Twin Cities Campus
Animal Sciences M.S.
Animal Science
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Animal Science, 305 Haecher Hall, 1364 Eckles Avenue, Saint Paul, MN 55108 (612-624-3491; fax: 612-625-5789)
Email: ansci@umn.edu
Website: http://www.ansci.umn.edu/graduate-program

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Students in the Animal Sciences M.S. concentrate on one of the animal sciences emphasis areas: genetics; growth biology; nutrition; physiology; or production systems. Students have the option of tailoring their individual programs to include study in more than one emphasis area.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Plan A: Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 24 major credits and 6 credits outside the major. The final exam is written and oral. A capstone project is required.

Capstone Project: The Plan B project requires approximately 120 hours to complete. The nature and extent of the project is agreed
upon in advance by the student and faculty advisor.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

Plan A requires a minimum of 14 semester credits in the major and 6 credits in a designated minor or related field outside the major. Selection of courses to fulfill this requirement and development of the thesis project are primarily the responsibility of the student and faculty advisor. Students also must register for a minimum of 10 thesis credits.

Plan B requires a minimum of 30 credits, which must include 14 or more credits in the major area and at least 6 credits in one or more related fields outside the major. The balance of credits is chosen by agreement between the advisor and student. In addition to coursework, students must complete the Plan B capstone project, which requires approximately 120 hours. The nature and extent of the project is agreed upon in advance by the student and faculty advisor.

Ethics Requirement
All students are required to be trained in ethical issues in science. Please select one course from the list below to meet this requirement.
- ANSC 8134 - Ethical Conduct of Animal Research (3.0 cr)
- APEC 8901 - Graduate Seminar: MS & PhD (1.0 cr)
- APEC 8902 - Graduate Research Development Seminar (1.0 cr)
- APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- BBE 8001 - Seminar I (1.0 cr)
- BBE 8002 - Seminar II (1.0 cr)
- CONS 8001 - Conservation Biology Seminar (1.0 cr)
- ENT 8061 - Scientific Communication and Ethics (1.0 cr)
- FSCN 8318 - Current Issues in Food Science (2.0 cr)
- NUTR 8621 - Presentation Skills (1.0 cr)
- PLPA 8123 - Research Ethics in Plant and Environmental Sciences (0.5 cr)
- SOIL 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- WRS 8581 - Research and Professional Ethics in Water Resources and Environmental Science (0.5 cr)

Seminar Requirement
All master's students are required to take 4 credits of AnSc 8510 Graduate Seminar
- ANSC 8510 - Graduate Seminar (1.0 cr)
Twin Cities Campus

Animal Sciences Minor

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Animal Science, 305 Haecker Hall, 1364 Eckles Avenue, Saint Paul, MN 55108 (612-624-3491; fax: 612-625-5789)
Email: ansci@umn.edu
Website: http://www.ansci.umn.edu/GraduateProgram/index.htm

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Students pursuing the Animal Sciences minor concentrate on one of the animal sciences emphasis areas: genetics; growth biology; nutrition; physiology; or production systems. Students have the option of tailoring their minor to include study in more than one emphasis area.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Requirements are designed to fit the student's needs. A master's minor requires 6 credits in areas not closely related to the major; no more than 2 of these credits may be in research or special problems. A doctoral minor requires 12 credits in areas not closely related to the major; no more than 3 of these credits may be in research or special problems.

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters
Minor Requirements
The AnSci program does not require specific courses for completion of the minor. The minor requires at least 6 credits of graduate-level courses to be chosen in consultation with the student's major adviser, the AnSci faculty member who will serve on the student's examination committee as the minor program representative, and the AnSci Director of Graduate Studies.

Doctoral
Minor Requirements
The AnSci program does not require specific courses for completion of the minor. The minor requires at least 12 credits of graduate-level courses to be chosen in consultation with the student's major adviser, the AnSci faculty member who will serve on the student's examination committee as the minor program representative, and the AnSci Director of Graduate Studies.
Twin Cities Campus
Animal Sciences Ph.D.
Animal Science
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Animal Science, 305 Haecker Hall, 1364 Eckles Avenue, Saint Paul, MN 55108 (612-624-3491; fax: 612-625-5789)
Email: ansci@umn.edu
Website: http://www.ansci.umn.edu/GraduateProgram/index.htm

• Program Type: Doctorate
• Requirements for this program are current for Fall 2016
• Length of program in credits: 76
• This program does not require summer semesters for timely completion.
• Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Students in the Ph.D. program concentrate on one of the animal sciences emphasis areas: genetics, nutrition, physiology, or production systems. Students have the option of tailoring their program to include study in more than one emphasis area and to emphasize basic or applied science.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

A bachelor's degree in agriculture or a biological field with training in biology, chemistry, physics, and mathematics is required.

Applicants must submit their test score(s) from the following:
• GRE

International applicants must submit score(s) from one of the following tests:
• TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
• IELTS
  - Total Score: 6.5
• MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
40 credits are required in the major.
12 credits are required outside the major.
24 thesis credits are required.
This program may not be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

**Ethics Requirement**

All students are required to be trained in ethical issues in science. Please select one course from the list below to meet this requirement.

- **ANSC 8134** - Ethical Conduct of Animal Research (3.0 cr)
- **or APEC 8901** - Graduate Seminar: MS & PhD (1.0 cr)
- **or APEC 8902** - Graduate Research Development Seminar (1.0 cr)
- **or APSC 8123** - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- **or BBE 8001** - Seminar I (1.0 cr)
- **or BBE 8002** - Seminar II (1.0 cr)
- **or CONS 8001** - Conservation Biology Seminar (1.0 cr)
- **or ENT 8061** - Scientific Communication and Ethics (1.0 cr)
- **or FSCN 8318** - Current Issues in Food Science (2.0 cr)
- **or NUTR 8621** - Presentation Skills (1.0 cr)
- **or PLPA 8123** - Research Ethics in Plant and Environmental Sciences (0.5 cr)
- **or SOIL 8123** - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- **or WRS 8581** - Research and Professional Ethics in Water Resources and Environmental Science (0.5 cr)

**Seminar Requirement**

All doctoral students are required to take 6 credits of AnSc 8510 Graduate Seminar

- **ANSC 8510** - Graduate Seminar (1.0 cr)

**Thesis Requirement**

All doctoral students are required to take 24 thesis credits of AnSc 8888 Graduate Seminar

- **ANSC 8888** - Thesis Credit: Doctoral (1.0 - 24.0 cr)
Twin Cities Campus
Applied Economics M.S.
Applied Economics
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Applied Economics Graduate Program, 231 Ruttan Hall, 1994 Buford Avenue, Saint Paul, MN 55108-6040 (612-625-3777; fax: 612-625-6245)
Email: apecdgs@umn.edu
Website: http://www.catalogs.umn.edu/grad/programs/g004.html

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The M.S. degree in applied economics prepares students for employment opportunities in the public and private sectors, and for further graduate study. This rigorous but flexible program includes core coursework in economic theory and quantitative methods, and offers opportunities for specialized coursework and research in all the fields of study offered by the program.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
The following coursework is considered the minimum preparation for the M.S. program: micro and macroeconomic theory at the intermediate undergraduate level, statistics, two semesters of calculus, and introductory linear algebra. Additional coursework in economics, statistics, and math is highly desirable and recommended, especially for students who intend to apply for the doctoral program after completion of the M.S. degree.

Special Application Requirements:
Applicants must submit scores from the General Test of the GRE, three letters of recommendation from persons familiar with the applicant's scholarship and research potential, a complete set of college or university transcripts, and a clearly written statement of academic and career interests, goals, and objectives. For complete application instructions, visit the website: http://www.apecgrad.umn.edu/Admissions/index.htm. Students should apply by the December deadline to ensure priority consideration for admissions and funding.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language.
Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

**Plan A:** Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

**Plan B:** Plan B requires 14 major credits and 12 credits outside the major. The final exam is oral. A capstone project is required.

**Capstone Project:** A project that demonstrates familiarity with the theoretical and empirical tools of economics. The Plan B project requires between 4 and 6 project credits (APEC 8793).

This program may be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 3.00 is required for students to remain in good standing.

M.S. students are required to complete graduate-level courses in microeconomic theory, macroeconomic theory, and econometrics or statistics, and are required to participate in two 1-credit M.S. seminars. Both Plan A and Plan B require a minimum of 30 credits, 14 credits of which must be in the major field (APEC, ECON, or STAT classes). These 14 major field credits must include a minimum of 9 credits in applied economics (excluding thesis and special topics, independent study, and APEC 8901-02). Plan A requires 10 thesis credits. Plan B requires a 4- to 6-credit project.

**Required Courses**

All students must complete 11 credits taken A-F only excluding seminars.

- APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
- APEC 5151 - Applied Microeconomics: Firm and Household (3.0 cr)
- APEC 5152 - Applied Macroeconomics: Income and Employment (3.0 cr)
- APEC 8901 - Graduate Seminar: MS & PhD (1.0 cr)
- APEC 8902 - Graduate Research Development Seminar (1.0 cr)

**Plan A**

**Electives**

9 credits required (A-F only). Courses can be chosen from APEC, ECON, STAT (excluding STAT 5021, 5022, 5031) at 5xxx or 8xxx in consultation with advisor. Recommended course APEC 5032.

- APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)

10 credits required in APEC 8777.

- APEC 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

**Plan B**

**Electives**

13 credits required (A-F only). Courses can be chosen from APEC, ECON, STAT (excluding STAT 5021, 5022, and 5031) at 5xxx, or 8xxx in consultation with advisor. Recommended course APEC 5032.

- APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)

**Plan B Project**

4 to 6 credits required in APEC 8793.

- APEC 8793 - Master's Paper: Plan B Project (1.0 - 6.0 cr)

**Joint- or Dual-degree Coursework:** MS-Applied Economics/MBASubject may take a total of 18 credits in common among the academic programs.
Twin Cities Campus
Applied Economics Minor
Applied Economics
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Applied Economics Graduate Program, 231 Ruttan Hall, 1994 Buford Avenue, Saint Paul, MN 55108-6040 (612-625-3777; fax: 612-625-6245)
Email: apecdgs@umn.edu
Website: http://www.catalogs.umn.edu/grad/programs/g004.html

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 9
- Length of program in credits (Doctorate): 15
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Graduate study in applied economics requires an operational knowledge of economic theory and modern methods of quantitative analysis, as well as practical application in specialized fields of inquiry, which include consumer behavior; household economics; health economics; labor economics; policy analysis; production and marketing economics; resource and environmental economics; and trade and development economics.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Special Application Requirements:
Courses for the minor must be approved by the director of graduate studies in the Applied Economics Graduate Program.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters
At least 9 credits of 5xxx or 8xxx coursework in applied economics, approved by the Applied Economics director of Graduate Studies, are required. All courses in the minor must be taken A-F and completed with a GPA of 3.00 or higher.

Doctoral
At least 15 credits of 5xxx or 8xxx courses in applied economics, approved by the Applied Economics director of Graduate Studies, are required. All courses in the minor must be taken A-F and completed with a GPA of 3.00 or higher.
Twin Cities Campus

Applied Economics Ph.D.

Applied Economics

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

**Contact Information:**
Department of Applied Economics Graduate Program, 231 Ruttan Hall, 1994 Buford Avenue, Saint Paul, MN  55108-6040 (612-625-3777; fax: 612-625-6245)
Email: apecdgs@umn.edu
Website: [http://www.catalogs.umn.edu/grad/programs/g004.html](http://www.catalogs.umn.edu/grad/programs/g004.html)

- Program Type: Doctorate
- Requirements for this program are current for Fall 2016
- Length of program in credits: 48 to 66
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The PhD degree program in applied economics prepares students for careers in academia, government, and the private sector. This rigorous program includes core coursework in economic theory, quantitative methods, and two fields of specialization selected from the following: consumer behavior and household economics; production and marketing economics; trade and development economics; natural resource and environmental economics; health economics; labor economics; and policy analysis.

**Program Delivery**
This program is available:
- via classroom (the majority of instruction is face-to-face)

**Prerequisites for Admission**
The preferred undergraduate GPA for admittance to the program is 3.00.

The minimum preferred undergraduate GPA for admittance to the program is a B average (3.00/4.00). Most admitted students will have a higher GPA.

Other requirements to be completed before admission:
Applicants for the PhD degree should have completed an MS degree in economics, agricultural economics, or a related field; or have equivalent coursework and research experience. Applicants without a master's degree are, except in a few special cases, considered for admission into the MS program.

Prior training should include micro- and macro-economic theory at the master's level, multivariate calculus, differential equations and linear algebra, and mathematical statistics. Students lacking background in economics or quantitative methods may be required to complete additional coursework before entering the program.

**Special Application Requirements:**
Applicants must submit scores from the General Test of the GRE, three letters of recommendation from persons familiar with the applicant's scholarship and research potential, a complete set of college or university transcripts, and a clearly written statement of academic and career interests, goals, and objectives. For complete application instructions, visit the website: [http://www.apecgrad.umn.edu/Admissions/index.htm](http://www.apecgrad.umn.edu/Admissions/index.htm). Students should apply by the December deadline to ensure priority consideration for admissions and funding.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
Paper Based - Total Score: 550
IELTS - Total Score: 6.5
MELAB - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
24 to 42 credits are required in the major.
0 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 3.00 is required for students to remain in good standing.

Most students take at least 42 credits of coursework and must take 24 doctoral thesis credits. Required courses in microeconomic theory, macroeconomic theory and applied econometrics, and at least two-thirds of the remaining credits included in the PhD degree program are to be completed on the A-F grade basis.

Students must complete at least 18 course credits in applied economics at the 8xxx-level while enrolled as a current student in the graduate program (not including APEC 8901-04 and APEC 8991), PA, PUBH, and HRIR courses included in the list of fields noted in the Graduate Student Handbook can be applied to this requirement. Up to 6 credits of Department of Economics 8xxx-level field courses may be substituted for these credits (excluding ECON 8001-04, 8101-04, 8105-06, and 8205-08).

Students must pass a written preliminary exam in microeconomic theory and at least one field examination in one of the seven PhD fields offered by the Applied Economics graduate program. In addition, there is a requirement for a qualifying paper written in the second year of the program.

For more details, please see the Graduate Student Handbook at: http://www.apec.umn.edu/sites/apec.umn.edu/files/2015-16_apec_graduatestudenthandbook_final.pdf

Microeconomic Theory
All students must complete one of the three microeconomics theory sequences noted below (A-F only).

APEC - Applied Microeconomic Theory
APEC 8001 - Applied Microeconomic Analysis of Consumer Choice and Consumer Demand (2.0 cr)
APEC 8002 - Applied Microeconomic Analysis of Production and Choice Under Uncertainty (2.0 cr)
APEC 8003 - Applied Microeconomic Analysis of Game Theory and Information (2.0 cr)
APEC 8004 - Applied Microeconomic Analysis of Social Choice and Welfare (2.0 cr)

or

ECON - Microeconomic Analysis (Minors Sequence)
ECON 8001 - Microeconomic Analysis (2.0 cr)
ECON 8002 - Microeconomic Analysis (2.0 cr)
ECON 8003 - Microeconomic Analysis (2.0 cr)
ECON 8004 - Microeconomic Analysis (2.0 cr)

or

ECON - Microeconomic Theory (Majors Sequence)
ECON 8101 - Microeconomic Theory (2.0 cr)
ECON 8102 - Microeconomic Theory (2.0 cr)
ECON 8103 - Microeconomic Theory (2.0 cr)
ECON 8104 - Microeconomic Theory (2.0 cr)

Macroeconomic Theory
All students must complete the following two courses (A-F only).
ECON 8105 - Macroeconomic Theory (2.0 cr)
ECON 8106 - Macroeconomic Theory (2.0 cr)
Econometrics
All students must complete the following two courses (A-F only).
APEC
- APEC 8211 - Econometric Analysis I (4.0 cr)
- APEC 8212 - Econometric Analysis II (4.0 cr)

First Year Seminars
All students must complete the following two courses (S-N only).
APEC 8901 - Graduate Seminar: MS & PhD (1.0 cr)
APEC 8902 - Graduate Research Development Seminar (1.0 cr)

Second Year Seminars
All students must complete the following two courses (S-N only).
APEC 8903 - PhD Qualifying Paper Seminar I (1.0 cr)
APEC 8904 - PhD Qualifying Paper Seminar II (1.0 cr)

Electives
(A-F only).
Take 18 or more credit(s) from the following:
- APEC 8202 - Mathematical Optimization in Applied Economics (3.0 cr)
- APEC 8203 - Applied Welfare Economics and Public Policy (3.0 cr)
- APEC 8206 - Dynamic Optimization: Applications in Economics and Management (3.0 cr)
- APEC 8341 - Applied Public Finance (3.0 cr)
- APEC 8401 - Consumer Behavior and Household Economics (2.0 cr)
- APEC 8402 - Information and Behavioral Economics (2.0 cr)
- APEC 8403 - Consumer Theory and Demand Analysis (3.0 cr)
- APEC 8501 - Labor Economics I (2.0 cr)
- APEC 8502 - Labor Economics II (2.0 cr)
- APEC 8601 - Natural Resource Economics (3.0 cr)
- APEC 8602 - Economics of the Environment (3.0 cr)
- APEC 8701 - International Economic Development, Growth, and Trade (3.0 cr)
- APEC 8702 - Economic and Trade Policy: Sectoral and Institutional Issues (3.0 cr)
- APEC 8703 - Microeconomic Analysis of Economic Development (3.0 cr)
- APEC 8801 - Applied Production Theory (3.0 cr)
- APEC 8803 - Marketing Economics (3.0 cr)
- APEC 8804 - Managerial Economics (3.0 cr)
- HRIR 8801 - Core Seminar: Fundamentals of Economic Analysis for Work and Organizations (4.0 cr)
- PA 8302 - Applied Policy Analysis (4.0 cr)
- PA 8312 - Analysis of Discrimination (4.0 cr)
- PUBH 6832 - Economics of the Health Care System (3.0 cr)
- PUBH 8811 - Research Methods in Health Care (3.0 cr)
- PUBH 8821 - Health Economics II (3.0 cr)

Doctoral Thesis Credits
Students must enroll for a minimum of 24 thesis credits.
Take 24 or more credit(s) from the following:
- APEC 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)
Twin Cities Campus
Applied Plant Sciences M.S.
Agronomy & Plant Genetics, Horticultural Science
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Agronomy and Plant Genetics, 411 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108-6026 (612-625-4742; fax: 612-625-1268)
Email: apsc@umn.edu
Website: http://www.appliedplantsciences.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Applied plant sciences is an interdisciplinary program for educating students to become professional scientists well grounded in the applied disciplines of agronomy/agroecology, horticulture, and plant breeding/molecular genetics. Graduates of the program are able to provide innovative leadership and contribute to problem solving within their disciplines in the public or private sector and within society at large. The program develops the quantitative and qualitative research skills necessary to conduct high quality research and scholarship. Students choose from among four specialization tracks: agronomy/agroecology, applied plant sciences, horticulture, or plant breeding/plant molecular genetics. Students gain broad familiarity with all of the disciplines within the program and gain in-depth knowledge within their area of expertise. The program's graduate faculty is drawn primarily from the Department of Agronomy and Plant Genetics and the Department of Horticultural Science; but also from the Departments of Plant Biology; Plant Pathology; Soil, Water, and Climate; Ecology, Evolution and Behavior; and Fisheries, Wildlife and Conservation Biology. The faculty embrace the University of Minnesota's position that promoting and supporting diversity among the student body is central to our academic mission.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Students entering the program should have a foundation in the physical and biological sciences, preferably with some emphasis in plant science. A minimum of 10 credits of math and physics, 12 credits of chemistry and biochemistry, and 15 credits of biological and/or agricultural sciences are recommended for admission. In addition, students should have completed a BS or BA degree in agriculture, biology, or other related life science. Students with a BS or BA degree outside these areas may be admitted with the requirement that they take the prerequisite courses noted above at the undergraduate level in addition to their graduate coursework.

