated with the undergraduate major in natural history and interpretation reflect the interdisciplinary and holistic nature of this subject area. Students become well-grounded in the natural sciences and in the skills specific to communication. This major seeks to integrate training in organismal biology, including a required field component, with in-depth training in the literature and context of natural history and a suite of environmental interpretation offerings. Students gain work experiences through an internship, where the recently acquired knowledge and skills in this arena can be applied.

The program prepares students for employment in nature centers, science museums, federal and state agencies, zoos, urban parks, arboreta and aquaria, as well as in the ecotourism industry and travel agencies that sponsor natural history opportunities, such as birding and whale watching. Training in natural history and interpretation also provides a strong basis for a rewarding career in teaching and environmental education and can act as a springboard for entry into graduate programs.

Undergraduate Program Requirements

Required Courses (68 credits)

APM	105	Survey of Calculus and Its Applications I <i>Meets the requirements for general education skills and knowledge area. A complete listing of ESF or Syracuse University courses that meet general education standards established by SUNY is listed in Undergraduate Education and on the Internet at www.esf.edu/catalog/GenEd.pdf</i>	G	4
APM	391	Introduction to Probability and Statistics		3
CLL	190	Writing and the Environment (or English with a focus on writing)	G	3
CLL	290	Writing, Humanities and the Environment (or literature with a focus on writing)	G	3
EFB	101/102	General Biology I and Laboratory	G	4
EFB	103/104	General Biology II and Laboratory		4
EFB	120	The Global Environment & the Evolution of Human Society	G	3
EFB	132	Orientation Seminar: Environmental Biology <i>Transfer students take ESF 332 Seminar for New Transfer Students (0 credit), and take EFB 202 at their earliest opportunity.</i>		1
EFB	200	Physics of Life		3
EFB	215	Interpreting Science Through Art	G	3

EFB	307/ 308	Principles of Genetics and Laboratory	4
EFB	311	Principles of Evolution	3
EFB	320	General Ecology	4
EFB	404	Natural History Museums and Modern Science	3
EFB	405	Literature of Natural History	2
EFB	406	Great Naturalist Seminar	1
EFB	416	Introduction to Environmental Interpretation	3
EFB	420	Internship in Environmental and Forest Biology	3
FOR	372	Fundamentals of Outdoor Recreation	3
FCH	150/ 151	General Chemistry I and Laboratory	4
FCH	152/ 153	General Chemistry II and Laboratory	4
PHY	101	Major Concepts of Physics I <i>Physics also can be satisfied by PHY 101 or by PHY 211 and PHY 221, taken together.</i>	4

The summer following the first or second year, students must take:

EFB	202	Ecological Monitoring and Biodiversity Assessment	3
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Electives (58 credits)

General Education Course: American History	G	3
General Education Course: Western Civilization	G	3
General Education Course: Other World Civilizations	G	3
Directed Electives		24
Open Electives		25

Total minimum credits for the degree 126

Directed Electives

Twenty-four credit hours in upper-division coursework must be distributed among the following subject areas, as indicated. Depending on category, acceptable courses are listed below or can be found in lists in the student handbook or obtained from the curriculum coordinator.

- Conservation Biology (3 credits): EFB 490 Wildlife Ecology and Management or EFB 413 Introduction to Conservation Biology
- Advanced Communication (3 credits): CLL 405 Writing for Science Professionals or LSA 300 Computer Graphics for Design Communications

- Advanced Interpretation (3 credits): EFB 417 Perspectives of Interpretive Design or EFB 521 Principles of Interpretive Programming
- Organismal Diversity (12 credits): four courses, at least one from each group
 - Diversity of Microorganisms
 - Diversity of Plants
 - Diversity of Invertebrate Animals
 - Diversity of Vertebrate Animals
- Field Experience Electives (3 credits)

Bachelor of Science in Wildlife Science

Wildlife science is the application of ecological knowledge in a manner that strikes a balance between the needs of wildlife populations and the needs of people. Research and teaching in wildlife science began at ESF in 1914, one of the first such programs in the United States, and was quickly followed by establishment of the Roosevelt Wild Life Station in 1919. Today, our program is recognized nationally and internationally, and our graduates are employed worldwide. The focus is applied wildlife ecology, and students engage the environmental challenges associated with managing wildlife, ranging from endangered species to overabundant populations. The program recognizes and accommodates the fact that wildlife scientists increasingly must deal with all forms of wildlife, including plants and invertebrates, and the scope is becoming more international.

Students obtain background in the basic sciences (math, chemistry, physics), then learn the basic ecological principles and evolutionary forces that affect wildlife and their associated habitats. Coursework then addresses the assessment and management of wildlife resources as well as the biology and natural history of various taxonomic groups. Students are advised to enhance career opportunities via taxonomic proficiency with one or more plant or animal groups, special skills such as GIS, and practical working experience as an intern, volunteer or paid employee of a conservation agency.

The program prepares students for careers with state and federal agencies as well as an array of domestic and international non-governmental organizations. Diverse job functions include management of wildlife on state, federal or private lands; inventory and assessment of wildlife populations and associated habitats; and interaction with the public to convey the value and rationale of wildlife conservation programs and initiatives. Students who excel academically will also be prepared to continue toward a graduate degree, which can greatly expand employment opportunities and is often necessary for even entry-level, career-track positions.

Undergraduates in wildlife science take advantage of ESF's field stations, which are unmatched nationally and provide myriad opportunities. These properties include the 15,000-acre Adirondack Ecological Center and the Cranberry Lake Biological Station in the Adirondacks, as well as the Heiberg Forest south of Syracuse. Many of the courses taken by wildlife science undergraduates include field exercises at these facilities, and the properties are also used for undergraduate research and other projects in which undergraduate students can become involved.

Undergraduate Program Requirements

Required Courses (71 credits)

APM	105	Survey of Calculus and Its Applications I <i>Meets the requirements for general education skills and knowledge area. A complete listing of ESF or Syracuse University courses that meet general education standards established by SUNY is listed in Undergraduate Education and on the Internet at www.esf.edu/catalog/GenEd.pdf</i>	G	4
APM	391	Introduction to Probability and Statistics		3
CLL	190	Writing and the Environment (or English with a focus on writing)	G	3
CLL	290	Writing, Humanities and the Environment (or literature with a focus on writing)	G	3
EFB	101/102	General Biology I & Laboratory	G	4
EFB	103/104	General Biology II & Laboratory		4
EFB	120	The Global Environment & the Evolution of Human Society	G	3
EFB	132	Orientation Seminar: Environmental Biology <i>Transfer students take ESF 332 Seminar for New Transfer Students (0 credit), and take EFB 202 at their earliest opportunity.</i>		1
EFB	200	Physics of Life <i>Physics also can be satisfied by PHY 101 or by PHY 211 and PHY 221, taken together.</i>		3
EFB	307/308	Principles of Genetics and Laboratory		4
EFB	311	Principles of Evolution		3
EFB	320	General Ecology		4
EFB	390	Wildlife Ecology and Management		4
EFB	462	Animal Physiology		3
EFB	491	Applied Wildlife Science		3
EFB	493	Wildlife Habitats and Populations		4
ESF	300	Introduction to Geospatial Information Systems		3
FCH	150/151	General Chemistry I and Laboratory		4
FCH	152/153	General Chemistry II and Laboratory		4
FCH	210	Elements of Organic Chemistry		4

The summer following the first or second year, students must take:

EFB	202	Ecological Monitoring and Biodiversity Assessment	3
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Electives (55 credits)

General Education Course: American History	G	3
General Education Course: The Arts	G	3
General Education Course: Western Civilization	G	3
General Education Course: Other World Civilizations	G	3
Directed Electives		18
Open Electives		25

Total minimum credits for the degree 126 credits

Directed Electives

Eighteen credits must be obtained in the following subject areas, through specified courses that are designed for juniors or seniors (i.e., courses numbered 300 or higher). Lists of acceptable courses are available from the student handbook and the curriculum coordinator. The subject areas are:

- Field Experience (3 credits)
- Vertebrate Diversity (6 credits)
- Plant Diversity (3 credits)
- Invertebrate Diversity (3 credits)
- Policy/Communications (6 credit)

Graduate Program

The graduate program in environmental and forest biology is organized in areas of study designed to provide a strong background within specific interest areas. Faculty with nationally and internationally recognized expertise define the scope of subject matter within each study area, recommend acceptance of students, and guide them through a course of study appropriate to student goals and aspirations. Most students develop a degree of depth and specialization in at least one large taxonomic group, such as plants, fungi, vertebrates, or insects.