Special Application Requirements:
Applicants must submit scores from the General (Aptitude) Test of the GRE; three letters of recommendation from persons familiar with their scholarship and research potential; a complete set of transcripts; and a clearly written personal statement of career interests, goals, and objectives as part of the online application. Students should apply by December 5 for admission into fall semester of the following year. Students should apply by October 1 for admission into spring semester of the following year.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
- Paper Based - Total Score: 550
- IELTS - Total Score: 6.5
- MELAB - Final score: 550

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

**Plan A:** Plan A requires 20 major credits, up to null credits outside the major, and 10 thesis credits. The final exam is oral.

**Plan B:** Plan B requires 30 major credits and up to null credits outside the major. The final exam is written and oral. A capstone project is required.

**Capstone Project:** Determined in consultation with advisor.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

MS students must complete the core curriculum, requirements for their specialization track, and present one graduate seminar. Additional course requirements are flexible and determined in consultation with the students advisor(s) and advisory committee.

**Required Courses**
- AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
- AGRO 8270 - Graduate Seminar (1.0 cr)
- APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- STAT 5021 - Statistical Analysis (4.0 cr)
  or NR 5021 - Statistics for Agriculture and Natural Resource Professionals (3.0 cr)

**Plan A Thesis Credits**
- Plan A students must take at least 10 master's thesis credits.
- APSC 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

**Program Sub-plans**
A sub-plan is not required for this program. Students may not complete the program with more than one sub-plan.

**Agronomy and Agroecology**
Students conduct research to increase their knowledge of cropping systems and weed science, including alternative approaches and management strategies. Emphasis is on improving production efficiency and profitability in an environmentally sound approach that benefits society. Mechanisms of crop physiology and ecology underlying plant responses to the environment are a particular emphasis of this track.

In addition to the APS core curriculum, students pursuing the Agronomy and Agroecology specialization track must complete remaining MS credit requirements, which will include at least two agroecology/agronomy courses, one plant biology course, and one additional course. Other specialization courses can be substituted with agreement of the advisor, the advisory committee, and director of graduate studies.

**Agroecology/Agronomy Courses**
- Students must complete two courses from this group
AGRO 4401 - Plant Genetics and Breeding (4.0 cr)
or AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
or AGRO 4605 - Strategies for Agricultural Production and Management (3.0 cr)
or AGRO 5021 - Plant Breeding Principles (3.0 cr)
or AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or AGRO 5999 - Special Topics: Workshop in Agronomy (1.0 - 6.0 cr)
or AGRO 8201 - Advanced Plant Breeding (3.0 cr)
or AGRO 8280 - Current Topics in Applied Plant Sciences (1.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

Plant Biology
Students must complete one course in plant biology such as:
P BIO 5516 - Plant Cell Biology (3.0 cr)
or PBIO 5412 - Plant Physiology and Development (3.0 cr)
or PBIO 5601 - Topics in Plant Biochemistry (3.0 cr)

Suggested Additional Courses
Students must take at least one course from the following courses:
BIOL 5407 - Ecology (3.0 cr)
or EEB 4068 - Plant Physiological Ecology (3.0 cr)
or EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
or EEB 5609 - Ecosystem Ecology (3.0 cr)
or ESPM 5108 - Ecology of Managed Systems (4.0 cr)
or ESPM 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
or ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
or HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or SOIL 4111 - Introduction to Precision Agriculture (3.0 cr)
or SOIL 5611 - Soil Biology and Fertility (4.0 cr)

Horticulture
Students conduct research related to fruits, vegetables, potatoes, flowers, ornamental trees and shrubs, or turf; on the physiology, production, environmental impact of cropping systems; and use of horticultural crops. Research areas include the effect of horticultural commodities on human health, hormonal, and stress physiology; flower development and flowering physiology; integrated pest management; post harvest physiology; and cropping system strategies. Students get a broad range of experiences in the field, greenhouse, and/or laboratory using genetic, molecular, biochemical, and ecological tools to answer research questions.

In addition to the APS core curriculum, students pursuing the horticulture specialization track must complete remaining MS credit requirements, which will include at least two courses in Area 1 (cross commodity horticulture), and at least two courses in Area 2 (commodity-based horticulture).

Area 1: Cross Commodity Horticulture
Students must complete at least two courses in Area 1.
AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
or AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
or HORT 4461 - Horticultural Marketing (3.0 cr)
or HORT 4850 - Pollinator Protection in Managed Landscapes (3.0 cr)
or HORT 5007 - Advanced Plant Propagation (3.0 cr)
or HORT 5023 - Public Garden Management (2.0 cr)
or HORT 8044 - Manipulation of Plant Growth and Reproduction (2.0 cr)
or HORT 8280 - Current Topics in Applied Plant Sciences (1.0 cr)
or MBA 6210 - Marketing Management (3.0 cr)
or MKTG 6051 - Marketing Research (4.0 cr)
or MKTG 6082 - Brand Management (4.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

Area 2: Commodity-based Horticulture
Students must complete at least two courses in Area 2.
HORT 4061W - Turfgrass Management [WI] (3.0 cr)
or HORT 4062 - Turfgrass Weed and Disease Science (3.0 cr)
or HORT 4063 - Turfgrass Science (3.0 cr)
or HORT 5011 - Common Chinese Medicinal Plants: Classification, Identification, and Application (3.0 cr)
or HORT 5012 - Common Chinese Medicinal Plants: Growing and Processing (3.0 cr)
or HORT 5031 - Fruit Production and Viticulture for Local and Organic Markets (3.0 cr)
or HORT 5032 - Organic Vegetable Production (3.0 cr)
or HORT 5051 - Plant Production II (4.0 cr)
or HORT 5061 - Advanced Turfgrass Science (2.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)

Area 3: Additional Coursework
Courses other than those listed below can be substituted with agreement of the advisor, advisory committee, and director of graduate studies.

HORT 5058 - Plant Cytogenetics (2.0 cr)
or HORT 5059 - Plant Cytogenetics Lab (1.0 cr)
or PBIO 5412 - Plant Physiology and Development (3.0 cr)
or PBIO 5516 - Plant Cell Biology (3.0 cr)
or PBIO 5601 - Topics in Plant Biochemistry (3.0 cr)
or PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or SOIL 4111 - Introduction to Precision Agriculture (3.0 cr)
or SOIL 5611 - Soil Biology and Fertility (4.0 cr)
or PBIO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)

Plant Breeding and Plant Molecular Genetics
This track allows students to select from genetic research projects ranging from applied plant breeding projects emphasizing breeding procedures and methodologies to molecular genetic projects doing biotechnology, genetic engineering, and genomic research in agronomic and horticultural crops. These research projects give students the opportunity to integrate the latest developments in the laboratory with applied applications in the field to reach the overarching goal of developing new germplasm that will improve the sustainability of our food/feed/fiber/fuel systems.

In addition to the APS core curriculum, students pursuing the plant breeding and plant molecular genetics specialization track must complete remaining MS credit requirements, which will include at least one course from each of the following areas: genetics, molecular genetics, and plant breeding area, with any additional credits determined in consultation with the students advisor and advisory committee.

Genetics
Take at least one course from the following:
EEB 5042 - Quantitative Genetics (3.0 cr)
or GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)

Molecular Genetics
Take at least one course from the following:
GCD 4034 - Molecular Genetics (3.0 cr)
or AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)

Plant Breeding
Take at least one course from the following:
AGRO 8201 - Advanced Plant Breeding (3.0 cr)
or AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)

Other suggested courses
Courses other than those listed below can be substituted with approval of the advisor, advisory committee, and director of graduate studies.
AGRO 8280 - Current Topics in Applied Plant Sciences (1.0 cr)
or AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
or PBIO 4601 - Topics in Plant Biochemistry (3.0 cr)
or BIOC 8001 - Biochemistry: Structure, Catalysis, and Metabolism (3.0 cr)
or BIOC 8002 - Molecular Biology and Regulation of Biological Processes (3.0 cr)
or HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
or HORT 5058 - Plant Cytogenetics (2.0 cr)
or HORT 5059 - Plant Cytogenetics Lab (1.0 cr)
or AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
or PBIO 5516 - Plant Cell Biology (3.0 cr)
or PLPA 5301 - Plant Genomics (3.0 cr)
or AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or EEB 5221 - Molecular Evolution (3.0 cr)
or PBIO 5412 - Plant Physiology and Development (3.0 cr)
or HORT 8044 - Manipulation of Plant Growth and Reproduction (2.0 cr)
or PBIO 5516 - Plant Cell Biology (3.0 cr)
or PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or PLPA 8104 - Plant Virology (2.0 cr)
or PLPA 8105 - Plant Bacteriology (2.0 cr)
or AGRO 5121 - Applied Experimental Design (4.0 cr)
or ANSC 5200 - Statistical Genetics and Genomics (4.0 cr)
or STAT 5301 - Sampling Methodology in Finite Populations (3.0 cr)
or STAT 5302 - Applied Regression Analysis (4.0 cr)
or STAT 5303 - Designing Experiments (4.0 cr)
or STAT 5401 - Applied Multivariate Methods (3.0 cr)
or STAT 5421 - Analysis of Categorical Data (3.0 cr)
or STAT 5601 - Nonparametric Methods (3.0 cr)
or ENT 5126 - Spatial and Temporal Analysis of Ecological Data (3.0 cr)
or ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
or FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
or FW 8051 - Statistical Modeling of Ecological Data using R and WinBugs/JAGS (4.0 cr)
or GIS 5555 - Basic Spatial Analysis (3.0 cr)

**Applied Plant Sciences**

Students who choose to complete the MS without a track must complete the APS core curriculum: at least one course from the areas of genetics and plant breeding, organismal biology, and cropping systems, communities, and commodities; and any remaining credits to meet MS credit requirements.

**Genetics and Plant Breeding**

Take at least one course from the following:

- AGRO 5021 - Plant Breeding Principles (3.0 cr)
- AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
- AGRO 8023 - Evolution of Crop Plants (3.0 cr)
- AGRO 8201 - Advanced Plant Breeding (3.0 cr)
- AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)
- AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
- EEB 5042 - Quantitative Genetics (3.0 cr)
- GCD 4034 - Molecular Genetics (3.0 cr)
- HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
- HORT 5058 - Plant Cytogenetics (2.0 cr)
- HORT 5059 - Plant Cytogenetics Lab (1.0 cr)
- PBIO 5301 - Plant Genomics (3.0 cr)

**Organismal Biology**

Take at least one course from the following:

- HORT 5007 - Advanced Plant Propagation (3.0 cr)
- HORT 8044 - Manipulation of Plant Growth and Reproduction (2.0 cr)
- PBIO 5412 - Plant Physiology and Development (3.0 cr)
- PBIO 5516 - Plant Cell Biology (3.0 cr)
- PBIO 5601 - Topics in Plant Biochemistry (3.0 cr)
- PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
- PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
- PLPA 5480 - Principles of Plant Pathology (3.0 cr)
- PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
- PLPA 8104 - Plant Virology (2.0 cr)
- PLPA 8105 - Plant Bacteriology (2.0 cr)

**Cropping Systems, Communities, and Commodities**

Take at least one course from the following:

- AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
- AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
- HORT 4062 - Turfgrass Weed and Disease Science (3.0 cr)
- HORT 4141W - Scheduling Crops for Protected Environments [WI] (4.0 cr)
or HORT 5031 - Fruit Production and Viticulture for Local and Organic Markets (3.0 cr)
or HORT 5032 - Organic Vegetable Production (3.0 cr)
or HORT 5051 - Plant Production II (4.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or HORT 5131 - Student Organic Farm Planning, Growing, and Marketing (3.0 cr)
or PLPA 5202 - Field Plant Pathology (2.0 cr)
or PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
Twin Cities Campus

Applied Plant Sciences Minor
Agronomy & Plant Genetics, Horticultural Science
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Agronomy and Plant Genetics, 411 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108-6026 (612-625-4742; fax: 612-625-1268)
Email: apsc@umn.edu
Website: http://www.appliedplantsciences.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 12
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The minor in applied plant sciences provides students in other fields an opportunity to gain knowledge and expertise in plant sciences at the molecular, organismal and community levels with applications to sustainable production of horticultural and agronomic crops. Applied Plant Sciences is an interdisciplinary program for educating students to become professional scientists well-grounded in the applied disciplines of agronomy/agroecology, horticulture, and plant breeding/molecular genetics. Graduates of the program are able to provide innovative leadership and contribute to problem solving within their disciplines in the public or private sector and within society at large. The program develops the quantitative and qualitative research skills necessary to conduct high quality research and scholarship. Students choose from among four specialization tracks: agronomy/agroecology, applied plant sciences, horticulture, or plant breeding/ molecular genetics. Students gain broad familiarity with all of the disciplines within the program and gain in-depth knowledge within their area of expertise. The program's graduate faculty is drawn primarily from the Departments of Agronomy and Plant Genetics and Horticultural Science; but also from the Departments of Plant Biology; Plant Pathology; Soil, Water, and Climate; Ecology, Evolution and Behavior; and Fisheries, Wildlife and Conservation Biology. The faculty embrace the University of Minnesotas position that promoting and supporting diversity among the student body is central to our academic mission.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Students entering the program should have a foundation in the physical and biological sciences, preferably with some emphasis in plant science. A minimum of 10 credits of math and physics, 12 credits of chemistry and biochemistry, and 15 credits of biological and/or agricultural sciences are recommended for admission. In addition, students should have completed a BS or BA degree in agriculture, biology, or other related life science. Students with a BS or BA degree outside these areas may be admitted with the requirement that they take the prerequisite courses noted above at the undergraduate level in addition to their graduate coursework.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Coursework is determined in consultation with the applied plant sciences director of graduate studies and may include but is not limited to the recommended courses listed below.
Recommended Courses
Select from these recommended courses.
Take 12 or more credit(s) from the following:

- AGRO 4401 - Plant Genetics and Breeding (4.0 cr)
- AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
- AGRO 4605 - Strategies for Agricultural Production and Management (3.0 cr)
- AGRO 4888 - Issues in Sustainable Agriculture (2.0 cr)
- AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
- AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
- AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
- AGRO 5999 - Special Topics: Workshop in Agronomy (1.0 - 6.0 cr)
- AGRO 8201 - Advanced Plant Breeding (3.0 cr)
- AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)
- AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
- AGRO 8280 - Current Topics in Applied Plant Sciences (1.0 cr)
- EEB 5042 - Quantitative Genetics (3.0 cr)
- GCD 4034 - Molecular Genetics (3.0 cr)
- GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
- HORT 4062 - Turfgrass Weed and Disease Science (3.0 cr)
- HORT 4063 - Turfgrass Science (3.0 cr)
- HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
- HORT 4141W - Scheduling Crops for Protected Environments [WI] (4.0 cr)
- HORT 4461 - Horticultural Marketing (3.0 cr)
- HORT 4850 - Pollinator Protection in Managed Landscapes (3.0 cr)
- HORT 5007 - Advanced Plant Propagation (3.0 cr)
- HORT 5011 - Common Chinese Medicinal Plants: Classification, Identification, and Application (3.0 cr)
- HORT 5012 - Common Chinese Medicinal Plants: Growing and Processing (3.0 cr)
- HORT 5023 - Public Garden Management (2.0 cr)
- HORT 5031 - Fruit Production and Viticulture for Local and Organic Markets (3.0 cr)
- HORT 5032 - Organic Vegetable Production (3.0 cr)
- HORT 5051 - Plant Production II (4.0 cr)
- HORT 5058 - Plant Cytogenetics (2.0 cr)
- HORT 5059 - Plant Cytogenetics Lab (1.0 cr)
- HORT 5061 - Advanced Turfgrass Science (2.0 cr)
- HORT 5071 - Ecological Restoration (4.0 cr)
- HORT 5131 - Student Organic Farm Planning, Growing, and Marketing (3.0 cr)
- HORT 5204 - Manipulation of Plant Growth and Reproduction (2.0 cr)
- HORT 8201 - Advanced Plant Breeding (3.0 cr)
- HORT 8280 - Current Topics in Applied Plant Sciences (1.0 cr)
- PBIO 5301 - Plant Genomics (3.0 cr)
- PBIO 5412 - Plant Physiology and Development (3.0 cr)
- PBIO 5516 - Plant Cell Biology (3.0 cr)
- PBIO 5601 - Topics in Plant Biochemistry (3.0 cr)
- PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
- PLPA 5202 - Field Plant Pathology (2.0 cr)
- PLPA 5203 - Introduction to Fungal Biology (3.0 cr)
- PLPA 5301 - Plant Genomics (3.0 cr)
- PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
- PLPA 5480 - Principles of Plant Pathology (3.0 cr)
- PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
- PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
- PLPA 8104 - Plant Virology (2.0 cr)
- PLPA 8105 - Plant Bacteriology (2.0 cr)
- SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters
Coursework is determined in consultation with the applied plant sciences director of graduate studies and may include but is not limited to the list of recommended courses.
Doctoral
Coursework is determined in consultation with the applied plant sciences director of graduate studies and may include but is not limited to the list of recommended courses.
Twin Cities Campus
Applied Plant Sciences Ph.D.
Agronomy & Plant Genetics, Horticultural Science
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Agronomy and Plant Genetics, 411 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108-6026 (612-625-4742; fax: 612-625-1268)
Email: apsc@umn.edu
Website: http://www.appliedplantsciences.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2016
- Length of program in credits: 54
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Applied plant sciences is an interdisciplinary program for educating students to become professional scientists well grounded in the applied disciplines of agronomy/agroecology, horticulture, and plant breeding/molecular genetics. Graduates of the program are able to provide innovative leadership and contribute to problem solving within their disciplines in the public or private sector and within society at large. The program develops the quantitative and qualitative research skills necessary to conduct high quality research and scholarship. Students choose from among four specialization tracks: agronomy/agroecology, applied plant sciences, horticulture, or plant breeding/plant molecular genetics. Students gain broad familiarity with all of the disciplines within the program and gain in-depth knowledge within their area of expertise. The program's graduate faculty is drawn primarily from the Department of Agronomy and Plant Genetics and the Department of Horticultural Science; but also from the Departments of Plant Biology; Plant Pathology; Soil, Water, and Climate; Ecology, Evolution and Behavior; and Fisheries, Wildlife and Conservation Biology. The faculty embrace the University of Minnesota's position that promoting and supporting diversity among the student body is central to our academic mission.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Students entering the program should have a foundation in the physical and biological sciences, preferably with some emphasis in plant science. A minimum of 10 credits of math and physics, 12 credits of chemistry and biochemistry, and 15 credits of biological and/or agricultural sciences are recommended for admission. In addition, students should have completed a BS or BA degree in agriculture, biology, or other related life science. Students with a BS or BA degree outside these areas may be admitted with the requirement that they take the prerequisite courses noted above at the undergraduate level in addition to their graduate coursework.

Special Application Requirements:
Applicants must submit scores from the General (Aptitude) Test of the GRE; three letters of recommendation from persons familiar with their scholarship and research potential; a complete set of official transcripts; and a clearly written personal statement of career interests, goals, and objectives as part of the online application. Students should apply by December 1 for admission into fall semester of the following year. Students should apply by October 1 for admission into spring semester of the following year.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19

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Information current as of December 20, 2016
Program Requirements

30 credits are required in the major.
0 credits are required outside the major.
24 thesis credits are required.