M.S. — The master of science degree entails a research-based thesis (6-12 credits of thesis research) in addition to 18-24 credits of graduate coursework (including special research topics and at least three seminars) for a total of at least 30 graduate credits. Students earning a M.S. degree find a much wider range of job options that have greater responsibilities and pay compared to jobs that require only a B.S. degree. Many jobs at the M.S. level require an ability to perform research. Students interested in research-type positions in government, non-profit organizations, and academic and industry settings should pursue a M.S., rather than M.P.S. degree. Additionally, although not required by many graduate schools, a M.S. degree is often a key step toward earning a Ph.D. The M.S. student presents a thesis proposal to the major professor and committee who will guide completion of the research and writing of the thesis. A capstone seminar and defense of thesis are required.

M.P.S. — The master of professional studies degrees require graduate coursework credits and graduate seminars. Depending on the area of study, students may complete the M.P.S. degree

with coursework and seminars, or a combination of coursework, seminars, and professional experience (internship). The M.P.S. degree is designed to accommodate a great breadth of student goals and needs, including students desiring additional education following some experience in their field, and science teachers seeking the master's degree for permanent certification. As in all degree programs in EFB, the student will be guided through the M.P.S. by a steering committee.

Coursework Option for the following areas of study: chemical ecology, conservation biology, ecology, entomology, environmental interpretation, environmental physiology, fish and wildlife biology and management, forest pathology and mycology, or plant science and biotechnology: At least 30 of the 42 credits required must be taken in residence at ESF. Coursework in this option includes seminars (EFB 797), and a maximum of six credits earned in EFB 798, or 898. Neither a comprehensive examination nor a capstone seminar is required.

Coursework Option for the area of study in applied ecology: Coursework requirements include three credit hours each from five of the seven focus areas, two credit hours in graduate seminars (EFB 797) and additional 19 credit hours of graduate coursework for a total of 36 credit hours. Neither a comprehensive examination nor a capstone seminar is required.

Coursework Option for the area of study in biotechnology: Coursework requirements consist of 19 credit hours of core coursework including two credit hours of graduate seminars (EFB 797), nine credit hours of directed electives and eight credit hours of open electives for a total of 36 credit hours. Neither a comprehensive examination nor a capstone seminar is required.

Professional Experience Option for the following areas of study: chemical ecology, conservation biology, ecology, entomology, environmental interpretation, environmental physiology, fish and wildlife biology and management, forest pathology and mycology, or plant science and biotechnology: In addition to an internship earning 6-12 credits (EFB 898), this option requires at least 30 credits of graduate coursework, of which 24 must be taken in residence at ESF. Coursework for this option includes seminars (EFB 797) and a maximum of three credits earned in EFB 798. A written report of the internship is required as well as an oral comprehensive exam and capstone seminar. For students completing the concurrent degree program (M.P.S./M.S.) leading to certification in biology (7-12), 12 credits of student teaching and coursework will be accepted as equivalent to a professional experience.

Ph.D. — The doctor of philosophy degree may be pursued directly from the bachelor's level, or following a master's degree program. Doctoral study culminates in a dissertation (or its equivalent as refereed publications) based on original research. In many cases this work serves as a foundation for future studies and publications throughout the student's career. Research activity is often funded through extramural grants to the student's major professor. Abundant opportunities exist to gain teaching experience during the doctoral program. A written and oral examination is required to proceed to doctoral candidacy, at least one year prior to the capstone seminar and defense of the dissertation. Of the 60 credits required, 30-48 are awarded for coursework (including special research topics and at least five seminars) and 12-30 credits for the dissertation.

Facilities and Academic Setting

The center of activity for environmental and forest biology is Illick Hall, with laboratories, classrooms, growth chambers, and equipment in a modern building in which 8,000 square meters of working space is available for graduate study and research. Laboratories, many of them temperature controlled, are provided for study and research in plant development, physiology, tissue culture, molecular biology, biochemistry and toxicology, ecology and animal behavior. An herbarium, mycological collections, insect and other invertebrate collections, and the Roosevelt Wild Life Collection of vertebrates are maintained as resources for the academic program. Eight rooftop glasshouse units are important to the full array of interests in plant science and plant-animal interactions. An important catalyst for graduate studies is the Roosevelt Wild Life Station, which helps to focus teaching, research and outreach in field studies.

Students and faculty have access to a variety of sophisticated instrumentation; a computer center and many computer clusters; diverse analytical equipment and measuring devices, including automated DNA sequencer; gas-liquid chromatography; and comprehensive analytical expertise. The N.C. Brown Center for Ultrastructure Studies offers coursework and research in scanning and transmission electron microscopy.

Supportive to the program are the academic resources and courses at Syracuse University, SUNY's Upstate Medical University and the several campus facilities described elsewhere in this catalog. Our students also participate in courses and utilize faculty and facilities at Cornell University and several SUNY campuses in cooperative exchanges.

Excellent field sites and facilities are available for research in all aspects of the program. In addition to the College's several campuses and field stations that offer a broad diversity of forest types, sites and conditions, there are New York state Department of Environmental Conservation lands, the Montezuma National Wildlife Refuge, the Adirondack and Catskill Mountains and the transition zones near Lake Ontario, Oneida Lake and Cicero Swamp. These areas offer a variety of habitat diversity from aquatic, wetland and terrestrial zones. The ponds, streams and lakes in Central New York and the St. Lawrence River are regularly used by graduate students in aquatic ecology, fisheries biology and ecosystem science. Faculty and students have access to a broad array of boats, motors, nets and sophisticated field sampling instrumentation.

Additional academic facilities enhancing the graduate program include the Adirondack Ecological Center (www.esf.edu/aec) and the Roosevelt Wild Life Station (www.esf.edu/rwls/).

Further academic advantages stem from the urban setting of the Syracuse campus. Nearby Onondaga Lake serves as a focus for many research and teaching activities. The greater Syracuse area provides a convenient laboratory for studies basic to urban ecology: urban wildlife, the conservation of natural areas, greenspace maintenance, the ecological restoration of waste beds and other badly degraded lands and waters, and the detoxification of pollutants. Disposal of industrial and human wastes requires deeper understanding of the role of plants, animals and microorganisms in the biodegradation of organic matter. The conversion of organic materials into energy (biofuels), into additives for plant growth, or into protein feeds for domestic animals are stimulating topics.

Funding Opportunities

In addition to graduate assistantships, various awards are available to graduate students in environmental and forest biology. These include the Alexander Wetlands Award, the Betty Moore Chamberlaine Award, Henrietta and John Simeone Fellowship in Forest Entomology, the Robert L. Burgess Graduate Scholarship in Ecology, the Josiah L. Lowe – Hugh Wilcox Graduate Fellowship, the Leroy C. Stegeman Award, and the Robert Zabel Award. These awards are decided upon by a department committee selection process.

Areas of Study

Eleven areas of graduate study are available: applied ecology, conservation biology, ecology, entomology, environmental interpretation, environmental physiology, fish and wildlife biology and management, forest pathology and mycology, plant biotechnology, and plant science and biotechnology. One area, chemical ecology, is shared with the Department of Chemistry. Additional information on each of these areas of study is available by telephone, e-mail or written request to any of the professors listed. Programs that bridge two or more areas may be developed by the student and steering committee.