This program may not be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

PhD students must complete the core curriculum, requirements for their specialization, and present one graduate seminar. Additional course requirements are flexible and determined in consultation with the students advisor(s) and advisory committee.

Required Courses

PhD students are exempt from APSC 8123 if completed while pursuing the APS masters at the University.
- AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
- AGRO 8270 - Graduate Seminar (1.0 cr)
- AGRO 8280 - Current Topics in Applied Plant Sciences (1.0 cr)
- APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- GRAD 8101 - Teaching in Higher Education (3.0 cr)
- SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
- NR 5021 - Statistics for Agriculture and Natural Resource Professionals (3.0 cr)
  or STAT 5021 - Statistical Analysis (4.0 cr)

Program Sub-plans

A sub-plan is not required for this program.
Students may not complete the program with more than one sub-plan.

Agronomy and Agroecology

Students conduct research to increase their knowledge of cropping systems and weed science, including alternative approaches and management strategies. Emphasis is on improving production efficiency and profitability in an environmentally sound approach that benefits society. Mechanisms of crop physiology and ecology underlying plant responses to the environment are a particular emphasis of this track.

Students pursuing the agroecology/agronomy specialization track must complete at least two agroecology/agronomy courses, one plant biology course, and one ecology course.

Courses listed within agroecology/agronomy, plant biology, and ecology/plant pathology/soil science groups are provided as a guide for students and faculty. Other specialization courses can be substituted with agreement of the advisor, the advisory committee, and director of graduate studies.

Agronomy/Agroecology

Students must complete two courses from this group.
- AGRO 4401 - Plant Genetics and Breeding (4.0 cr)
  or AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
or AGRO 4605 - Strategies for Agricultural Production and Management (3.0 cr)
or AGRO 5021 - Plant Breeding Principles (3.0 cr)
or AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or AGRO 5999 - Special Topics: Workshop in Agronomy (1.0 - 6.0 cr)
or AGRO 8201 - Advanced Plant Breeding (3.0 cr)
or HORT 4401 - Plant Genetics and Breeding (4.0 cr)
or HORT 8201 - Advanced Plant Breeding (3.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

Plant Biology
Students must complete one course in plant biology such as:
PBIO 5516 - Plant Cell Biology (3.0 cr)
or PBIO 5412 - Plant Physiology and Development (3.0 cr)

Ecology/Plant Pathology/Soil Science
Students must complete at least one course from the following list:
BIOL 5407 - Ecology (3.0 cr)
or EEB 4068 - Plant Physiological Ecology (3.0 cr)
or EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
or EEB 5609 - Ecosystem Ecology (3.0 cr)
or ESPM 5108 - Ecology of Managed Systems (4.0 cr)
or ESPM 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
or ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
or HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 5202 - Field Plant Pathology (2.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or SOIL 4111 - Introduction to Precision Agriculture (3.0 cr)
or SOIL 5611 - Soil Biology and Fertility (4.0 cr)

Horticulture
Students conduct research related to fruits, vegetables, potatoes, flowers, ornamental trees and shrubs, or turf; and on the physiology, production, environmental impact of cropping systems, and use of horticultural crops. Research areas include the effect of horticultural commodities on human health, hormonal, and stress physiology; flower development and flowering physiology; integrated pest management; post harvest physiology; and cropping system strategies. Students get a broad range of experiences in the field, greenhouse, and/or laboratory using genetic, molecular, biochemical, and ecological tools to answer research questions.

Students pursuing the PhD with a horticulture specialization track must take a minimum of four courses from Areas 1 and 2, with at least one course from each of the two areas.

Area 1 - Cross Commodity Horticulture
Students must complete at least one Area 1 course.
HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
or AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
or AGRO 4461 - Horticultural Marketing (3.0 cr)
or AGRO 4850 - Pollinator Protection in Managed Landscapes (3.0 cr)
or AGRO 5007 - Advanced Plant Propagation (3.0 cr)
or AGRO 5023 - Public Garden Management (2.0 cr)
or AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or MKTG 6051 - Marketing Research (4.0 cr)
or MKTG 6055 - Buyer Behavior (4.0 cr)
or MKTG 6082 - Brand Management (4.0 cr)
or MBA 6210 - Marketing Management (3.0 cr)
or HORT 8044 - Manipulation of Plant Growth and Reproduction (2.0 cr)

Area 2 - Commodity-based Horticulture
Students must complete at least one Area 2 course.
HORT 4062 - Turfgrass Weed and Disease Science (3.0 cr)
or HORT 4063 - Turfgrass Science (3.0 cr)
or HORT 5011 - Common Chinese Medicinal Plants: Classification, Identification, and Application (3.0 cr)
or HORT 5012 - Common Chinese Medicinal Plants: Growing and Applications (3.0 cr)
or HORT 5031 - Fruit Production and Viticulture for Local and Organic Markets (3.0 cr)
or HORT 5032 - Organic Vegetable Production (3.0 cr)
or HORT 5051 - Plant Production II (4.0 cr)
or HORT 5061 - Advanced Turfgrass Science (2.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
Area 3 - Related Fields
Students must complete at least one Area 3 course. Courses other than those listed below can be substituted with agreement of the advisor, advisory committee, and director of graduate studies.

AGRO 5021 - Plant Breeding Principles (3.0 cr)
or AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or AGRO 8201 - Advanced Plant Breeding (3.0 cr)
or BIOL 5407 - Ecology (3.0 cr)
or EEB 4068 - Plant Physiological Ecology (3.0 cr)
or EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
or EEB 5609 - Ecosystem Ecology (3.0 cr)
or ESPM 5108 - Ecology of Managed Systems (4.0 cr)
or ESPM 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
or ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
or HORT 5058 - Plant Cytogenetics (2.0 cr)
or HORT 5059 - Plant Cytogenetics Lab (1.0 cr)
or HORT 8201 - Advanced Plant Breeding (3.0 cr)
or PBIOL 5412 - Plant Physiology and Development (3.0 cr)
or PBIOL 5516 - Plant Cell Biology (3.0 cr)
or PBIOL 5601 - Topics in Plant Biochemistry (3.0 cr)
or PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 5202 - Field Plant Pathology (2.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or SOIL 4111 - Introduction to Precision Agriculture (3.0 cr)
or SOIL 5611 - Soil Biology and Fertility (4.0 cr)

Plant Breeding and Plant Molecular Genetics
This track allows students to select from genetic research projects ranging from applied plant breeding projects emphasizing breeding procedures and methodologies to molecular genetic projects doing biotechnology, genetic engineering, and genomic research in agronomic and horticultural crops. These research projects give students the opportunity to integrate the latest developments in the laboratory with applied applications in the field to reach the overarching goal of developing new germplasm that will improve the sustainability of our food/feed/fiber/fuel systems.

Students pursuing the PhD with a plant breeding and plant molecular genetics track must complete at least one course from each of these three areas: genetics, molecular genetics, and plant breeding.

Required courses
AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
AGRO 8270 - Graduate Seminar (1.0 cr)
APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
GRAD 8101 - Teaching in Higher Education (3.0 cr)
SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
STAT 5021 - Statistical Analysis (4.0 cr)

Genetics
Take at least one course from the following:
EEB 5042 - Quantitative Genetics (3.0 cr)
or GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)

Molecular Genetics
Take at least one course from the following:
GCD 4034 - Molecular Genetics (3.0 cr)
or AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)

Plant Breeding
Take at least one course from the following:
AGRO 8201 - Advanced Plant Breeding (3.0 cr)
or HORT 8201 - Advanced Plant Breeding (3.0 cr)
or AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)

Other Suggested Courses
Courses other than those listed below can be substituted with approval of the advisor, advisory committee, and director of graduate studies.

Agroecology
AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

Biochemistry
BIOC 8001 - Biochemistry: Structure, Catalysis, and Metabolism (3.0 cr)
or BIOC 8002 - Molecular Biology and Regulation of Biological Processes (3.0 cr)

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Information current as of December 20, 2016
Applied Plant Sciences

Students who choose to pursue the PhD without a specialization track must complete the APS required core curriculum and at least one course from these three areas: genetics and plant breeding; organismal biology; and cropping systems, communities, and commodities.

**Genetics and Plant Breeding**

Take at least one course from the following:
- AGRO 5021 - Plant Breeding Principles (3.0 cr)
- AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
- AGRO 8201 - Advanced Plant Breeding (3.0 cr)
- AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)
- AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
- EEB 5042 - Quantitative Genetics (3.0 cr)
- GCD 4034 - Molecular Genetics (3.0 cr)
- GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
- HORT 5058 - Plant Cytogenetics (2.0 cr)
- HORT 5059 - Plant Cytogenetics Lab (1.0 cr)
- HORT 8201 - Advanced Plant Breeding (3.0 cr)
- PLPA 5301 - Plant Genomics (3.0 cr)
- PBIO 5601 - Topics in Plant Biochemistry (3.0 cr)

**Organismal Biology**

Take at least one course from the following:
- HORT 5007 - Advanced Plant Propagation (3.0 cr)
- HORT 8044 - Manipulation of Plant Growth and Reproduction (2.0 cr)
- PBIO 5412 - Plant Physiology and Development (3.0 cr)
- PBIO 5516 - Plant Cell Biology (3.0 cr)
- PBIO 5601 - Topics in Plant Biochemistry (3.0 cr)
or PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 5203 - Introduction to Fungal Biology (3.0 cr)
or PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or PLPA 8104 - Plant Virology (2.0 cr)
or PLPA 8105 - Plant Bacteriology (2.0 cr)

Cropping Systems, Communities, and Commodities
Take at least one course from the following:
AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
or AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or HORT 4062 - Turfgrass Weed and Disease Science (3.0 cr)
or HORT 4063 - Turfgrass Science (3.0 cr)
or HORT 4141W - Scheduling Crops for Protected Environments [WI] (4.0 cr)
or HORT 5031 - Fruit Production and Viticulture for Local and Organic Markets (3.0 cr)
or HORT 5032 - Organic Vegetable Production (3.0 cr)
or HORT 5051 - Plant Production II (4.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or HORT 5131 - Student Organic Farm Planning, Growing, and Marketing (3.0 cr)
or PLPA 5202 - Field Plant Pathology (2.0 cr)
or PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
Twin Cities Campus

Bioproducts and Biosystems Science, Eng and Mgmt M.S.

Bioproducts and Biosystems Engineering

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Bioproducts and Biosystems Engineering, Biosystems and Agricultural Engineering Building, 1390 Eckles Avenue, St. Paul, MN 55108 (612-625-7733; fax: 612-624-3005)
Email: bbe@umn.edu
Website: http://www.bbe.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The master of science degree in the bioproducts and biosystems science engineering and management (BBSEM) graduate program provides a strong foundation in the basic sciences, engineering, and management in support of the renewable bio-resources utilization, environmental quality, and national security, while improving our global competitiveness. The areas of specialization include bioproducts science and engineering, biosystems science and engineering, and bioproducts marketing and management.

Bioproducts science and engineering specialization focuses on the fundamental science and engineering of the various manufacturing processes used in sustainable conversion of biomass into bio-based industrial and consumer products, and their effective end-use applications. Bioproducts include "green" materials, chemicals and energy derived from bio-resources, including biofuels, bioenergy, biocomposites, bio-based plastics, adhesives, pulp and paper, building materials, and more.

Biosystems science and engineering specialization is designed for students who seek to develop a strong foundation in physical sciences and engineering principles, which are applied to important problems involving biological systems. Potential areas of interest include water and soil management and protection; livestock environment; food engineering and value-added processing; machinery systems design; grain quality; safety, health, and risk management; renewable energy systems; and waste management.

Bioproducts marketing and management specialization is designed for graduate students who seek to build on a strong diverse background encompassing liberal arts, basic sciences, communications and product development, and marketing and management of bioproducts.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Students seeking a master's degree should have a bachelor's degree in engineering, mathematics, the physical or biological sciences, or a related field from a recognized U.S. or international university. Applicants should have a performance level of at least a 3.0 GPA (on a 4.0 grading scale) on previous academic work required for a degree.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
- Paper Based - Total Score: 550
• IELTS
  - Total Score: 6.5
• MELAB
  - Final score: 80

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

**Plan A:** Plan A requires 20 major credits, up to null credits outside the major, and 10 thesis credits. The final exam is oral.

**Plan B:** Plan B requires 30 major credits and up to null credits outside the major. The final exam is oral. A capstone project is required.

**Capstone Project:** Students complete a project that involves a total of about 120 hours of work, and write a Plan B paper on their project.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 2.80 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

All master's level students must take BBE 8013, Parameter Estimation (3 cr), unless they can demonstrate to the BBE 8013 instructor that they have already mastered the course material or can identify a suitable alternative.

Students and their advisors must include a letter of explanation if submitting a graduate degree plan that includes more than 4 credits of special problems or advanced problems coursework.

**Required Courses**
- BBE 8001 - Seminar I (1.0 cr)
- BBE 8002 - Seminar II (1.0 cr)
- BBE 8013 - Parameter Estimation in Biosystems and Agricultural Engineering (3.0 cr)

**Master's Plan A and Master's Plan B**

**Master's Plan A**
- Take at least 15 additional credits, in consultation with advisor and approved by the director of Graduate Studies.
- Students need to take a total of 10 thesis credits.
  - BBE 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)
  - OR-

**Master's Plan B**
- Take an additional 25 credits, in consultation with advisor and approved by the director of Graduate Studies.
Twin Cities Campus

Bioproducts and Biosystems Science, Engineering and Management Minor

Bioproducts and Biosystems Engineering

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Bioproducts and Biosystems Engineering, Biosystems and Agricultural Engineering Building, 1390 Eckles Avenue, St. Paul, MN 55108 (612-625-7733; fax: 612-624-3005)
Email: bbe@umn.edu
Website: http://www.bbe.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The bioproducts and biosystems science engineering and management (BBSEM) graduate program provides a strong foundation in the basic sciences, engineering, and management in support of the renewable bio-resources utilization, environmental quality, and national security while improving our global competitiveness. The areas of specialization include bioproducts science and engineering, biosystems science and engineering, and bioproducts marketing and management.

Bioproducts science and engineering specialization focuses on the fundamental science and engineering of the various manufacturing processes used in the sustainable conversion of biomass into bio-based industrial and consumer products and their effective end-use applications. Bioproducts include “green” materials, chemicals and energy derived from bio-resources including biofuels, bioenergy, biocomposites, bio-based plastics, adhesives, pulp and paper, building materials, and more. Biosystems science and engineering specialization is designed for students who seek to develop a strong foundation in physical sciences and engineering principles which are applied to important problems involving biological systems. Potential areas of interest include water and soil management and protection; livestock environment; food engineering and value-added processing; machinery systems design; grain quality; safety, health, and risk management; renewable energy systems; and waste management. Bioproducts marketing and management specialization is designed for graduate students who seek to build on a strong diverse background encompassing liberal arts, basic sciences, communications and product development, and marketing and management of bioproducts.

Program Delivery

This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission

Other requirements to be completed before admission:
The student must be in good standing in their degree program to apply for this minor.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Program Sub-plans

Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters
Select at least 6 credits of graduate-level BBE coursework in consultation with an adviser and approved by the director of graduate studies in bioproducts and biosystems science engineering and management.

**Doctoral**
Select at least 12 credits of graduate-level BBE coursework in consultation with an adviser and approved by the director of graduate studies in bioproducts and biosystems science engineering and management.
Twin Cities Campus

Bioproducts and Biosystems Science, Engineering and Management Ph.D.
Bioproducts and Biosystems Engineering
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Bioproducts and Biosystems Engineering, Biosystems and Agricultural Engineering Building, 1390 Eckles Avenue, St. Paul, MN 55108 (612-625-7733; fax: 612-624-3005)
Email: bbe@umn.edu
Website: http://www.bbe.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2016
- Length of program in credits: 69
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The PhD offered by the bioproducts and biosystems science engineering and management (BBSEM) graduate program provides a strong foundation in the basic sciences, engineering, and management in support of the renewable bio-resources utilization, environmental quality, and national security while improving our global competitiveness. The areas of specialization include bioproducts science and engineering, biosystems science and engineering, and bioproducts marketing and management.

Bioproducts science and engineering specialization focuses on the fundamental science and engineering of the various manufacturing processes used in the sustainable conversion of biomass into bio-based industrial and consumer products and their effective end-use applications. Bioproducts include "green" materials, chemicals and energy derived from bio-resources, including biofuels, bioenergy, biocomposites, bio-based plastics, adhesives, pulp and paper, building materials, and more.

Biosystems science and engineering specialization is designed for students who seek to develop a strong foundation in physical sciences and engineering principles, which are applied to important problems involving biological systems. Potential areas of interest include water and soil management and protection; livestock environment; food engineering and value-added processing; machinery systems design; grain quality; safety, health, and risk management; renewable energy systems; and waste management.

Bioproducts marketing and management specialization is designed for graduate students who seek to build on a strong, diverse background encompassing liberal arts, basic sciences, communications and product development, and marketing and management of bioproducts.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.20.

Students seeking the PhD should have a bachelor's degree in engineering, mathematics, the physical or biological sciences, or a related field from a recognized U.S. or international university.

Special Application Requirements:
Students seeking the PhD should also have a master's degree in engineering, mathematics, the physical or biological sciences, or a related field from a recognized U.S. or international university. Applicants should have a performance level on previous academic work required for a degree of at least a 3.2 GPA (on a 4.0 grading scale). Students expecting to pursue a PhD normally complete a master of science Plan A degree before starting their PhD programs. Exceptional students who want to go straight to the PhD from the bachelor's level may be admitted subject to conditions agreed upon by the advisor, the director of graduate studies, and the graduate program coordinator.

Applicants must submit their test score(s) from the following:
- GRE
International applicants must submit score(s) from one of the following tests:

- **TOEFL**
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550

- **IELTS**
  - Total Score: 6.5

- **MELAB**
  - Final score: 80

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

36 credits are required in the major.
9 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with advisor approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 3 semesters must be completed before filing a Degree Program Form.

All doctoral level students must take BBE 8001, Seminar I (1 cr), and BBE 8002, Seminar II (1 cr), and BBE 8013, Parameter Estimation (3 cr), unless they can demonstrate to the BBE 8013 instructor that they have already mastered the course material, or have justified the selection of a suitable alternative.

BBE 8001, BBE 8002, and BBE 8013, if taken at the master's level, count toward the PhD and do not have to be retaken.

The PhD in bioproducts and biosystems science engineering and management requires extended study and intense intellectual effort, conducting cutting-edge research and advancing the forefront of knowledge in the subject matter area. Students develop skills that enable them to define problems or research questions, plan research, conduct independent research and/or lead research efforts, analyze data, and effectively communicate research results to a variety of audiences.

All PhD degree programs must include a minimum of 45 graduate course credits beyond the B.S. degree, and a minimum of 24 doctoral thesis credits (BBE 8888). PhD degree programs should contain a minimum of 9 course credits in a concentrated area of scientific or theoretical development that is related to the student's research, and may contain up to 3 credits of enrichment courses.

**Required Courses**

- **BBE 8001** - Seminar I (1.0 cr)
- **BBE 8002** - Seminar II (1.0 cr)
- **BBE 8013** - Parameter Estimation in Biosystems and Agricultural Engineering (3.0 cr)

**31 Credits in Major Area of Study**

31 credits in major area of study selected with advisor, and approved by the director of Graduate Studies. The student is encouraged to take up to 3 credits of enrichment courses, which are included in the 31-credit requirement.