Applied Ecology (M.P.S)

Participating Faculty: BALDASSARRE (Wetlands, Waterfowl), BRUNNER (Infectious Diseases of Wildlife), DOVCIK (Forest Ecology, Ecosystem Management and Restoration), FARRELL (Riverine Fish Ecology, Freshwater Coastal Wetlands, Great Lakes), FIERKE (Forest Insects, Tree Defenses), FRAIR (Vertebrate and Landscape Ecology), GIBBS (Vertebrate Conservation Biology), C. HALL (Systems Ecology), HORTON (Ecology, Fungal Communities, Mycorrhizal Relationships), KIMMERER (Bryocology, Restoration Ecology), LEOPOLD (Forest and Wetland Ecology, Restoration Ecology), LIMBURG (Fish Ecology), LOMOLINO (Mammalian Diversity, Biogeography), MCGEE (Plant Ecology), MCGRATH (Aquatic Ecology), MCNULTY (Forest Ecology), MITCHELL (Biogeochemistry), NAKAS (Microbiology), NORTON (Invertebrates), PARRY (Forest Insects, Biological Control), PORTER (Vertebrate Ecology), RINGLER (Aquatic Ecology, Fish Behavior), SCHLAEPFER (Vertebrate Ecology, Reptiles and Amphibians), SCHULZ (Limnology), SHIELDS (Vertebrate Behavior), STEWART (Aquatic Ecology), TURNER (Physiological Ecology), WEIR (mycology), WHIPPS (Infectious Diseases of Fish)

This area of study in the M.P.S. degree is designed for students who desire to solidify their background in applied ecology and professionals who would return for "retooling"; suitable for careers in environmental oversight, policy, planning, law, and education. This program begins with a three-day orientation in August at one or more of the ESF field facilities. Coursework requirements include three credit hours each from five of the seven focus areas: *GIS tools*, *Statistical Tools*, *Specialty Tools*, *Ecosystem Ecology*, *Organismal Ecology*, *Human Dimensions in Ecology*, and *Communications in Ecology*; two credit hours in graduate seminars (EFB 797) and additional 19 credit hours of graduate coursework for a total of 36 credit hours. A complete list of courses in each focus area is available from the graduate program director.

Conservation Biology (M.S., M.P.S., Ph.D.)

Participating Faculty: BALDASSARRE (Wetlands, Birds, Waterfowl), BRUNNER (Amphibian Conservation), DOVCIK (Plant Ecology),

FARRELL (Riverine Fish Ecology, Freshwater Coastal Wetlands, Great Lakes), FIERKE (Forest Insects), FRAIR (Vertebrate and Landscape Ecology), GIBBS (Vertebrate Conservation Biology), C. HALL (Systems Ecology, GIS), HORTON (Ecology, Fungal Communities, Mycorrhizal Relationships), KIMMERER (Plant Restoration Ecology, Bryology), LEOPOLD (Wetlands, Restoration Ecology, Rare Species Conservation), LIMBURG (Riverine Fish and Estuarine Ecology), LOMOLINO (Mammalian Diversity, Biogeography), MCGRATH (Aquatic Ecology and Restoration), MCNULTY (Forest Ecology), NORTON (Ecology and Evolution, Invertebrates, Arachnids), PARRY (Insects, Biological Control, Invasive Species), PORTER (Wildlife Conservation, Habitat Management), POWELL (Genetic Engineering in Plant Conservation), RINGLER (Aquatic and Fisheries Restoration, Fish Ecology and Behavior), SAUNDERS (Science Education and Environmental Interpretation), SCHLAEPFER (Amphibian and Reptile Conservation and Ecology), SCHULZ (Aquatic Ecology, Plankton), SHIELDS (Conservation Theory, Genetics, Behavior in Birds and Mammals, Forensic DNA Analysis), STEWART (Tropical Fish Ecology and Systematics, Lake Systems Ecology), TEALE (Insect Behavior, Pheromones), TURNER (Physiological Ecology), UNDERWOOD (Wildlife Ecology), WEIR (Conservation Mycology), WHIPPS (Fish Conservation and Molecular Systematics)

This area entails study and maintenance of biological diversity at the level of genes, populations, communities, ecosystems and biomes; intellectual underpinnings include evolutionary theory, systematic biology, population biology and ecosystem science. Conservation biology seeks ways to integrate biological principles with social, economic and political perspectives to achieve conservation goals.

The field is a response of the scientific community to the biodiversity crisis. Conservation biologists view nature's diversity as important and having inherent value. Training in this field includes experience with the fundamental disciplines and theory of conservation biology, as well as specialization in conservation issues. Students are encouraged to explore the human dimensions of biological conservation through coursework in other departments of the college, and to acquire firsthand experience in the application of biological knowledge to problems by working for a conservation agency. Students find employment in a variety of government and private conservation agencies and in academic institutions. Many also work as administrators, policymakers, teachers and communicators. Current research areas in conservation biology include global climate change, endangered species biology, conservation genetics theory and practice, behavioral ecology, habitat fragmentation, restoration ecology, exotic species biology and control, forest and wetland ecosystem management, tropical ecology, ecological monitoring, conservation education and harvest management.

Ecology (M.S., M.P.S., Ph.D.)

Participating Faculty: BALDASSARRE (Wetlands, Waterfowl), DOVCIK (Forest Ecology, Ecosystem Management and Restoration), FARRELL (Riverine Fish Ecology, Freshwater Coastal Wetlands, Great Lakes), FIERKE (Forest Insects, Tree Defenses), FRAIR (Vertebrate and Landscape Ecology), GIBBS (Vertebrate Conservation Biology), C. HALL (Systems Ecology), HORTON (Ecology, Fungal Communities, Mycorrhizal Relationships), KIMMERER (Bryocology, Restoration Ecology), LEOPOLD (Forest and Wetland Ecology, Restoration Ecology), LIMBURG (Fish Ecology), LOMOLINO (Mammalian Diversity, Biogeography), MCGEE (Plant Ecology), MCGRATH (Aquatic Ecology), MCNULTY (Forest Ecology), MITCHELL (Biogeo-

chemistry), NAKAS (Microbiology), NORTON (Invertebrates), PARRY (Forest Insects, Biological Control), PORTER (Vertebrate Ecology), RINGLER (Aquatic Ecology, Fish Behavior), SCHLAEPFER (Vertebrate Ecology, Reptiles and Amphibians), SCHULZ (Limnology), SHIELDS (Vertebrate Behavior), STEWART (Aquatic Ecology), TURNER (Physiological Ecology), WEIR (Mycology)

This integrative study area allows students to investigate the relationships of organisms to their environment and those factors that affect their distribution and abundance. Both the practical and theoretical applications of ecology are emphasized through courses and research. There are four major areas in ecology: organismal ecology, population-evolutionary ecology, community ecology and systems ecology. In consultation with the student's steering committee, courses are chosen from these areas, as well as other disciplines. Specific research may encompass any of the four major areas of ecology and entail the study of the distribution and abundance of organisms, community structure including trophic relationships, diversity, succession and ecosystem properties, such as patterns of energy transfer and biogeochemical cycling.

Entomology (M.S., M.P.S., Ph.D.)

Participating Faculty: ABRAHAMSON (Forest Insects, Pest Management), CASTELLO (Virology, Insect Vectors), FIERKE (Forest Insects, Tree Defenses), NAKATSUGAWA (Toxicology), NORTON (Soil Arthropods, Systematics), PARRY (Forest Insects, Biological Control), RINGLER (Aquatic Entomology), TEALE (Insect Pheromones), TURNER (Physiology)

Graduate study opportunities prepare students in the basic aspects of insect life and the role of insects in relation to humans and their environment. The wide range of effects stemming from insect activity, from the beneficial to the deleterious, allows for a variety of research subjects in which insects play a major role. Thesis topics may concern insects that affect forests, shade trees and wood products, those relating to the health and well-being of humans, those playing key roles as parasites and predators of pest species, and those serving as food for many birds and vertebrate animals. Current research areas include population dynamics of forest defoliators, pheromone communications in beetles and moths, evolution of chemical communication, effects of forest practices on stream benthic insects, natural control of insects in forest systems and biochemistry of insect detoxification mechanisms.

Environmental Interpretation (M.S., M.P.S., Ph.D.)