**9 Credits of Scientific or Mathematical Theoretical Development**

9 credits of scientific or mathematical theoretical development that is related to the student's research, selected with advisor and approved by the director of Graduate Studies.

**24 Thesis Credits**

- **BBE 8888** - Thesis Credit: Doctoral (1.0 - 24.0 cr)
Twin Cities Campus
Conservation Sciences M.S.
Fisheries, Wildlife, and Conservation Biology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Fisheries, Wildlife, and Conservation Biology, 135 B Skok Hall, 2003 Upper Buford Circle, St. Paul, MN 55108 (612-624-7751)
Email: conssci@umn.edu
Website: http://www.conssci.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The conservation sciences (CS) program has two complementary objectives leading to a unique multidisciplinary program. The first is to provide students with sound graduate training in the biological sciences relevant to the global conservation of plants, animals, and ecosystems. The second objective promotes the study of social, political, and economic sciences that relate to recognition and solution of conservation problems. Students may select one of the two tracks, 1) conservation science or 2) fisheries and aquatic biology. Students may also pursue a joint degree in law and conservation sciences through the joint law degree program. The overall goal of the program is to prepare students to develop solutions or approaches to address problems that are scientifically and environmentally sound and likely to be acted upon or implemented within their social and political context.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

A BS/BA degree in biology or a closely related field is preferred. Applicants with a baccalaureate degree in another field are accepted, but may be required to take selected courses in biology.

Special Application Requirements:
A statement of career goals and three letters of recommendation evaluating the applicant's potential for graduate study are required. Scores less than five years old from the General Test of the GRE are required. TOEFL is required for applicants who speak English as a second language. Applicants to the joint law degree program must also apply to the Law School. Application deadline is December 15. Typically, students only are admitted for fall semester.

Applicants must submit their test score(s) from the following:
• GRE

International applicants must submit score(s) from one of the following tests:
• TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
• IELTS
  - Total Score: 6.5
• MELAB
  - Final score: 80
• MN Batt
Key to test abbreviations: GRE, TOEFL, IELTS, MELAB, MN Batt.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

Plan A: Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 14 major credits and 6 credits outside the major. The final exam is oral. A capstone project is required.

Capstone Project: Plan B master's students must demonstrate familiarity with the tools of research or scholarship in their major field, the ability to work independently, and the ability to present the results of their investigation effectively, by completing at least one Plan B project. The Plan B project should involve a combined total of approximately 120 hours (the equivalent of three full-time weeks) of work. The advisory committee specifies both the nature and extent of the options available to satisfy this requirement, subject to approval by the director of graduate studies. The Plan B project must be satisfied independent of the courses in the student's program.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.0 is required to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

Core Course

Take the following course for 3 credits:
FW 8452 - Conservation Biology (3.0 cr)

Seminar Requirement

Take 2 semesters of CBIO 8001. Students in the fisheries and aquatic biology track may substitute one semester of CBIO 8001 with FW 8200.
Take 2 or more credit(s) from the following:
• CONS 8001 - Conservation Biology Seminar (1.0 cr)
• FW 8200 - Seminar (1.0 - 4.0 cr)

Statistics Requirement

Take at least one 3-credit statistics or systematics course from following list, or select other 5xxx- or 8xxx-level coursework in consultation with the advisory committee.
Take 3 or more credit(s) from the following:
• BIOL 5272 - Applied Biostatistics (3.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• STAT 5302 - Applied Regression Analysis (4.0 cr)
• STAT 5303 - Designing Experiments (4.0 cr)
• STAT 5421 - Analysis of Categorical Data (3.0 cr)
• STAT 5601 - Nonparametric Methods (3.0 cr)
• FW 8051 - Statistical Modeling of Ecological Data using R and WinBugs/JAGS (4.0 cr)
• EEB 5371 - Principles of Systematics (3.0 cr)

Plan Options

Plan A
Take at least 10 master's thesis credits.
CONS 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

- OR -

Plan B
Take an additional 10 elective course credits, chosen in consultation with the advisor. Coursework may be from the electives section of the chosen track, or other 5xxx- or 8xxx-level courses.

Joint- or Dual-degree Coursework: JD/Conservation Sciences-MS
Student may take a total of 12 credits in common among the academic programs.
Program Sub-plans

Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.

Conservation Science

The conservation science track is available for students wishing to emphasize this concentration within the conservation sciences degree. The track provides structure and oversight for students interested in the interface of population, species, and ecosystem biology with disciplines of social sciences, education, economics. The conservation science track name will be posted to the transcript.

Conservation Science - Electives

Take at least 12 (Plan A) or at least 22 (Plan B) elective credits from the following list, or select other 5xxx- or 8xxx-level coursework in consultation with the advisory committee.

Take 12 or more credit(s) from the following:
- **APEC 5151** - Applied Microeconomics: Firm and Household (3.0 cr)
- **APEC 5651** - Economics of Natural Resource and Environmental Policy (3.0 cr)
- **EEB 4129** - Mammalogy (4.0 cr)
- **EEB 4134** - Introduction to Ornithology (4.0 cr)
- **EEB 5042** - Quantitative Genetics (3.0 cr)
- **EEB 5327** - Behavioral Ecology (3.0 cr)
- **EEB 5409** - Evolution (3.0 cr)
- **EEB 5609** - Ecosystem Ecology (3.0 cr)
- **ENT 4231** - Insect Behavior (3.0 cr)
- **ENT 5011** - Insect Structure and Function (4.0 cr)
- **ENT 5041** - Insect Ecology (3.0 cr)
- **EPSY 5221** - Principles of Educational and Psychological Measurement (3.0 cr)
- **EPSY 5243** - Principles and Methods of Evaluation (3.0 cr)
- **EPSY 8221** - Psychological Scaling (3.0 cr)
- **FNRM 5104** - Forest Ecology (4.0 cr)
- **FNRM 5114** - Hydrology and Watershed Management (3.0 cr)
- **FNRM 5131** - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- **FNRM 5203** - Forest Fire and Disturbance Ecology (3.0 cr)
- **FNRM 5204** - Landscape Ecology and Management (3.0 cr)
- **FNRM 5262** - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
- **FW 5003** - Human Dimensions of Biological Conservation (3.0 cr)
- **FW 5051** - Analysis of Populations (4.0 cr)
- **FW 5603W** - Habitats and Regulation of Wildlife [WI] (3.0 cr)
- **FW 5625** - Wildlife Handling and Immobilization for Research and Management (2.0 cr)
- **GEOG 8280** - Biogeography (3.0 cr)
- **HORT 5071** - Ecological Restoration (4.0 cr)
- **LA 5202** - Landscape Analysis Workshop (1.0 cr)
- **LA 5204** - Metropolitan Landscape Ecology (3.0 cr)
- **PA 5251** - Strategic Planning and Management (3.0 cr)
- **PA 5253** - Designing Planning and Participation Processes (3.0 cr)
- **PA 5501** - Theories and Policies of Development (3.0 cr)
- **PA 5511** - Community Economic Development (3.0 cr)
- **VMED 5181** - Spatial Analysis in Infectious Disease Epidemiology (3.0 cr)

Fisheries and Aquatic Biology

Three-quarters of the global ecosystem is water and most is a global commons. Many biologists and economists argue that freshwater is one of the most critical global resources and that the functional integrity and biodiversity within freshwater and marine ecosystems are highly threatened. The fisheries and aquatic biology (FAB) track is available for MS, PhD, and joint degree students wishing to emphasize this concentration. The track name will be posted to the transcript, and may be useful to the graduate for obtaining jobs with many federal and state agencies where such expertise is specified in job announcements or hiring criteria. The track designation clearly indicates that the student has specialized coursework and research or project experience leading to expertise in fisheries or aquatic biology. Combined with a typical undergraduate degree in biology or natural resource science, careful selection of courses in the graduate program will satisfy the educational requirements for professional certification by the American Fisheries Society.

Students in the track must be advised or co-advised by a faculty member affiliated with the track. Requests for admission to the track may be made during the application process or at any time after the student is admitted to conservation sciences. Students in the track must meet all MS degree requirements.

Students who designate this track will be expected to work closely with their Student Advisory Committee (SAC) to develop an appropriate course of study. The track coordinator will review each student's academic program to examine how track expectations are met and forward it with a recommendation to the director of graduate studies for approval.
Fisheries & Aquatic Biology - Required Courses
Take a minimum of 6 credits from the following list. Other advanced courses or colloquia on fisheries or aquatic biology, not listed here, may satisfy track requirements; consult with the track coordinator.
Take 6 or more credit(s) from the following:
• EEB 5601 - Limnology (3.0 cr)
• EEB 5605 - Limnology Laboratory (2.0 cr)
• EEB 8601 - Introduction to Stream Restoration (3.0 cr)
• EEB 8602 - Stream Restoration Practice (2.0 cr)
• ENT 5361 - Aquatic Insects (4.0 cr)
• FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
• FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
• FW 4401 - Fish Physiology and Behavior (3.0 cr)
• FW 5136 - Ichthyology (4.0 cr)
• FW 5601 - Fisheries Population Analysis (3.0 cr)
• FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
• FW 8459 - Stream and River Ecology (3.0 cr)
• FW 8465 - Fish Habitats and Restoration (3.0 cr)

Fisheries & Aquatic Biology - Electives
Take at least 6 (Plan A) or 16 (Plan B) course credits from following list, or select 5xxx- or 8xxx-level coursework in consultation with the advisory committee.
Take 6 or more credit(s) from the following:
• APEC 5151 - Applied Microeconomics: Firm and Household (3.0 cr)
• APEC 5651 - Economics of Natural Resource and Environmental Policy (3.0 cr)
• EEB 5042 - Quantitative Genetics (3.0 cr)
• EEB 5327 - Behavioral Ecology (3.0 cr)
• EEB 5409 - Evolution (3.0 cr)
• EEB 5609 - Ecosystem Ecology (3.0 cr)
• ENT 4231 - Insect Behavior (3.0 cr)
• ENT 5011 - Insect Structure and Function (4.0 cr)
• ENT 5041 - Insect Ecology (3.0 cr)
• EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
• EPSY 5243 - Principles and Methods of Evaluation (3.0 cr)
• EPSY 8221 - Psychological Scaling (3.0 cr)
• FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
• FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
• FNRM 5204 - Landscape Ecology and Management (3.0 cr)
• FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
• FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
• FW 5051 - Analysis of Populations (4.0 cr)
• GEOG 8280 - Biogeography (3.0 cr)
• HORT 5071 - Ecological Restoration (4.0 cr)
• LA 5202 - Landscape Analysis Workshop (1.0 cr)
• LA 5204 - Metropolitan Landscape Ecology (3.0 cr)
• PA 5251 - Strategic Planning and Management (3.0 cr)
• PA 5253 - Designing Planning and Participation Processes (3.0 cr)
• PA 5511 - Community Economic Development (3.0 cr)
• VMED 5181 - Spatial Analysis in Infectious Disease Epidemiology (3.0 cr)
**Twin Cities Campus**

**Conservation Sciences Minor**

Fisheries, Wildlife, and Conservation Biology

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

**Contact Information:**
Department of Fisheries, Wildlife, and Conservation Biology, 135 B Skok Hall, 2003 Upper Buford Circle, St. Paul, MN 55108 (612-624-7751)
Email: consbio@umn.edu
Website: http://www.consbio.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 7
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The conservation sciences (CS) program has two complementary objectives leading to a unique multidisciplinary program. The first is to provide students with sound graduate training in the biological sciences relevant to the global conservation of plants, animals, and ecosystems. The second objective promotes the study of social, political, and economic sciences that relate to recognition and solution of conservation problems. Students may select a named track, fisheries and aquatic biology, which offers an aquatic specialization. Students may also pursue a joint degree in law and conservation biology through the joint law degree program. The overall goal of the program is to prepare students to develop solutions or approaches to address problems that are scientifically and environmentally sound and likely to be acted upon or implemented within their social and political context.

**Program Delivery**
This program is available:
- via classroom (the majority of instruction is face-to-face)

**Prerequisites for Admission**
The preferred undergraduate GPA for admittance to the program is 3.00.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

**Program Requirements**
Use of 4xxx courses towards program requirements is not permitted.

**Program Sub-plans**
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

**Masters**
- Core Course
  - FW 8452 - Conservation Biology (3.0 cr)
- Seminar
  - CONS 8001 - Conservation Biology Seminar (1.0 cr)
- Electives
  - Three credits of electives in consultation with the director of graduate studies.

**Doctoral**
- Core Course
FW 8452 - Conservation Biology (3.0 cr)

Seminar
2 credits required including at least one credit of CBIO 8001.
Take 2 or more credit(s) from the following:
• CONS 8001 - Conservation Biology Seminar (1.0 cr)
• FW 8200 - Seminar (1.0 - 4.0 cr)

Electives
7 credits of electives in consultation with the director of graduate studies.
Twin Cities Campus
Conservation Sciences Ph.D.
Fisheries, Wildlife, and Conservation Biology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Fisheries, Wildlife, and Conservation Biology, 135 B Skok Hall, 2003 Upper Buford Circle, St. Paul, MN 55108 (612-624-7751)
Email: consbio@umn.edu
Website: http://www.consbio.umn.edu

• Program Type: Doctorate
• Requirements for this program are current for Fall 2016
• Length of program in credits: 48
• This program does not require summer semesters for timely completion.
• Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The conservation sciences (CS) program has two complementary objectives leading to a unique multidisciplinary program. The first is to provide students with sound graduate training in the biological sciences relevant to the global conservation of plants, animals, and ecosystems. The second objective promotes the study of social, political, and economic sciences that relate to recognition and solution of conservation problems. Students may select one of two tracks, conservation science track or fisheries and aquatic biology track. Students may also pursue a joint degree in law and conservation sciences through the joint law degree program. The overall goal of the program is to prepare students to develop solutions or approaches to address problems that are scientifically and environmentally sound and likely to be acted upon or implemented within their social and political context.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.50.

Other requirements to be completed before admission:
A BS/BA degree in biology or a closely related field is preferred. Applicants with a baccalaureate degree in another field are accepted, but these individuals may be required to take selected courses in biology. In general, PhD applicants holding a baccalaureate degree are first expected to complete a master's degree.

Special Application Requirements:
A statement of career goals and three letters of recommendation evaluating the applicant's potential for graduate study are required. Three letters of recommendation are required. Scores less than five years old from the General Test of the GRE are required. TOEFL is required for applicants who speak English as a second language. Applicants to the joint law degree program must also apply to the Law School. Application deadline is January 1. Typically, students are admitted only for fall semester.

Applicants must submit their test score(s) from the following:
• GRE

International applicants must submit score(s) from one of the following tests:
• TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
• IELTS
  - Total Score: 6.5
• MELAB
  - Final score: 80

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The University of Minnesota is an equal opportunity educator and employer.
Information current as of December 20, 2016
The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
12 credits are required in the major.
12 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.0 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

PhD students complete 48 credits, 24 credits in courses and 24 thesis credits. Students are expected to show competency in both the biological and social sciences. With their advisory committee, students develop a program that emphasizes the ecological and social aspects of conservation. Dissertation research may require proficiency in supporting areas (e.g., statistics, computing, communications).

Core Courses
All PhD students are required to take following core courses
FW 8452 - Conservation Biology (3.0 cr)
CONS 8095 - Contemporary Problems in Conservation Biology (1.0 cr)

Seminar Requirement
PhD students are required to take 3 semesters of conservation biology seminar, CBIO 8001. FAB track PhD students may substitute 1-2 semesters of FW 8200 to meet 3 semester conservation biology seminar requirement.
Take 3 or more credit(s) from the following:
• CONS 8001 - Conservation Biology Seminar (1.0 cr)
• FW 8200 - Seminar (1.0 - 4.0 cr)

Statistics Requirement
PhD students should take one statistics course (minimum of 3 semester credits) from the following list, or choose from 5- or 8-xxx level courses in other departments in consultation with the advisor and/or SAC.
Take 3 or more credit(s) from the following:
• BIOL 5272 - Applied Biostatistics (3.0 cr)
• EPSY 8251 - Statistical Methods in Education I (3.0 cr)
• EPSY 8252 - Statistical Methods in Education II (3.0 cr)
• EPSY 8261 - Statistical Methods in Education I (3.0 cr)
• EPSY 8262 - Statistical Methods in Education II (3.0 cr)
• FW 8051 - Statistical Modeling of Ecological Data using R and WinBugs/JAGS (4.0 cr)
• PSY 8960 - Graduate Seminar in Psychology (1.0 - 4.0 cr)
• PUBH 6810 - Survey Research Methods (3.0 cr)
• PUBH 7430 - Statistical Methods for Correlated Data (3.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• STAT 5302 - Applied Regression Analysis (4.0 cr)
• STAT 5303 - Designing Experiments (4.0 cr)
• STAT 5421 - Analysis of Categorical Data (3.0 cr)
• STAT 5601 - Nonparametric Methods (3.0 cr)

Thesis
All PhD students are required to take 24 thesis semester credits
CONS 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

Joint- or Dual-degree Coursework: Joint degree in conservation sciences and law Student may take a total of 12 credits in common among the academic programs.
Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Conservation Science
Conservation science track is available for MS, PhD, and joint degree students wishing to emphasize this concentration within a conservation sciences. This track name will be indicated on the student’s transcript. This track provides structure and oversight for students interested in the interface of population, species, and ecosystem biology with disciplines of social sciences, education, economics.

Conservation Science - Electives
Doctoral students should take a minimum of 14 credits from the following list, or choose 5- or 8-xxx level courses from other departments in consultation with SAC to meet minimum credit requirements.
Take 14 or more credit(s) from the following:
- APEC 5151 - Applied Microeconomics: Firm and Household (3.0 cr)
- APEC 5651 - Economics of Natural Resource and Environmental Policy (3.0 cr)
- EEB 4129 - Mammalogy (4.0 cr)
- EEB 4134 - Introduction to Ornithology (4.0 cr)
- EEB 5042 - Quantitative Genetics (3.0 cr)
- EEB 5327 - Behavioral Ecology (3.0 cr)
- EEB 5409 - Evolution (3.0 cr)
- EEB 5601 - Limnology (3.0 cr)
- EEB 5609 - Ecosystem Ecology (3.0 cr)
- EEB 8550 - Graduate Research Fellowship Proposal Writing Seminar (1.0 cr)
- ENT 4021 - Honey Bees and Insect Societies (3.0 cr)
- ENT 4231 - Insect Behavior (3.0 cr)
- ENT 5011 - Insect Structure and Function (4.0 cr)
- ENT 5041 - Insect Ecology (3.0 cr)
- EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
- EPSY 5243 - Principles and Methods of Evaluation (3.0 cr)
- EPSY 8221 - Psychological Scaling (3.0 cr)
- FNRM 5104 - Forest Ecology (4.0 cr)
- FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
- FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- FNRM 5203 - Forest Fire and Disturbance Ecology (3.0 cr)
- FNRM 5204 - Landscape Ecology and Management (3.0 cr)
- FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
- FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
- FW 5051 - Analysis of Populations (4.0 cr)
- FW 5401 - Fish Physiology and Behavior (3.0 cr)
- FW 5603W - Habitats and Regulation of Wildlife [WI] (3.0 cr)
- FW 5625 - Wildlife Handling and Immobilization for Research and Management (2.0 cr)
- GEOG 8280 - Biogeography (3.0 cr)
- GRAD 8101 - Teaching in Higher Education (3.0 cr)
- GRAD 8102 - Practicum for Future Faculty (3.0 cr)
- HORT 5071 - Ecological Restoration (4.0 cr)
- ISG 5010 - Risk Analysis for Introduced Species and Genotypes (3.0 cr)
- ISG 5020 - Risk Analysis Modeling for Introduced Species and Genotypes (1.0 cr)
- ISG 5031 - Discussions in Introduced Species and Genotypes (1.0 cr)
- ISG 8021 - Problem Solving Practicum in Risk Analysis (3.0 cr)
- ISG 8031 - Cooperative Learning Practicum (1.0 cr)
- LA 5202 - Landscape Analysis Workshop (1.0 cr)
- LA 5204 - Metropolitan Landscape Ecology (3.0 cr)
- PA 5251 - Strategic Planning and Management (3.0 cr)
- PA 5253 - Designing Planning and Participation Processes (3.0 cr)
- PA 5501 - Theories and Policies of Development (3.0 cr)
- PA 5511 - Community Economic Development (3.0 cr)
- VMED 5181 - Spatial Analysis in Infectious Disease Epidemiology (3.0 cr)

Fisheries and Aquatic Biology
Three-quarters of the global ecosystem is water and most is a global commons. Many biologists and economists argue that freshwater is one of the most critical global resources and that the functional integrity and biodiversity within freshwater and marine ecosystems are highly threatened. The fisheries and aquatic biology (FAB) track is available for MS, PhD, and joint degree students wishing to...
emphasize this concentration within a CS major. The track name will be indicated on the student's transcript and may be useful to the graduate for obtaining jobs with many federal and state agencies where such expertise is specified in job announcements or hiring criteria. The track designation clearly indicates that the student has specialized coursework and research or project experience leading to expertise in fisheries or aquatic biology. Combined with a typical undergraduate degree in biology or natural resource science, careful selection of courses in the graduate program will satisfy the educational requirements for professional certification by the American Fisheries Society.

Students in the track must be advised or co-advised by a faculty member affiliated with the track. Request for admission to the track may be made during the application process or any time after the student is admitted to the CS graduate program. Students in the track must meet all requirements for the PhD in CS.

Students who designate this track will be expected to work closely with their Student Advisory Committee (SAC) to develop an appropriate course of study. The track coordinator will review each student's academic program to examine how track expectations are met and forward it with a recommendation to the director of graduate studies for approval.

**Fisheries and Aquatic Biology - Required Courses**

In addition to course requirements for the conservation sciences major, PhD students in fisheries and aquatic biology track are required to take minimum of 8 semester credits from following list. Other advanced courses or colloquia on fisheries or aquatic biology that are not listed here may also satisfy needs of students in the track. Please check with FAB track coordinator to add other courses.

Take 8 or more credit(s) from the following:

- EEB 5601 - Limnology (3.0 cr)
- EEB 5605 - Limnology Laboratory (2.0 cr)
- EEB 8601 - Introduction to Stream Restoration (3.0 cr)
- EEB 8602 - Stream Restoration Practice (2.0 cr)
- ENT 5361 - Aquatic Insects (4.0 cr)
- FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
- FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
- FW 4401 - Fish Physiology and Behavior (3.0 cr)
- FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
- FW 5051 - Analysis of Populations (4.0 cr)
- FW 5136 - Ichthyology (4.0 cr)
- FW 5601 - Fisheries Population Analysis (3.0 cr)
- FW 8459 - Stream and River Ecology (3.0 cr)
- FW 8465 - Fish Habitats and Restoration (3.0 cr)

**Fisheries and Aquatic Biology - Electives**

PhD students should take a minimum of 6 semester credits either from the following list, or choose 5- or 8-xxxx courses from other departments in consultation with the advisor and/or SAC.

Take 6 or more credit(s) from the following:

- APEC 5151 - Applied Microeconomics: Firm and Household (3.0 cr)
- APEC 5651 - Economics of Natural Resource and Environmental Policy (3.0 cr)
- EEB 5042 - Quantitative Genetics (3.0 cr)
- EEB 5327 - Behavioral Ecology (3.0 cr)
- EEB 5409 - Evolution (3.0 cr)
- EEB 5601 - Limnology (3.0 cr)
- EEB 5609 - Ecosystem Ecology (3.0 cr)
- EEB 8550 - Graduate Research Fellowship Proposal Writing Seminar (1.0 cr)
- ENT 4231 - Insect Behavior (3.0 cr)
- ENT 5011 - Insect Structure and Function (4.0 cr)
- ENT 5041 - Insect Ecology (3.0 cr)
- EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
- EPSY 5243 - Principles and Methods of Evaluation (3.0 cr)
- EPSY 8221 - Psychological Scaling (3.0 cr)
- FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
- FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- FNRM 5203 - Forest Fire and Disturbance Ecology (3.0 cr)
- FNRM 5204 - Landscape Ecology and Management (3.0 cr)
- FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
- FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
- FW 5051 - Analysis of Populations (4.0 cr)
- FW 5401 - Fish Physiology and Behavior (3.0 cr)
- FW 5603W - Habitats and Regulation of Wildlife [WI] (3.0 cr)
- FW 5625 - Wildlife Handling and Immobilization for Research and Management (2.0 cr)
- GEOG 8280 - Biogeography (3.0 cr)
- GRAD 8101 - Teaching in Higher Education (3.0 cr)
- GRAD 8102 - Practicum for Future Faculty (3.0 cr)
• HORT 5071 - Ecological Restoration (4.0 cr)
• ISG 5010 - Risk Analysis for Introduced Species and Genotypes (3.0 cr)
• ISG 5020 - Risk Analysis Modeling for Introduced Species and Genotypes (1.0 cr)
• ISG 8001 - Discussions in Introduced Species and Genotypes (1.0 cr)
• ISG 8021 - Problem Solving Practicum in Risk Analysis (3.0 cr)
• ISG 8031 - Cooperative Learning Practicum (1.0 cr)
• LA 5202 - Landscape Analysis Workshop (1.0 cr)
• LA 5204 - Metropolitan Landscape Ecology (3.0 cr)
• PA 5251 - Strategic Planning and Management (3.0 cr)
• PA 5253 - Designing Planning and Participation Processes (3.0 cr)
• PA 5501 - Theories and Policies of Development (3.0 cr)
• PA 5511 - Community Economic Development (3.0 cr)
• VMED 5181 - Spatial Analysis in Infectious Disease Epidemiology (3.0 cr)
Twin Cities Campus
Entomology M.S.
Entomology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Entomology, 1980 Folwell Avenue, 219 Hodson Hall, St. Paul, MN 55108 (612-624-3636; fax: 612-625-5299)
Email: entodept@umn.edu
Website: http://www.entomology.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Entomology centers on the study of insects and includes specializations in ecology, behavior, molecular biology, microbiology, neurobiology, physiology, population dynamics, systematics, and taxonomy. Specialized or applied areas include apiculture, biological control, cell culture, insect conservation, insect-vector relations, integrated pest management, and modeling. Research programs are active in aquatic systems, forest systems, crop and animal agriculture, human health, and natural and urban environments.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
A bachelor's degree with a major in a biological science is a prerequisite. Preference is given to students with a broad background in the basic sciences. Admission depends primarily on applicant's undergraduate record, letters of recommendation, and the statement of interest from the applicant.

Special Application Requirements:
Applicants must submit a complete set of official transcripts and a clearly written statement of career interests, goals, and objectives. Three letters of recommendation are required from persons well acquainted with the student's academic record, and should be either uploaded or sent directly to the department.

Applicants must submit their test score(s) from the following:
• GRE

International applicants must submit score(s) from one of the following tests:
• TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.
Program Requirements

Plan A: Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 18 major credits and 12 credits outside the major. The final exam is oral.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

Required Coursework

ENT 5011 - Insect Structure and Function (4.0 cr)
ENT 5021 - Insect Biodiversity and Evolution (4.0 cr)
ENT 5041 - Insect Ecology (3.0 cr)

or ENT 5045 - Insect Population Dynamics (3.0 cr)

Plan Options

Plan A Requirements

Graduate Seminar
Take at least 1 credit of the following:
ENT 8300 - Graduate Seminar (1.0 - 2.0 cr)

Ethics Course Requirement
Take the following course for 1 credit. A different course or activity(ies) can be substituted with the approval of the Entomology director of graduate studies.
ENT 8061 - Scientific Communication and Ethics (1.0 cr)

Electives
Take at least 7 credits in consultation with the advisor.

Master's Thesis Credits
Take at least 10 master's thesis credits.
ENT 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

-OR-

Plan B Requirements

Take the following course for at least 6 credits:
ENT 5910 - Special Problems in Entomology (1.0 - 6.0 cr)

Ethics Course Requirement
Take the following course for 1 credit. A different course or activity(ies) can be substituted with the approval of the Entomology director of graduate studies.
ENT 8061 - Scientific Communication and Ethics (1.0 cr)

Electives
Take at least 12 credits in consultation with the advisor.
Twin Cities Campus

Entomology Minor

Entomology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Entomology, 1980 Folwell Ave, 219 Hodson Hall, St. Paul, MN 55108 (612-624-3636; fax: 612-625-5299)
Email: entodept@umn.edu
Website: http://www.entomology.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Entomology centers on the study of insects and includes specializations in ecology, behavior, molecular biology, microbiology, neurobiology, physiology, population dynamics, systematics, and taxonomy. Specialized or applied areas include apiculture, biological control, cell culture, insect conservation, insect-vector relations, integrated pest management, and modeling. Research programs are active in aquatic systems, forest systems, crop and animal agriculture, human health, and natural and urban environments.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Program Sub-plans
Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.

Masters
Courses are chosen in consultation with the student's major advisor and the Entomology director of graduate studies.

Master's Course List
Take at least six credits from the following:
ENT 4xxx
ENT 5xxx
ENT 8xxx

Doctoral
Courses are chosen in consultation with the student's major advisor and the Entomology director of graduate studies.

Doctoral Course List
Take at least 12 credits from the following:
**Twin Cities Campus**

**Entomology Ph.D.**

Entomology

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

**Contact Information:**
Department of Entomology, 1980 Folwell Avenue, 219 Hodson Hall, St. Paul, MN 55108 (612-624-3636; fax: 612-625-5299)
Email: entodept@umn.edu
Website: http://www.entomology.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2016
- Length of program in credits: 48
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Entomology centers on the study of insects and includes specializations in ecology, behavior, molecular biology, microbiology, neurobiology, physiology, population dynamics, systematics, and taxonomy. Specialized or applied areas include apiculture, biological control, cell culture, insect conservation, insect-vector relations, integrated pest management, and modeling. Research programs are active in aquatic systems, forest systems, crop and animal agriculture, human health, and natural and urban environments.

**Program Delivery**
This program is available:
- via classroom (the majority of instruction is face-to-face)

**Prerequisites for Admission**
The preferred undergraduate GPA for admittance to the program is 3.00.

A GPA of 3.00 (on a 4.00 scale).

A 3.50 GPA (on a 4.00 scale) for prior graduate work is preferred for admission.

Other requirements to be completed before admission:
A bachelor's degree with a major in a biological science is a prerequisite. Preference is given to students with a broad background in the basic sciences. Admission depends primarily on applicant's undergraduate record, letters of recommendation, and the statement of interest from the applicant.

**Special Application Requirements:**
Applicants must submit a complete set of official transcripts and a clearly written statement of career interests, goals, and objectives. Three letters of recommendation are required from persons well acquainted with the student's academic record, and should be either uploaded or sent directly to the department.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL).
Program Requirements
13 to 24 credits are required in the major.
0 to 11 credits are required outside the major.
24 thesis credits are required.
This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

In addition to coursework, students must accumulate three written examination points.

Core Courses
11 credits required
ENT 5021 - Insect Biodiversity and Evolution (4.0 cr)
ENT 5011 - Insect Structure and Function (4.0 cr)
ENT 5041 - Insect Ecology (3.0 cr)
or ENT 5045 - Insect Population Dynamics (3.0 cr)

Seminar Requirement
2 credits required
ENT 8300 - Graduate Seminar (1.0 - 2.0 cr)

Electives
Up to 11 credits required.

Students must work with their advisor(s) when selecting electives outside of the entomology program. Elective courses must be taken at the graduate (4xxx-8xxx) level. Elective courses can be taken from entomology or any University of Minnesota department.

Thesis Credits
24 credits required
ENT 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)
Twin Cities Campus
Food Science M.S.
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/graduate_programs/foodsciencegraduate/index.htm

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Food science applies scientific principles to the manufacture, distribution, marketing, and consumer aspects of food. Food scientists apply the basic principles and techniques of many disciplines, including chemistry, physics, microbiology, and nutrition, to food processing and preservation, new product development, and food marketing. Food scientists are concerned with the theoretical and practical aspects of the food chain, from the production of raw materials to the use of food products by consumers. Students may emphasize the chemistry, engineering, microbiology, nutrition, or technology of food products.

Students may spend a maximum of five (5) years in this degree program.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Applicants to the program need a bachelor's degree, or its international equivalent, in any field.

Other requirements to be completed before admission:
The minimum requirements are general chemistry with laboratory, organic chemistry with laboratory, physics with laboratory, biology with laboratory, and calculus. If preparation appears inadequate, certain additional courses may be required after admission.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.
Program Requirements

Plan A: Plan A requires 20 major credits, 0 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 30 major credits and 0 credits outside the major. The final exam is oral. A capstone project is required.

Capstone Project: The Plan B project is equivalent to 120 hours of work or three full weeks of research and writing. It should consist of one of the following options, which are intended to familiarize the candidate with the tools of research or scholarship in the field and serve to demonstrate the ability to work independently: 1) The candidate may prepare one paper equivalent to 120 hours of work in one advanced course, over and above the normal course requirement as approved by the instructor in consultation with the advisor. This course must be from the major field of interest. 2) The candidate may prepare one paper equivalent to the requirement of 120 hours in some related field or course as approved in consultation with the instructor and the adviser. 3) The student may do an equivalent amount of library or laboratory research and write a research report to satisfy the requirement as approved by the adviser. This may take the form of a research proposal.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 2.80 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

All students are expected to participate as teaching assistants during their graduate careers. Up to 9 credits of 4xxx-level courses are allowed.

Required Courses

All students take the following required courses for 11 credits:
- FSCN 4112 - Food Chemistry and Functional Foods (3.0 cr)
- FSCN 4121 - Food Microbiology (3.0 cr)
- FSCN 4332 - Food Processing Operations (3.0 cr)
- FSCN 8318 - Current Issues in Food Science (2.0 cr)

Take one of the following courses for a total of 2 to 4 credits:
- FSCN 5122 - Food Fermentations and Biotechnology (2.0 cr)
- or FSCN 5131 - Food Quality for Graduate Credit (3.0 cr)
- or FSCN 5312 - Food Analysis (4.0 cr)

Additional FSCN Credits

Take at least 3 additional FSCN credits, in consultation with the advisor.
- FSCN 5xxx
- or FSCN 8xxx

Electives

Choose remaining credits in consultation with the advisor to meet minimum credit requirements.

Plan Options

Plan A

Take 10 master's thesis credits.
- FSCN 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

-OR-

Plan B

Plan B students do not have additional requirements.
Twin Cities Campus
Food Science Minor
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/education/foodsciencegraduate/index.htm

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 10
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Food science applies scientific principles to the manufacture, distribution, marketing, and consumer aspects of food. Food scientists apply the basic principles and techniques of many disciplines, including chemistry, physics, microbiology, and nutrition, to food processing and preservation, new product development, and food marketing. Food scientists are concerned with the theoretical and practical aspects of the food chain, from the production of raw materials to the use of food products by consumers. Students may emphasize the chemistry, engineering, microbiology, nutrition, or technology of food products.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters
Students wishing to complete the Food Science minor must consult with the Food Science director of graduate studies to establish specific requirements and goals for an acceptable minor program of study.

Required Courses
- FSCN 4112 - Food Chemistry and Functional Foods (3.0 cr)
- FSCN 4121 - Food Microbiology (3.0 cr)
- FSCN 4332 - Food Processing Operations (3.0 cr)

Doctoral
Required Courses
Students wishing to complete the food science minor must consult with the Food Science director of graduate studies to establish specific requirements and goals for an acceptable minor program of study.
In addition to the 3 courses listed below, students pursuing the doctoral minor must take at least 3 5xxx- or 8xxx-level FSCN credits.

- FSCN 4112 - Food Chemistry and Functional Foods (3.0 cr)
- FSCN 4121 - Food Microbiology (3.0 cr)
- FSCN 4332 - Food Processing Operations (3.0 cr)

FSCN 5xxx
FSCN 8xxx
Twin Cities Campus
Food Science Ph.D.
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/graduate_programs/foodsciencegraduate/index.htm

- Program Type: Doctorate
- Requirements for this program are current for Fall 2016
- Length of program in credits: 48
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Food science applies scientific principles to the manufacture, distribution, marketing, and consumer aspects of food. Food scientists apply the basic principles and techniques of many disciplines, including chemistry, physics, microbiology, and nutrition, to food processing and preservation, new product development, and food marketing. Food scientists are concerned with the theoretical and practical aspects of the food chain, from the production of raw materials to the use of food products by consumers. Students may emphasize the chemistry, engineering, microbiology, nutrition, or technology of food products.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Applicants to the program need a bachelor's degree in any field or its international equivalent along with demonstrated research ability such as a MS degree or publications.

Other requirements to be completed before admission:
The minimum requirements are general chemistry with laboratory, organic chemistry with laboratory, physics with laboratory, biology with laboratory, and calculus. If preparation appears inadequate, certain additional courses may be required after admission. Graduate Record Examination (GRE) General Test scores, and the TOEFL (for international students) are also required.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
24 credits are required in the major.
0 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

All students also must participate as teaching assistants during their graduate career.

Required Courses
All students must take the following courses
FSCN 4112 - Food Chemistry and Functional Foods (3.0 cr)
FSCN 4121 - Food Microbiology (3.0 cr)
FSCN 4332 - Food Processing Operations (3.0 cr)
FSCN 8318 - Current Issues in Food Science (2.0 cr)

Course Options
Students must choose one of the following courses.
FSCN 5122 - Food Fermentations and Biotechnology (2.0 cr)
or FSCN 5131 - Food Quality for Graduate Credit (3.0 cr)
FSCN 5312 - Food Analysis (4.0 cr)

FSCN Elective Credits
Students must take at least three (3) FSCN course credits at the 5xxx or 8xxx level in addition to the courses listed above.

Thesis Credits
Food Science PhD students must take 24 thesis credits.
FSCN 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

Elective Courses
Students complete additional 5xxx and 8xxx level FSCN courses, in consultation with their advisor, to total at least 24 credits.
FSCN 5xxx
FSCN 8xxx
Land and Atmospheric Science M.S.

Soil, Water, & Climate

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Soil, Water, and Climate, 439 Borlaug Hall, 191 Upper Buford Circle, St. Paul, MN 55108 (612-625-5251; fax: 612-625-2208)
Email: kjarcho@umn.edu
Website: http://www.laas.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Land and atmospheric science (LAAS) is a science-based interdisciplinary program focused on the fundamentals of Earth system processes related to land and atmosphere and their coupled interactions. Students have the option to develop a program based on one of the more traditional areas in atmospheric science or soil science or to design their own interdisciplinary course of study bridging the two disciplines. The land and atmospheric science graduate program has no formal tracks or emphasis areas, but instead allows students to design a curriculum that addresses their interests within the scope of the program. This multidisciplinary program encompasses aspects of chemistry, physics, biology, atmospheric sciences, and geology.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.20.