Participating Faculty: FIERKE (Forest Entomology), LEOPOLD (Freshwater Wetlands, Forest Ecology, Rare Plants), PORTER (Wildlife Biology and Management), SAUNDERS (Wildlife Ecology, Mammalogy), TEALE (Insect Ecology, Pest Management), WEIR (Fungi and Humans)

Environmental interpretation sharpens the cutting edge of communication among scientists and various public sectors. Graduate study enables students to explore interpretation/conservation education processes through application to specific projects in the natural sciences and science education. Students pursue career pathways in natural resource agencies, in nature centers, museums, aquaria, botanical gardens and especially in the science classroom. The environmental interpretation program incorporates a 15,000-acre reserve in the heart of the Adirondack Park and an associated Visitor Interpretative Center with trail system. Internships and partnerships with a variety of conservation-based programs are vital to the program. Students

develop their course of study from a large palette of graduate courses in Environmental and Forest Biology.

Environmental Physiology (M.S., M.P.S., Ph.D.)

Participating Faculty: CASTELLO (Plant Virology), FERNANDO (Plant Developmental Biology), MITCHELL (Environmental Energetics), NAKAS (Microbial Physiology), NAKATSUGAWA (Insect and Vertebrate Toxicology), SMART (Plant Physiology), TURNER (Animal Physiology), WHIPPS (Fish Pathology)

Environmental physiology provides students with advanced training in the nature and control of biological processes. Current interests include: mechanisms of drought tolerance in plants; plant and microbial enzymology; virology; toxicity and disposition of insecticides and environmental toxicants in vertebrates; plant defenses against phytophagous invertebrates; thermal exchange in bird eggs; plant reproductive biology; and genetic improvement of willow and poplar.

Fish and Wildlife Biology and Management (M.S., M.P.S., Ph.D.)

Participating Faculty: BALDASSARRE (Waterfowl), BRUNNER (Wildlife Pathology), FARRELL (Riverine Fish Ecology, Freshwater Coastal Wetlands, Great Lakes), FRAIR (Vertebrate and Landscape Ecology), GIBBS (Vertebrate Conservation Biology), LIMBURG (Fish and Riverine Ecology), LOMOLINO (Mammalian Diversity, Biogeography), MCGRATH (Aquatic and Fish Ecology), MCNULTY (Forest Ecology), PORTER (Vertebrate Ecology), RINGLER (Fisheries, Aquatic Ecology), SHIELDS (Vertebrate Behavior), SCHLAEPFER (Vertebrate Ecology and Conservation), SCHULZ (Plankton Ecology, Limnology), STEWART (Fisheries, Aquatic Ecology), TURNER (Vertebrate Physiology), UNDERWOOD (Wildlife Population Dynamics), WHIPPS (Fish Pathology)

Study in this area provides students with advanced preparation in biological concepts of fish and wildlife populations as they relate to resource management. Increasing concern for these wild animal resources has been matched by strong student interest in educational programs that prepare them for careers in the fish and wildlife professions. Graduate education is rapidly becoming a universal prerequisite to employment as a professional fisheries or wildlife biologist. A major strength is the diversity of cooperators including the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, U.S. Geological Survey and the New York State Department of Environmental Conservation.

Areas of research include population habitat relationships, predator ecology, fish behavior, wildlife in Adirondack ecosystems, urban wildlife relationships, endangered species studies, feeding ecology of fishes, stream ecology, Great Lakes fisheries, ecology of larval fishes and estuarine properties of Great Lakes wetlands.

Forest Pathology and Mycology (M.S., M.P.S., Ph.D.)

Participating Faculty: ABRAHAMSON (Forest Pathology, Entomology), CASTELLO (Forest Pathology), FERNANDO (Plant Developmental Ecology), NAKAS (Microbiology), POWELL (Plant Pathology and Molecular Biology)

Forest pathology and mycology trains students to understand tree diseases and fungi from the perspective of basic biology and ecology as well as that of societal needs. This requires global understanding of the positive and negative ecological roles of diseases in the forest environment. It requires a broad knowledge of fungi, viruses, bacteria and abiotic environmental factors affecting forest systems. It also requires sophisticated application

of molecular biology, physiology and genetics to host pathogen systems. Areas of interest include environmental, fungal and viral tree diseases; mycorrhizae; wood decay; monitoring and impact assessment of disease in forest and urban tree systems; epidemiology of tree diseases and the genetics of resistance to tree diseases and pathogen variability; molecular biology and physiology of fungus infection and invasion; and taxonomy and ecology of fungi.