BS degree in a related field of science, or a graduate or professional degree.

Required prerequisites

Basic Sciences

Students are expected to have taken a minimum of four of the following courses (or their equivalent).

- MATH 1271 - Calculus I [MATH] (4.0 cr)
- or MATH 1142 - Short Calculus [MATH] (4.0 cr)
- or MATH 2243 - Linear Algebra and Differential Equations (4.0 cr)
- PHYS 1101W - Introductory College Physics I [PHYS, WI] (4.0 cr)
- PHYS 1102W - Introductory College Physics II [PHYS, WI] (4.0 cr)
- or ESPM 3131 - Environmental Physics (3.0 cr)
- or BIOL 1009 - General Biology [BIOL] (4.0 cr)
- or CHEM 1061 - Chemical Principles I [PHYS] (3.0 cr)
- CHEM 1065 - Chemical Principles I Laboratory [PHYS] (1.0 cr)
- CHEM 1062 - Chemical Principles II [PHYS] (3.0 cr)
- CHEM 1066 - Chemical Principles II Laboratory [PHYS] (1.0 cr)
- or STAT 3011 - Introduction to Statistical Analysis [MATH] (4.0 cr)

Environmental Sciences

Students are expected to have taken a minimum of two of the following (or similar) courses:

Take 2 - 6 course(s) from the following:

- ESPM 1011 - Issues in the Environment [ENV] (3.0 cr)
- ESPM 1425 - Introduction to Weather and Climate [PHYS, ENV] (4.0 cr)
- SOIL 2125 - Basic Soil Science [PHYS, ENV] (4.0 cr)
- ESCI 1001 - Earth and Its Environments [PHYS, ENV] (4.0 cr)
• ESPM 3612W - Soil and Environmental Biology [WI] (4.0 cr)
  or MICB 3301 - Biology of Microorganisms (5.0 cr)
• EEB 3407 - Ecology (3.0 cr)

Other requirements to be completed before admission:
Student course admission prerequisites are as shown below. Students who are admitted with deficiencies would be provided with a list of courses they are required to take before the completion of their degree. This list would be developed by the directors of graduate studies in consultation with the student's faculty advisor.

International applicants must submit score(s) from one of the following tests:
• TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
• IELTS
  - Total Score: 6.5
• MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

Plan A: Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 20 major credits and 10 credits outside the major. The final exam is oral. A capstone project is required.

Capstone Project: The Plan B project typically consists of a technical paper of a topic and length acceptable to the student’s advisory committee.

This program may be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

Core Courses
All students must complete the 5-credit core curriculum.
Take exactly 3 course(s) totaling exactly 5 credit(s) from the following:
• LAAS 5050 - Integrated Topics in Land & Atmospheric Science (3.0 cr)
• LAAS 8128 - Land and Atmospheric Science Seminar (1.5 cr)
• SOIL 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)

LAAS and Related Courses
Plan A students must select at least 15 credits (9 major credits and 6 related fields) from this list, and Plan B students must select at least 25 credits (15 major credits and 10 related fields). Courses are selected based on relevance to research interests and with the consent of the advisor.
Take 15 or more credit(s) from the following:
• LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
• LAAS 5425 - Atmospheric Processes I: Thermodynamics and Dynamics of the Atmosphere (3.0 cr)
• LAAS 5426 - Atmospheric Processes II: Radiation, Composition, and Climate (3.0 cr)
• LAAS 5515 - Soil Formation: Earth Surface Processes and Biogeochemistry (3.0 cr)
• AGRO 5121 - Applied Experimental Design (4.0 cr)
• AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
• BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BBE 5608</td>
<td>Environmental and Industrial Microbiolog (3.0 cr)</td>
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<tr>
<td>CEGE 4502</td>
<td>Water and Wastewater Treatment (3.0 cr)</td>
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<td>CEGE 4562</td>
<td>Environmental Remediation Technology (3.0 cr)</td>
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<td>CEGE 5180</td>
<td>Special Topics (1.0 - 4.0 cr)</td>
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<td>CEGE 5511</td>
<td>Urban Hydrology and Water Quality (4.0 cr)</td>
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<tr>
<td>CEGE 5541</td>
<td>Environmental Water Chemistry (3.0 cr)</td>
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<td>CEGE 5542</td>
<td>Experimental Methods in Environmental Engineering (3.0 cr)</td>
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<td>CEGE 5543</td>
<td>Introductory Environmental Fluid Mechanics (4.0 cr)</td>
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<td>CEGE 5551</td>
<td>Environmental Microbiology (3.0 cr)</td>
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<td>CEGE 5561</td>
<td>Air Quality Engineering (3.0 cr)</td>
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<td>CEGE 8501</td>
<td>Environmental Fluid Mechanics I (4.0 cr)</td>
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<td>CEGE 8502</td>
<td>Environmental Fluid Mechanics II (4.0 cr)</td>
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<td>CEGE 8503</td>
<td>Environmental Mass Transport (4.0 cr)</td>
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<td>CEGE 8506</td>
<td>Stochastic Hydrology (4.0 cr)</td>
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<td>CEGE 8521</td>
<td>The Atmospheric Boundary Layer (4.0 cr)</td>
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<td>CEGE 8541</td>
<td>Aquatic Chemistry (3.0 cr)</td>
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<td>CEGE 8542</td>
<td>Chemistry of Organic Pollutants in Environmental Systems (3.0 cr)</td>
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<td>CEGE 8551</td>
<td>Environmental Microbiology: Molecular Theory and Methods (4.0 cr)</td>
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<td>CEGE 8561</td>
<td>Analysis and Modeling of Aquatic Environments I (3.0 cr)</td>
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<tr>
<td>CEGE 8562</td>
<td>Analysis and Modeling of Aquatic Environments II (3.0 cr)</td>
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<td>CEGE 8572</td>
<td>Computational Environmental Fluid Dynamics (4.0 cr)</td>
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<td>EEB 4068</td>
<td>Plant Physiological Ecology (3.0 cr)</td>
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<td>EEB 4611</td>
<td>Biogeochemical Processes (3.0 cr)</td>
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<td>EEB 5053</td>
<td>Ecology: Theory and Concepts (4.0 cr)</td>
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<td>EEB 5601</td>
<td>Limnology (3.0 cr)</td>
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<td>EEB 5605</td>
<td>Limnology Laboratory (2.0 cr)</td>
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<td>ESCI 5102</td>
<td>Climate Change and Human History (3.0 cr)</td>
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<td>ESCI 5205</td>
<td>Fluid Mechanics in Earth and Environmental Sciences (3.0 cr)</td>
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<td>ESCI 5351</td>
<td>Geochemical Modeling of Aqueous Systems (3.0 cr)</td>
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<td>ESCI 5402</td>
<td>Science and Politics of Global Warming (3.0 cr)</td>
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<td>ESCI 8401</td>
<td>Aqueous Environmental Geochemistry (3.0 cr)</td>
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<td>ESCI 8402</td>
<td>Biogeochemical Cycles in the Ocean (3.0 cr)</td>
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<td>ESCI 8801</td>
<td>Geomicrobiology (3.0 cr)</td>
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<td>ESPM 5061</td>
<td>Water Quality and Natural Resources (3.0 cr)</td>
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<td>ESPM 5111</td>
<td>Hydrology and Water Quality Field Methods (3.0 cr)</td>
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<td>ESPM 5245</td>
<td>Sustainable Land Use Planning and Policy (3.0 cr)</td>
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<td>ESPM 5402</td>
<td>Biometeorology (3.0 cr)</td>
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<td>ESPM 5613</td>
<td>Principles of Waste Management (3.0 cr)</td>
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<tr>
<td>FNRM 5114</td>
<td>Hydrology and Watershed Management (3.0 cr)</td>
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<td>FNRM 5131</td>
<td>Geographical Information Systems (GIS) for Natural Resources (4.0 cr)</td>
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<td>FNRM 5153</td>
<td>Forest Hydrology &amp; Watershed Biogeochemistry (3.0 cr)</td>
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<td>FNRM 5262</td>
<td>Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)</td>
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<td>FW 8459</td>
<td>Stream and River Ecology (3.0 cr)</td>
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<td>GEOG 5401</td>
<td>Geography of Environmental Systems and Global Change (4.0 cr)</td>
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<td>GEOG 5426</td>
<td>Climatic Variations (3.0 cr)</td>
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<td>GEOG 5531</td>
<td>Numerical Spatial Analysis (4.0 cr)</td>
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<td>GEOG 5563</td>
<td>GIS Development Practicum (3.0 cr)</td>
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<td>GEOG 5565</td>
<td>Geographical Analysis of Human-Environment Systems (3.0 cr)</td>
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<td>GEOG 5839</td>
<td>Introduction to Dendrochronology (3.0 cr)</td>
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<td>GEOG 8270</td>
<td>Seminar: Climatology (3.0 cr)</td>
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<td>GIS 5555</td>
<td>Basic Spatial Analysis (3.0 cr)</td>
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<td>MICB 4111</td>
<td>Microbial Physiology and Diversity (3.0 cr)</td>
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<td>PBIO 5412</td>
<td>Plant Physiology and Development (3.0 cr)</td>
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<td>PLPA 8103</td>
<td>Plant-Microbe Interactions (3.0 cr)</td>
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<td>PUBH 6100</td>
<td>Topics: Environmental Health (0.5 - 4.0 cr)</td>
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<td>PUBH 6190</td>
<td>Environmental Chemistry (3.0 cr)</td>
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<td>SAQR 8010</td>
<td>Colloquium in Sustainable Agriculture (2.0 cr)</td>
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<td>SOIL 5232</td>
<td>Vadose Zone Hydrology (3.0 cr)</td>
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<td>SOIL 5555</td>
<td>Wetland Soils (3.0 cr)</td>
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<td>SOIL 5611</td>
<td>Soil Biology and Fertility (4.0 cr)</td>
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<td>SOIL 8510</td>
<td>Advanced Topics in Pedology (2.0 - 4.0 cr)</td>
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<td>SOIL 8541</td>
<td>Aquatic and Soil Chemistry (3.0 cr)</td>
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<tr>
<td>STAT 5021</td>
<td>Statistical Analysis (4.0 cr)</td>
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</table>
Plan Options

Plan A
Take 10 or more credit(s) from the following:
• LAAS 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

-OR-

Plan B
Plan B students do not have additional requirements other than those described above.
Twin Cities Campus
Land and Atmospheric Science Minor
Soil, Water, & Climate
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Email: kiarcho@umn.edu
Website: http://www.laas.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 9
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Land and Atmospheric Science (LAAS) is a science-based interdisciplinary program focused on the fundamentals of Earth system processes related to land and atmosphere and their coupled interactions. Students have the option to develop a program based on one of the more traditional areas in atmospheric science or soil science or to design their own interdisciplinary course of study bridging the two disciplines. The Land and Atmospheric Science Graduate Program has no formal tracks or emphasis areas, but instead allows students to design a curriculum that addresses their interests within the scope of the program. This multidisciplinary program encompasses aspects of chemistry, physics, biology, atmospheric sciences, and geology.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.20.

B.S. degree in a related science field.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

All minor courses must be taken A-F, unless approved by the Graduate Advisory Committee, or if they are offered on the S-N basis only. Courses for use in the minor must be selected with the consultation of the Land and Atmospheric Science graduate faculty member serving as the minor advisor and approved by the director of graduate studies.

Program Sub-plans
Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.

Masters
Integrated Topics
All students are required to take the following course.
Take exactly 1 course(s) totaling exactly 3 credit(s) from the following:
• LAAS 5050 - Integrated Topics in Land & Atmospheric Science (3.0 cr)

Other LAAS courses
Take 6 credits for M.S. minor from the following options, or others approved by the DGS and the LAAS graduate faculty member serving as the minor advisor.
Take 6 or more credit(s) from the following:
• LAAS 5051 - Thesis Proposal Writing for Land & Atmospheric Science (2.0 cr)
• LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
• LAAS 5425 - Atmospheric Processes I: Thermodynamics and Dynamics of the Atmosphere (3.0 cr)
• LAAS 5426 - Atmospheric Processes II: Radiation, Composition, and Climate (3.0 cr)
• LAAS 5515 - Soil Formation: Earth Surface Processes and Biogeochemistry (3.0 cr)
• LAAS 8128 - Land and Atmospheric Science Seminar (1.5 cr)

Doctoral
Integrated Topics
All students are required to take the following course.
Take exactly 1 course(s) totaling exactly 3 credit(s) from the following:
• LAAS 5050 - Integrated Topics in Land & Atmospheric Science (3.0 cr)

Other LAAS courses
Take 9 credits for PhD minor from the following options, or others approved by the DGS and the LAAS graduate faculty member serving as the minor advisor.
Take 9 or more credit(s) from the following:
• LAAS 5051 - Thesis Proposal Writing for Land & Atmospheric Science (2.0 cr)
• LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
• LAAS 5425 - Atmospheric Processes I: Thermodynamics and Dynamics of the Atmosphere (3.0 cr)
• LAAS 5426 - Atmospheric Processes II: Radiation, Composition, and Climate (3.0 cr)
• LAAS 5515 - Soil Formation: Earth Surface Processes and Biogeochemistry (3.0 cr)
• LAAS 8128 - Land and Atmospheric Science Seminar (1.5 cr)
Land and Atmospheric Science Ph.D.

Contact Information:
Department of Soil, Water, and Climate, 439 Borlaug Hall, 1911 Upper Buford Circle, St. Paul, MN 55108 (612-625-5251; fax: 612-625-2208)
Email: laas@umn.edu
Website: http://www.laas.umn.edu

• Program Type: Doctorate
• Requirements for this program are current for Fall 2016
• Length of program in credits: 50
• This program does not require summer semesters for timely completion.
• Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Land and atmospheric science (LAAS) is a science-based interdisciplinary program focused on the fundamentals of Earth system processes related to land and atmosphere and their coupled interactions. Students have the option to develop a program based on one of the more traditional areas in atmospheric science or soil science or to design their own interdisciplinary course of study bridging the two disciplines. The Land and atmospheric science graduate program has no formal tracks or emphasis areas, but instead allows students to design a curriculum that addresses their interests within the scope of the program. This multidisciplinary program encompasses aspects of chemistry, physics, biology, atmospheric sciences, and geology.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.20.

Applicants to the LAAS PhD program are expected to have an MS degree or equivalent in a related field of science.

Required prerequisites
Basic Sciences
Students are expected to have taken a minimum of four of the following courses (or their equivalent):
MATH 1271 - Calculus I [MATH] (4.0 cr)
or MATH 1142 - Short Calculus [MATH] (4.0 cr)
MATH 2243 - Linear Algebra and Differential Equations (4.0 cr)
PHYS 1101W - Introductory College Physics I [PHYS, WI] (4.0 cr)
PHYS 1102W - Introductory College Physics II [PHYS, WI] (4.0 cr)
or ESPM 3131 - Environmental Physics (3.0 cr)
or BIOL 1009 - General Biology [BIOL] (4.0 cr)
or CHEM 1061 - Chemical Principles I [PHYS] (3.0 cr)
CHEM 1065 - Chemical Principles I Laboratory [PHYS] (1.0 cr)
CHEM 1062 - Chemical Principles II [PHYS] (3.0 cr)
CHEM 1066 - Chemical Principles II Laboratory [PHYS] (1.0 cr)
or STAT 3011 - Introduction to Statistical Analysis [MATH] (4.0 cr)

Environmental Sciences
Students are expected to have taken a minimum of two of the following (or similar) courses:
Take 2 - 6 course(s) from the following:
• ESPM 1011 - Issues in the Environment [ENV] (3.0 cr)
• ESPM 1425 - Introduction to Weather and Climate [PHYS, ENV] (4.0 cr)
• SOIL 2125 - Basic Soil Science [PHYS, ENV] (4.0 cr)
• ESCI 1001 - Earth and Its Environments [PHYS, ENV] (4.0 cr)
• ESPM 3612W - Soil and Environmental Biology [WI] (4.0 cr)
  or MICB 3301 - Biology of Microorganisms (5.0 cr)
• EEB 3407 - Ecology (3.0 cr)

Other requirements to be completed before admission:
Students with a BS degree and outstanding scholarship can request direct admission to the LAAS PhD program. Each request will be considered on a case-by-case basis by the Graduate Advisory Committee. Evidence of outstanding scholarship may include: peer-reviewed publications, a pre-doctoral fellowship, a National Science Foundation PhD Fellowship, high GPA/GRE scores, or strong previous research experience. Current MS candidates who exhibit outstanding scholarship may request transfer to a PhD degree program after completion of their first two semesters of coursework.

International applicants must submit score(s) from one of the following tests:
• TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
• Paper Based - Total Score: 550
• IELTS
  - Total Score: 6.5
• MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
16 credits are required in the major.
10 credits are required outside the major.
24 thesis credits are required.