Plant Biotechnology (M.P.S.)

Participating Faculty: BRUNNER (Wildlife Pathology), CASTELLO (Virology), FERNANDO (Plant Developmental Biology), HORTON (Ecology, Fungal Communities, Mycorrhizal Relationships), NAKAS (Microbiology), POWELL (Plant Pathology and Molecular Biology), SMART (Plant Physiology, Molecular Biology), WHIPPS (Fish Pathology)

This area of study in the M.P.S. degree is designed for students who need to broaden their knowledge base and technical skills in biotechnology, for professionals returning for "retooling", and for the recent graduate in a variety of disciplines in biology and chemistry. Requirements consist of 19 credit hours of core coursework including two credit hours of graduate seminars (EFB 797), nine credit hours of directed electives and eight credit hours of open electives for a total of 36 credit hours.

Required Core Courses (19 credit hours):

EFB	530	Plant Physiology (3)
EFB	531	Plant Physiology Lab (2)
EFB	601	Molecular Biology Techniques (3)
EFB	625	Plant Biotechnology (3)
EFB	626/	
FOR	626	Plant Tissue Culture Methods (3)
EFB	627	Plant Developmental Biology (3)
EFB	797	Seminar in Environmental and Forest Biology (2)

A complete list of directed elective courses is available from the graduate program director.

Plant Science and Biotechnology (M.S., M.P.S., Ph.D.)

Participating Faculty: CASTELLO (Virology), DOVCIK (Plant Diversity), FERNANDO (Plant Developmental Biology), C. HALL (Systems Ecology), HORTON (Ecology, Fungal Communities, Mycorrhizal Relationships), KIMMERER (Bryocology, Restoration Ecology), LEOPOLD (Dendrology, Forest and Wetland Ecology), MCGEE (Plant Ecology), NAKAS (Microbiology), POWELL (Plant Pathology and Molecular Biology), SMART (Plant Physiology, Molecular Biology), WHIPPS (Molecular Systematics)

Plants, as the base for ecological food chains, serve as the structural and functional foundation of natural and managed systems. The study of plant science and biotechnology provides opportunity in a broad range of specialties fundamental to the understanding of plants and their interaction with other organisms and for specializing in plant biotechnology. Emphasis is on forests and related plant systems. Current research interests include: dynamics of plant communities as affected by humans and the environment; mechanisms of plant succession; epidemiology of forest and urban tree diseases; taxonomy, physiology, growth and ultrastructure of fungi; heritability of wood properties and disease resistance of trees; biochemistry and physiology of plant stress response; photosynthesis; mycorrhizae; plant reproductive biology; genetic engineering; transformation; molecular evolution; phylogenetics; taxonomy; plant-pathogen interactions, tissue culture and study of ancient DNA.

Chemical Ecology (M.S., M.P.S., Ph.D.)

Participating Faculty: BOYER (Environmental Biochemistry), GINER (Natural Insecticides), NAKAS (Microbial Ecology), NAKATSUGAWA (Xenobiotic Plant-Animal Interactions), TEALE (Insect Pheromones), TEECE (Chemical-Thermal Relationships), WEBSTER (Pheromone Chemistry)

The area of study in chemical ecology is offered through collaboration between the Department of Environmental and Forest Biology and the Department of Chemistry. Interested students should apply to the department of major interest, which will have prime responsibility for setting requirements. Faculty from both areas contribute to the development of a plan of study enabling a student to acquire sophisticated skills in either chemistry or biology and an ample understanding of the other field to grapple with problems requiring an understanding of both.

As a relatively new interdisciplinary endeavor, workers in this field attempt to understand organismal interactions, both intra- and interspecific, mediated by chemical substances such as hormones, pheromones, kairomones and phytoalexins. These interactions occur at all taxonomic levels: between uni- and multicellular organisms, microbes and plants, plants and plants, plants and animals, microbes and animals and various species of animals. Study of such interactions has accelerated in recent years through joint efforts of biologists and chemists in basic and applied research in the laboratory and field.