This program may not be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

Core Courses
All doctoral students must complete the 10-credit core curriculum.
Take exactly 5 course(s) totaling exactly 10 credit(s) from the following:
• LAAS 5050 - Integrated Topics in Land & Atmospheric Science (3.0 cr)
• LAAS 8128 - Land and Atmospheric Science Seminar (1.5 cr)
• SOIL 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
• LAAS 5051 - Thesis Proposal Writing for Land & Atmospheric Science (2.0 cr)
• GRAD 8101 - Teaching in Higher Education (3.0 cr)

LAAS and Related Courses
Choose courses relevant to particular area of research with consent of advisor. Take at least 6 credits from the following list to complete the 16-credit minimum for the major, and at least 10 credits for the supporting program minimum.
Take 16 or more credit(s) from the following:
• LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
• LAAS 5425 - Atmospheric Processes I: Thermodynamics and Dynamics of the Atmosphere (3.0 cr)
• LAAS 5426 - Atmospheric Processes II: Radiation, Composition, and Climate (3.0 cr)
• LAAS 5515 - Soil Formation: Earth Surface Processes and Biogeochemistry (3.0 cr)
• AGRO 5121 - Applied Experimental Design (4.0 cr)
• AGRO 5221 - Ecology of Agricultural Systems (3.0 cr)
• BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
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<td>Water and Wastewater Treatment (3.0 cr)</td>
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<td>CEGE 4562</td>
<td>Environmental Remediation Technology (3.0 cr)</td>
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<td>CEGE 5180</td>
<td>Special Topics (1.0 - 4.0 cr)</td>
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<td>CEGE 5511</td>
<td>Urban Hydrology and Water Quality (4.0 cr)</td>
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<td>Environmental Water Chemistry (3.0 cr)</td>
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<td>Experimental Methods in Environmental Engineering (3.0 cr)</td>
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<td>CEGE 5561</td>
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<td>Environmental Fluid Mechanics II (4.0 cr)</td>
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<td>CEGE 8503</td>
<td>Environmental Mass Transport (4.0 cr)</td>
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<td>CEGE 8506</td>
<td>Stochastic Hydrology (4.0 cr)</td>
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<td>CEGE 8521</td>
<td>The Atmospheric Boundary Layer (4.0 cr)</td>
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<td>Aquatic Chemistry (3.0 cr)</td>
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<td>CEGE 8542</td>
<td>Chemistry of Organic Pollutants in Environmental Systems (3.0 cr)</td>
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<td>CEGE 8551</td>
<td>Environmental Microbiology: Molecular Theory and Methods (4.0 cr)</td>
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<td>Analysis and Modeling of Aquatic Environments I (3.0 cr)</td>
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<td>Analysis and Modeling of Aquatic Environments II (3.0 cr)</td>
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<td>Computational Environmental Fluid Dynamics (4.0 cr)</td>
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<td>Biogeochemical Processes (3.0 cr)</td>
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<td>EEB 5053</td>
<td>Ecology: Theory and Concepts (4.0 cr)</td>
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<td>EEB 5605</td>
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<td>ESCI 5102</td>
<td>Climate Change and Human History (3.0 cr)</td>
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<td>ESPM 5111</td>
<td>Hydrology and Water Quality Field Methods (3.0 cr)</td>
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<td>ESPM 5245</td>
<td>Sustainable Land Use Planning and Policy (3.0 cr)</td>
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<td>ESPM 5402</td>
<td>Biometeorology (3.0 cr)</td>
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<td>ESPM 5601</td>
<td>Principles of Waste Management (3.0 cr)</td>
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<td>FNRM 5114</td>
<td>Hydrology and Watershed Management (3.0 cr)</td>
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<td>FNRM 5131</td>
<td>Geographical Information Systems (GIS) for Natural Resources (4.0 cr)</td>
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<td>FNRM 5153</td>
<td>Forest Hydrology &amp; Watershed Biogeochemistry (3.0 cr)</td>
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<td>FNRM 5262</td>
<td>Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)</td>
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<td>FW 8459</td>
<td>Stream and River Ecology (3.0 cr)</td>
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<td>Numerical Spatial Analysis (4.0 cr)</td>
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<td>GIS Development Practicum (3.0 cr)</td>
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<td>Geographical Analysis of Human-Environment Systems (3.0 cr)</td>
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<td>GEOG 5839</td>
<td>Introduction to Dendrochronology (3.0 cr)</td>
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<td>Seminar: Climatology (3.0 cr)</td>
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<td>GIS 5555</td>
<td>Basic Spatial Analysis (3.0 cr)</td>
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<td>Microbial Physiology and Diversity (3.0 cr)</td>
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<td>PBIOL 5412</td>
<td>Plant Physiology and Development (3.0 cr)</td>
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<td>PLPA 8103</td>
<td>Plant-Microbe Interactions (3.0 cr)</td>
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<td>PUBH 6100</td>
<td>Topics: Environmental Health (0.5 - 4.0 cr)</td>
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<td>Colloquium in Sustainable Agriculture (2.0 cr)</td>
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<td>Aquatic and Soil Chemistry (3.0 cr)</td>
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<tr>
<td>STAT 5021</td>
<td>Statistical Analysis (4.0 cr)</td>
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</table>
• STAT 5302 - Applied Regression Analysis (4.0 cr)
• STAT 5303 - Designing Experiments (4.0 cr)
• WRS 5101 - Water Policy (3.0 cr)

Thesis credits
Take 24 or more credit(s) from the following:
• LAAS 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)
Twin Cities Campus
Natural Resources Science and Management M.S.
Bioproducts and Biosystems Engineering, Fisheries, Wildlife, and Conservation Biology, Forest Resources
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Forest Resources, 116d Green Hall, 1530 Cleveland Avenue N, St. Paul MN 55108 (612-624-7683; fax: 612-625-5212)
Email: nrsm@umn.edu
Website: http://www.nrsm.umn.edu

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Students in the Natural Resources Science and Management program emphasize one of the following tracks: 1) forests: biology, ecology, conservation, and management; 2) economics, policy, management, and society; 3) assessment, monitoring, and geospatial analysis; 4) recreation resources, tourism, and environmental education; 5) forest hydrology and watershed management; 6) forest products; 7) paper science and engineering; or 8) wildlife ecology and management.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Most admitted students have earned degrees in natural resource-related majors. Applicants with exceptional academic records but no related background are eligible; if admitted, they may complete the prerequisites for advanced courses during the early stages of their graduate program. These prerequisites will vary depending upon the student's track and major advisor.

Applicants will not be admitted unless a member of the program faculty agrees to advise them ahead of time. This decision depends on admissibility (the applicant's overall credentials), mutual research interests, and the faculty member's ability to take on a new student. Some faculty members will not advise students unless they have funding for the student. Applicants are encouraged to review faculty profiles on the program website and begin making contacts prior to and during the application process.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
- Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
  - Reading Score: 6.5
- Writing Score: 6.5
- MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language.
Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

Plan A: Plan A requires 20 major credits, 0 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 30 major credits and up to null credits outside the major. The final exam is oral. A capstone project is required. Capstone Project: Plan B project(s) is(are) designed in consultation with the student's advisor and committee. It(They) must develop and demonstrate competence in the student's track.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

The M.S. is offered under Plan A (with thesis) and Plan B (without thesis). Plan A requires at least 20 coursework credits and Plan B requires at least 30 coursework credits. Plan A students must also register for 10 thesis credits. Plan A students usually design a program to support their specific thesis project. In consultation with faculty members, Plan B students design a program that develops competence in at least one track. Students present a seminar on the thesis or the Plan B project. Specific requirements vary by track and research project; prospective students should contact the director of graduate studies or a prospective faculty advisor for specific information. Students must also receive training in the ethical conduct of research and present a formal seminar to faculty and peers. This presentation is separate from the final exam seminar.

Required Seminar

All students in NRSM must take the Forest Resources Seminar course. This is the only required course for all students. Please see the specific subplan for further course suggestions.

FNRM 8107 - Seminar: Forest Resources (1.0 cr)

Joint- or Dual-degree Coursework: Law, Science & Technology

Student may take a total of 12 credits in common among the academic programs.

Program Sub-plans

A sub-plan is not required for this program. Students may not complete the program with more than one sub-plan.

Assessment, Monitoring, and Geospatial Analysis

Addresses measurements and related technology applications and resource analysis. Graduate students in this track may choose to specialize in topics such as: geographic information systems (GIS); remote sensing; geospatial analysis; survey design (including forest inventory and monitoring), measurement, modeling; and biometrics. Studies typically focus on landscape, region, or global levels.

Assessment, Monitoring, and Geospatial Analysis - Suggested Course List

NRSM students in the assessment, monitoring, and geospatial analysis track should refer to this list when enrolling in courses that are appropriate for their area of study. Plan A students must enroll in 19 coursework credits in addition to their seminar requirement and thesis credits, and Plan B students must enroll in 29 credits in addition to their seminar requirement. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

• AGRO 5121 - Applied Experimental Design (4.0 cr)
• APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
• APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
• APEC 8211 - Econometric Analysis I (4.0 cr)
• APEC 8212 - Econometric Analysis II (4.0 cr)
• CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
• CSCI 5302 - Analysis of Numerical Algorithms (3.0 cr)
• CSCI 5707 - Principles of Database Systems (3.0 cr)
• DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
• ECON 8201 - Econometric Analysis (2.0 cr)
• ECON 8203 - Econometric Analysis (2.0 cr)
• ECON 8204 - Econometric Analysis (2.0 cr)
• EEB 5068 - Plant Physiological Ecology (3.0 cr)
• EEB 5609 - Ecosystem Ecology (3.0 cr)
• EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
• EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
• EPSY 5247 - Qualitative Methods in Educational Psychology (3.0 cr)
• EPSY 5261 - Introductory Statistical Methods (3.0 cr)
• EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
• EPSY 8261 - Statistical Methods in Education I (3.0 cr)
• EPSY 8262 - Statistical Methods in Education II (3.0 cr)
• EPSY 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
• ESPM 5031 - Applied Global Positioning Systems for Geographic Information Systems (3.0 cr)
• ESPM 5071 - Ecological Restoration (4.0 cr)
• ESPM 5101 - Conservation of Plant Biodiversity (3.0 cr)
• ESPM 5111 - Hydrology and Water Quality Field Methods (3.0 cr)
• ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
• ESPM 5242 - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
• ESPM 5261 - Economics and Natural Resources Management (4.0 cr)
• ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
• ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
• FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
• FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
• FNRM 5218 - Measuring and Modeling Forests (3.0 cr)
• FNRM 5228 - Advanced Topics in Assessment and Modeling of Forests (3.0 cr)
• FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
• FNRM 5412 - Advanced Remote Sensing and Geospatial Analysis (3.0 cr)
• FNRM 5471 - Forest Planning and Management (3.0 cr)
• FNRM 8101 - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
• FNRM 8102 - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
• FNRM 8103 - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
• FNRM 8104 - Research Problems: Forest Ecology (1.0 - 5.0 cr)
• FNRM 8105 - Research Problems: Silviculture (1.0 - 5.0 cr)
• FNRM 8106 - Research Problems: Urban Forestry–Biology and Management (1.0 - 5.0 cr)
• FNRM 8201 - Research Problems: Forest Economics (1.0 - 5.0 cr)
• FNRM 8202 - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
• FNRM 8203 - Research Problems: Forest Recreation (1.0 - 5.0 cr)
• FNRM 8204 - Research Problems: Forest Policy (1.0 - 5.0 cr)
• FNRM 8205 - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
• FNRM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
• FNRM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
• FNRM 8208 - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
• GEOG 5531 - Numerical Spatial Analysis (4.0 cr)
• GEOG 5562 - GIS Development Practicum (3.0 cr)
• GEOG 8260 - Seminar: Physical Geography (2.0 cr)
• GIS 5555 - Basic Spatial Analysis (3.0 cr)
• GIS 5571 - ArcGIS I (3.0 cr)
• GIS 5572 - ArcGIS II (3.0 cr)
• GIS 5575 - Practical Surveying for GIS (2.0 cr)
• GIS 5577 - Spatial Database Design and Administration (3.0 cr)
• GIS 5578 - GIS Programming (3.0 cr)
• OLPD 5061 - Ethnographic Research Methods (3.0 cr)
• OLPD 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
• PA 5002 - Introduction to Policy Analysis (1.5 cr)
• PA 5031 - Empirical Analysis I (4.0 cr)
• PA 5035 - Survey Research and Data Collection (1.5 cr)
• PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
• PA 5920 - Skills Workshop (0.5 - 4.0 cr)
• POL 8126 - Qualitative Methods (3.0 cr)
• PUBH 7250 - Designing and Conducting Focus Group Interviews (1.0 cr)
• PUBH 7407 - Analysis of Categorical Data (3.0 cr)
• PUBH 8472 - Spatial Biostatistics (3.0 cr)
• SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
• SOC 8801 - Sociological Research Methods (4.0 cr)
• SOC 8811 - Advanced Social Statistics (4.0 cr)
• SOIL 5555 - Wetland Soils (3.0 cr)
### Degree Plan Options

**Plan A**

Plan A students are required to complete 10 thesis credits of NR 8777.

*OR*

**Plan B**

Plan B students do not need to complete additional research credits.

### Economics, Policy, Management, and Society

For students interested in focusing on how society values and makes decisions about the use, management, and protection of natural and environmental resources. Graduate students in this track can specialize in areas such as: economics, policy, administration and management, planning, operations research, conflict resolution, human dimensions, and land use planning. Studies might consider choices, impacts, and tradeoffs in protecting, restoring, developing, and allocating natural and environmental resources. The research conducted by students in this track may address a wide range of issues and problems from local to international in scope.

### Economics, Policy, Management, and Society - Suggested Course List

NRSM students in the economics, policy, management, and society track should refer to this list when enrolling in courses that are appropriate for their area of study. Plan A students must enroll in 19 coursework credits in addition to their seminar requirement and thesis credits, and Plan B students must enroll in 29 credits in addition to their seminar requirement. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

- **AGRO 5121**: Applied Experimental Design (4.0 cr)
- **APEC 5031**: Methods of Economic Data Analysis (3.0 cr)
- **APEC 5032**: Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- **APEC 5151**: Applied Microeconomics: Firm and Household (3.0 cr)
- **APEC 5152**: Applied Macroeconomics: Income and Employment (3.0 cr)
- **APEC 5321**: Regional Economic Analysis (3.0 cr)
- **APEC 5651**: Economics of Natural Resource and Environmental Policy (3.0 cr)
- **APEC 5721**: Economics of Science and Technology Policy (3.0 cr)
- **APEC 8004**: Applied Microeconomic Analysis of Social Choice and Welfare (2.0 cr)
- **APEC 8202**: Mathematical Optimization in Applied Economics (3.0 cr)
- **APEC 8203**: Applied Welfare Economics and Public Policy (3.0 cr)
- **APEC 8211**: Econometric Analysis I (4.0 cr)
- **APEC 8212**: Econometric Analysis II (4.0 cr)
- **APEC 8601**: Natural Resource Economics (3.0 cr)
- **APEC 8602**: Economics of the Environment (3.0 cr)
- **BIOL 5407**: Ecology (3.0 cr)
- **CEGE 5570**: Design for Sustainable Development: Discovery (3.0 - 9.0 cr)
- **CEGE 5573**: Design for Sustainable Development: Create II (1.0 - 5.0 cr)
- **CI 5537**: Principles of Environmental Education (3.0 cr)
- **CI 5747**: Global and Environmental Education: Content and Practice (3.0 cr)
- **CI 8149**: Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- **COMM 5250**: Environmental Communication (3.0 cr)
- **COMM 5402**: Advanced Interpersonal Communication (3.0 cr)
- **COMM 5441**: Communication in Human Organizations (3.0 cr)
- **COMM 8452**: Seminar: Methods of Intercultural/Diversity Facilitation (3.0 cr)
- **DES 8103**: Qualitative and Mixed Methods Research (3.0 cr)
- **ECON 8105**: Macroeconomic Theory (2.0 cr)
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<td>Survey Design, Sampling, and Implementation</td>
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<td>Timber Harvesting and Road Planning</td>
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<td>Forest Planning and Management</td>
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<td>FNRM 5501</td>
<td>Urban Forest Management: Managing Greenspaces for People</td>
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<td>GEOG 5561</td>
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<td>GIS 5555</td>
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• LA 5004 - Regional Environmental Landscape Planning (4.0 cr)
• LAW 6062 - Energy Law (3.0 cr)
• MGMT 6033 - Managing the Strategy Process (2.0 cr)
• MGMT 6050 - Management of Innovation and Change (2.0 cr)
• OLPD 5061 - Ethnographic Research Methods (3.0 cr)
• OLPD 5104 - Strategies for International Development of Education Systems (3.0 cr)
• OLPD 5501 - Principles and Methods of Evaluation (3.0 cr)
• OLPD 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
• OLPD 5611 - Facilitation and Meeting Skills (1.0 cr)
• PA 5002 - Introduction to Policy Analysis (1.5 cr)
• PA 5011 - Management of Organizations (3.0 cr)
• PA 5021 - Economics For Policy Analysis and Planning I (3.0 cr)
• PA 5022 - Economics For Policy Analysis and Planning II (1.5 - 3.0 cr)
• PA 5031 - Empirical Analysis I (4.0 cr)
• PA 5035 - Survey Research and Data Collection (1.5 cr)
• PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
• PA 5101 - Management and Governance of Nonprofit Organizations (3.0 cr)
• PA 5122 - Law and Public Affairs (3.0 cr)
• PA 5242 - Environmental Planning, Policy, and Decision Making (3.0 cr)
• PA 5251 - Strategic Planning and Management (3.0 cr)
• PA 5253 - Designing Planning and Participation Processes (3.0 cr)
• PA 5271 - Geographic Information Systems: Applications in Planning and Policy Analysis (3.0 cr)
• PA 5311 - Program Evaluation (3.0 cr)
• PA 5501 - Theories and Policies of Development (3.0 cr)
• PA 5503 - Economics of Development (3.0 cr)
• PA 5721 - Energy and Environmental Policy (3.0 cr)
• PA 5722 - Environmental and Resource Economics Policy (3.0 cr)
• PA 5741 - Risk, Resilience and Decision Making (1.5 cr)
• PA 5790 - Topics in Science, Technology, and Environmental Policy (1.0 - 3.0 cr)
• PA 5890 - Topics in Foreign Policy and International Affairs (1.0 - 5.0 cr)
• PA 5920 - Skills Workshop (0.5 - 4.0 cr)
• PA 8790 - Advanced Topics in Science, Technology, and Environmental Policy (1.0 - 3.0 cr)
• POL 5315 - State Governments: Laboratories of Democracy (4.0 cr)
• POL 8126 - Qualitative Methods (3.0 cr)
• PSY 5202 - Attitudes and Social Behavior (3.0 cr)
• PSY 5960 - Topics in Psychology (1.0 - 4.0 cr)
• PUBH 7407 - Analysis of Categorical Data (3.0 cr)
• SCO 8735 - Supply Chain Management (3.0 cr)
• SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
• SOC 8701 - Sociological Theory (4.0 cr)
• SOC 8801 - Sociological Research Methods (4.0 cr)
• SOC 8811 - Advanced Social Statistics (4.0 cr)
• SOIL 5611 - Soil Biology and Fertility (4.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
• STAT 5302 - Applied Regression Analysis (4.0 cr)
• STAT 5303 - Designing Experiments (4.0 cr)
• STAT 5401 - Applied Multivariate Methods (3.0 cr)
• STAT 5421 - Analysis of Categorical Data (3.0 cr)
• STAT 5601 - Nonparametric Methods (3.0 cr)
• STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
• STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
• STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
• STAT 8054 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
• WRIT 5051 - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)
• WRS 5101 - Water Policy (3.0 cr)

Degree Plan Options

Plan A
Plan A students are required to complete 10 thesis credits of NR 8777.

-OR-

Plan B
Plan B students do not need to complete additional research credits.

Forest Hydrology and Watershed Management
Brings together the integrally related areas of earth sciences, soils, and water resources management with an applied focus on wildland ecosystems, which may include the interface of forests with grasslands, wetlands, and agriculture. Graduate students in this track may specialize in areas such as: forest hydrology, water quality, and watershed management. Research would focus on forest, riparian, and wetland ecosystems.

Forest Hydrology and Watershed Management - Suggested Course List
NRSM students in the forest hydrology and watershed management track should refer to this list when enrolling in courses that are appropriate for their area of study. Plan A students must enroll in 19 coursework credits in addition to their seminar requirement and thesis credits, and Plan B students must enroll in 29 credits in addition to their seminar requirement. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:
- AGRO 5121 - Applied Experimental Design (4.0 cr)
- APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
- APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- APEC 8211 - Econometric Analysis I (4.0 cr)
- APEC 8212 - Econometric Analysis II (4.0 cr)
- BBE 5513 - Watershed Engineering (3.0 cr)
- BBE 5523 - Ecological Engineering Design (3.0 cr)
- BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
- BBE 8013 - Parameter Estimation in Biosystems and Agricultural Engineering (3.0 cr)
- BBE 8513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
- CEGE 4501 - Hydrologic Design (4.0 cr)
- CEGE 4512 - Open Channel Hydraulics (4.0 cr)
- CEGE 5541 - Environmental Water Chemistry (3.0 cr)
- CEGE 8506 - Stochastic Hydrology (4.0 cr)
- CEGE 8511 - Mechanics of Sediment Transport (3.0 cr)
- CEGE 8561 - Analysis and Modeling of Aquatic Environments I (3.0 cr)
- CEGE 8562 - Analysis and Modeling of Aquatic Environments II (3.0 cr)
- CEGE 8601 - Introduction to Stream Restoration (3.0 cr)
- CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
- EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
- EEB 5601 - Limnology (3.0 cr)
- EEB 5609 - Ecosystem Ecology (3.0 cr)
- EEB 8601 - Introduction to Stream Restoration (3.0 cr)
- EEB 8602 - Stream Restoration Practice (2.0 cr)
- EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
- EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
- EPSY 5247 - Qualitative Methods in Educational Psychology (3.0 cr)
- EPSY 5261 - Introductory Statistical Methods (3.0 cr)
- EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
- EPSY 8261 - Statistical Methods in Education I (3.0 cr)
- EPSY 8262 - Statistical Methods in Education II (3.0 cr)
- EPSY 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
- ESCI 4702 - General Hydrogeology (3.0 cr)
- ESCI 4703 - Glacial Geology (4.0 cr)
- ESCI 5205 - Fluid Mechanics in Earth and Environmental Sciences (3.0 cr)
- ESPM 4216 - Contaminant Hydrology (3.0 cr)
- ESPM 5061 - Water Quality and Natural Resources (3.0 cr)
- ESPM 5071 - Ecological Restoration (4.0 cr)
- ESPM 5111 - Hydrology and Water Quality Field Methods (3.0 cr)
- ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- ESPM 5241 - Natural Resource and Environmental Policy (3.0 cr)
- ESPM 5242 - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- ESPM 5261 - Economics and Natural Resources Management (4.0 cr)
- ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
- ESPM 5402 - Biometeorology (3.0 cr)
- ESPM 5555 - Wetland Soils (3.0 cr)
- ESPM 5575 - Wetlands (3.0 cr)
- ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
- ESPM 5703 - Agroforestry in Watershed Management (3.0 cr)
• ESPM 5811 - Environmental Interpretation (3.0 cr)
• FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
• FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
• FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
• FNRM 8101 - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
• FNRM 8102 - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
• FNRM 8103 - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
• FNRM 8104 - Research Problems: Forest Ecology (1.0 - 5.0 cr)
• FNRM 8105 - Research Problems: Silviculture (1.0 - 5.0 cr)
• FNRM 8106 - Research Problems: Urban Forestry--Biology and Management (1.0 - 5.0 cr)
• FNRM 8201 - Research Problems: Forest Economics (1.0 - 5.0 cr)
• FNRM 8202 - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
• FNRM 8203 - Research Problems: Forest Recreation (1.0 - 5.0 cr)
• FNRM 8204 - Research Problems: Forest Policy (1.0 - 5.0 cr)
• FNRM 8205 - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
• FNRM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
• FNRM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
• FNRM 8208 - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
• FW 8051 - Statistical Modeling of Ecological Data using R and WinBugs/JAGS (4.0 cr)
• GEOG 8260 - Seminar: Physical Geography (2.0 cr)
• GIS 5555 - Basic Spatial Analysis (3.0 cr)
• GIS 5577 - Spatial Database Design and Administration (3.0 cr)
• LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
• OLPD 5061 - Ethnographic Research Methods (3.0 cr)
• OLPD 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
• PA 5002 - Introduction to Policy Analysis (1.5 cr)
• PA 5031 - Empirical Analysis I (4.0 cr)
• PA 5035 - Survey Research and Data Collection (1.5 cr)
• PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
• PA 5920 - Skills Workshop (0.5 - 4.0 cr)
• POL 8126 - Qualitative Methods (3.0 cr)
• PUBH 6190 - Environmental Chemistry (3.0 cr)
• PUBH 7250 - Designing and Conducting Focus Group Interviews (1.0 cr)
• PUBH 7407 - Analysis of Categorical Data (3.0 cr)
• SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
• SOC 8801 - Sociological Research Methods (4.0 cr)
• SOC 8811 - Advanced Social Statistics (4.0 cr)
• SOIL 5232 - Vadose Zone Hydrology (3.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
• STAT 5302 - Applied Regression Analysis (4.0 cr)
• STAT 5303 - Designing Experiments (4.0 cr)
• STAT 5401 - Applied Multivariate Methods (3.0 cr)
• STAT 5421 - Analysis of Categorical Data (3.0 cr)
• STAT 5601 - Nonparametric Methods (3.0 cr)
• STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
• STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
• STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
• STAT 8054 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
• WRIT 5051 - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)
• WRS 5101 - Water Policy (3.0 cr)

Degree Plan Options

Plan A
Plan A students are required to complete 10 thesis credits of NR 8777.

-OR-

Plan B
Plan B students do not need to complete additional research credits.

Forest Products
For students who wish to specialize in areas such as: wood and fiber as raw materials; deterioration of wood; wood mechanics and structural design; wood moisture interactions and drying; processing and performance of composites; economics of manufacturing systems; technology and processing of solid wood products; marketing, design and production of housing components; and energy...
efficient building construction.

**Forest Products - Suggested Course List**

NRSM students in the forest products track should refer to this list when enrolling in courses that are appropriate for their area of study. Plan A students must enroll in 19 coursework credits in addition to their seminar requirement and thesis credits, and Plan B students must enroll in 29 credits in addition to their seminar requirement. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

- AGRO 5121 - Applied Experimental Design (4.0 cr)
- APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
- APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- APEC 8211 - Econometric Analysis I (4.0 cr)
- APEC 8212 - Econometric Analysis II (4.0 cr)
- BBE 5001 - Chemistry of Biomass and Biomass Conversion to Fuels and Products (4.0 cr)
- BBE 5023 - Process Control and Instrumentation (3.0 cr)
- BBE 5001 - Applied Surface and Colloid Science (3.0 cr)
- BBE 5302 - Biodegradation of Bioproducts (3.0 cr)
- BBE 5303 - Introduction to Bio-based Materials Science (3.0 cr)
- BBE 5401 - Bioproducts Separation and Purification Processes (3.0 cr)
- BBE 5402 - Bio-based Products Engineering Lab I (1.0 cr)
- BBE 5403 - Bio-based Products Engineering Lab II (1.0 cr)
- BBE 5404 - Biopolymers and Biocomposites Engineering (3.0 cr)
- BBE 5412 - Biocomposites and Biomass Energy (4.0 cr)
- BBE 5414 - Advanced Residential Building Science (4.0 cr)
- BBE 5416 - Building Testing & Diagnostics (2.0 cr)
- BBE 5608 - Environmental and Industrial Microbiology (3.0 cr)
- BBE 5713 - Biological Process Engineering (3.0 cr)
- BBE 5733 - Renewable Energy Technologies (3.0 cr)
- BBE 8001 - Seminar I (1.0 cr)
- BBE 8002 - Seminar II (1.0 cr)
- BBE 8013 - Parameter Estimation in Biosystems and Agricultural Engineering (3.0 cr)
- CHEM 4214 - Polymers (3.0 cr)
- CHEM 4221 - Introduction to Polymer Chemistry (3.0 cr)
- CHEM 5210 - Materials Characterization (4.0 cr)
- CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
- ENTR 6041 - Initiating New Product Design and Business Development (2.0 - 4.0 cr)
- EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
- EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
- EPSY 5247 - Qualitative Methods in Educational Psychology (3.0 cr)
- EPSY 5261 - Introductory Statistical Methods (3.0 cr)
- EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
- EPSY 8261 - Statistical Methods in Education I (3.0 cr)
- EPSY 8262 - Statistical Methods in Education II (3.0 cr)
- ESPM 5226 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- ESPM 5242 - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
- FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- FNRM 8101 - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
- FNRM 8102 - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
- FNRM 8103 - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
- FNRM 8104 - Research Problems: Forest Ecology (1.0 - 5.0 cr)
- FNRM 8105 - Research Problems: Silviculture (1.0 - 5.0 cr)
- FNRM 8106 - Research Problems: Urban Forestry - Biology and Management (1.0 - 5.0 cr)
- FNRM 8201 - Research Problems: Forest Economics (1.0 - 5.0 cr)
- FNRM 8202 - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
- FNRM 8203 - Research Problems: Forest Recreation (1.0 - 5.0 cr)
- FNRM 8204 - Research Problems: Forest Policy (1.0 - 5.0 cr)
- FNRM 8205 - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
- FNRM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
- FNRM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
- FNRM 8208 - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
- GIS 5555 - Basic Spatial Analysis (3.0 cr)
- ME 5228 - Introduction to Finite Element Modeling, Analysis, and Design (4.0 cr)
OLPD 5061 - Ethnographic Research Methods (3.0 cr)
OLPD 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
PA 5002 - Introduction to Policy Analysis (1.5 cr)
PA 5031 - Empirical Analysis I (4.0 cr)
PA 5035 - Survey Research and Data Collection (1.5 cr)
PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
PA 5920 - Skills Workshop (0.5 - 4.0 cr)
POL 8126 - Qualitative Methods (3.0 cr)
PUBH 7250 - Designing and Conducting Focus Group Interviews (1.0 cr)
PUBH 7407 - Analysis of Categorical Data (3.0 cr)
SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
SOC 8801 - Sociological Research Methods (4.0 cr)
SOC 8811 - Advanced Social Statistics (4.0 cr)
STAT 5021 - Statistical Analysis (4.0 cr)
STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
STAT 5302 - Applied Regression Analysis (4.0 cr)
STAT 5303 - Designing Experiments (4.0 cr)
STAT 5401 - Applied Multivariate Methods (3.0 cr)
STAT 5421 - Analysis of Categorical Data (3.0 cr)
STAT 5601 - Nonparametric Methods (3.0 cr)
STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
STAT 8054 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
WRIT 5051 - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)

Degree Plan Options

Plan A
Plan A students are required to complete 10 thesis credits of NR 8777.

-OR-

Plan B
Plan B students do not need to complete additional research credits.

Forests: Biology, Ecology, Conservation, and Management
Focuses on forest resources and allows students to choose from specializations in the following areas: forest biology, ecology, ecophysiology; genetics and tree improvement; tree physiology; reproductive biology and forest regeneration; forest growth and vegetation dynamics; timber harvesting, silviculture, and sustainable forest management; landscape ecology, restoration, and management; conservation of biodiversity and wildlife habitat management; forest health; disturbance (including fire) ecology; urban and community forestry; and agroforestry. Research normally focuses on forest and related ecosystems.

Forests: Biology, Ecology, Conservation, and Management - Suggested Course List
NRSM students in the forests: biology, ecology, conservation, and management track should refer to this list when enrolling in courses that are appropriate for their area of study. Plan A students must enroll in 19 coursework credits in addition to their seminar requirement and thesis credits, and Plan B students must enroll in 29 credits in addition to their seminar requirement. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.
Take 0 or more course(s) from the following:
- AGRO 5121 - Applied Experimental Design (4.0 cr)
- APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
- APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- APEC 5651 - Economics of Natural Resource and Environmental Policy (3.0 cr)
- APEC 8211 - Econometric Analysis I (4.0 cr)
- APEC 8212 - Econometric Analysis II (4.0 cr)
- BBE 5001 - Chemistry of Biomass and Biomass Conversion to Fuels and Products (4.0 cr)
- BBE 5302 - Biodegradation of Bioproducts (3.0 cr)
- BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
- CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
- EEB 4609W - Ecosystem Ecology [ENV, WJ] (3.0 cr)
- EEB 5068 - Plant Physiological Ecology (3.0 cr)
- EEB 5609 - Ecosystem Ecology (3.0 cr)
- EEB 8200 - Sustainability Science Distributed Graduate Seminar (3.0 cr)
- ENT 4251 - Forest and Shade Tree Entomology (3.0 cr)
- EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
• EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
• EPSY 5247 - Qualitative Methods in Educational Psychology (3.0 cr)
• EPSY 5261 - Introductory Statistical Methods (3.0 cr)
• EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
• EPSY 8261 - Statistical Methods in Education I (3.0 cr)
• EPSY 8262 - Statistical Methods in Education II (3.0 cr)
• EPSY 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
• ESPM 5071 - Ecological Restoration (4.0 cr)
• ESPM 5101 - Conservation of Plant Biodiversity (3.0 cr)
• ESPM 5108 - Ecology of Managed Systems (4.0 cr)
• ESPM 5202 - Environmental Conflict Management, Leadership, and Planning (3.0 cr)
• ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
• ESPM 5242 - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
• ESPM 5266 - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
• ESPM 5555 - Wetland Soils (3.0 cr)
• ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
• ESPM 5703 - Agroforestry in Watershed Management (3.0 cr)
• FNRM 5104 - Forest Ecology (4.0 cr)
• FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
• FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
• FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
• FNRM 5203 - Forest Fire and Disturbance Ecology (3.0 cr)
• FNRM 5204 - Landscape Ecology and Management (3.0 cr)
• FNRM 5205 - Productivity and Ecology of Forest Soils (3.0 cr)
• FNRM 5218 - Measuring and Modeling Forests (3.0 cr)
• FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
• FNRM 5264 - Advanced Forest Management Planning (3.0 cr)
• FNRM 5411 - Managing Forest Ecosystems: Silviculture (3.0 cr)
• FNRM 5413 - Managing Forest Ecosystems: Silviculture Lab (1.0 cr)
• FNRM 5501 - Urban Forest Management: Managing Greenspaces for People (3.0 cr)
• FNRM 8101 - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
• FNRM 8102 - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
• FNRM 8103 - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
• FNRM 8104 - Research Problems: Forest Ecology (1.0 - 5.0 cr)
• FNRM 8105 - Research Problems: Silviculture (1.0 - 5.0 cr)
• FNRM 8106 - Research Problems: Urban Forestry--Biological and Management (1.0 - 5.0 cr)
• FNRM 8107 - Research Problems: Forest Economics (1.0 - 5.0 cr)
• FNRM 8202 - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
• FNRM 8203 - Research Problems: Forest Recreation (1.0 - 5.0 cr)
• FNRM 8204 - Research Problems: Forest Policy (1.0 - 5.0 cr)
• FNRM 8205 - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
• FNRM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
• FNRM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
• FNRM 8208 - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
• FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
• FW 5603W - Habitats and Regulation of Wildlife [WI] (3.0 cr)
• FW 8051 - Statistical Modeling of Ecological Data using R and WinBugs/JAGS (4.0 cr)
• FW 8452 - Conservation Biology (3.0 cr)
• GEOG 5426 - Climatic Variations (3.0 cr)
• GEOG 5839 - Introduction to Dendrochronology (3.0 cr)
• GEOG 8260 - Seminar: Physical Geography (2.0 cr)
• GIS 5555 - Basic Spatial Analysis (3.0 cr)
• HORT 5071 - Ecological Restoration (4.0 cr)
• OLPD 5061 - Ethnographic Research Methods (3.0 cr)
• OLPD 5526 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
• PA 5002 - Introduction to Policy Analysis (1.5 cr)
• PA 5031 - Empirical Analysis I (4.0 cr)
• PA 5035 - Survey Research and Data Collection (1.5 cr)
• PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
• PA 5920 - Skills Workshop (0.5 - 4.0 cr)
• PA 8201 - Environment and Infrastructure Planning (4.0 cr)
• PLPA 5003 - Diseases of Forest and Shade Trees (3.0 cr)
• PLPA 5480 - Principles of Plant Pathology (3.0 cr)
• POL 8126 - Qualitative Methods (3.0 cr)
• PUBH 7250 - Designing and Conducting Focus Group Interviews (1.0 cr)
• PUBH 7407 - Analysis of Categorical Data (3.0 cr)
• SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
• SOC 8801 - Sociological Research Methods (4.0 cr)
• SOC 8811 - Advanced Social Statistics (4.0 cr)
• SOIL 5611 - Soil Biology and Fertility (4.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
• STAT 5302 - Applied Regression Analysis (4.0 cr)
• STAT 5303 - Designing Experiments (4.0 cr)
• STAT 5401 - Applied Multivariate Methods (3.0 cr)
• STAT 5421 - Analysis of Categorical Data (3.0 cr)
• STAT 5601 - Nonparametric Methods (3.0 cr)
• STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
• STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
• STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
• STAT 8054 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
• WRIT 5051 - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)

Degree Plan Options

Plan A
Plan A students are required to complete 10 thesis credits of NR 8777.

-OR-

Plan B
Plan B students do not need to complete additional research credits.

Paper Science and Engineering
Specializes in areas such as: the chemistry and biotechnology of lignocellulosic materials; material science of paper and fiber products; paper recycling; energy and manufacturing efficiency in the pulp and paper-making process; novel and environmentally friendly pulping and bleaching, transport processes through porous media, surface and colloid science of papermaking; chemical engineering applications in pulp and paper processes; and statistical process control.

Paper Science and Engineering - Suggested Course List
NRSM students in the paper science and engineering track should refer to this list when enrolling in courses that are appropriate for their area of study. Plan A students must enroll in 19 coursework credits in addition to their seminar requirement and thesis credits, and Plan B students must enroll in 29 credits in addition to their seminar requirement. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:
• AGRO 5121 - Applied Experimental Design (4.0 cr)
• APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
• APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
• APEC 8211 - Econometric Analysis I (4.0 cr)
• APEC 8212 - Econometric Analysis II (4.0 cr)
• BBE 5001 - Chemistry of Biomass and Biomass Conversion to Fuels and Products (4.0 cr)
• BBE 5023 - Process Control and Instrumentation (3.0 cr)
• BBE 5301 - Applied Surface and Colloid Science (3.0 cr)
• BBE 5302 - Biodegradation of Bioproducts (3.0 cr)
• BBE 5303 - Introduction to Bio-based Materials Science (3.0 cr)
• BBE 5305 - Pulp and Paper Technology [WI] (3.0 cr)
• BBE 5401 - Bioproducts Separation and Purification Processes (3.0 cr)
• BBE 5402 - Bio-based Products Engineering Lab I (1.0 cr)
• BBE 5403 - Bio-based Products Engineering Lab II (1.0 cr)
• BBE 5404 - Biopolymers and Biocomposites Engineering (3.0 cr)
• BBE 5412 - Biocomposites and Biomass Energy (4.0 cr)
• BBE 5608 - Environmental and Industrial Microbiolog (3.0 cr)
• BBE 5713 - Biological Process Engineering (3.0 cr)
• BBE 5733 - Renewable Energy Technologies (3.0 cr)
• BEE 8001 - Seminar I (1.0 cr)
• BEE 8002 - Seminar II (1.0 cr)
• BEE 8013 - Parameter Estimation in Biosystems and Agricultural Engineering (3.0 cr)
• BEE 8300 - Research Problems (1.0 - 10.0 cr)
• CHEM 5210 - Materials Characterization (4.0 cr)
• CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
• DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
- EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
- EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
- EPSY 5247 - Qualitative Methods in Educational Psychology (3.0 cr)
- EPSY 5261 - Introductory Statistical Methods (3.0 cr)
- EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
- EPSY 8261 - Statistical Methods in Education I (3.0 cr)
- EPSY 8262 - Statistical Methods in Education II (3.0 cr)
- EPSY 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- ESPM 5242 - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
- FNRM 5104 - Forest Ecology (4.0 cr)
- FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- FNRM 8101 - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
- FNRM 8102 - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
- FNRM 8103 - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
- FNRM 8104 - Research Problems: Forest Ecology (1.0 - 5.0 cr)
- FNRM 8105 - Research Problems: Silviculture (1.0 - 5.0 cr)
- FNRM 8106 - Research Problems: Urban Forestry--Biology and Management (1.0 - 5.0 cr)
- FNRM 8201 - Research Problems: Forest Economics (1.0 - 5.0 cr)
- FNRM 8202 - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
- FNRM 8203 - Research Problems: Forest Recreation (1.0 - 5.0 cr)
- FNRM 8204 - Research Problems: Forest Policy (1.0 - 5.0 cr)
- FNRM 8205 - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
- FNRM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
- FNRM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
- FNRM 8208 - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
- GIS 5555 - Basic Spatial Analysis (3.0 cr)
- ME 5228 - Introduction to Finite Element Modeling, Analysis, and Design (4.0 cr)
- OLPD 5061 - Ethnographic Research Methods (3.0 cr)
- OLPD 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
- PA 5002 - Introduction to Policy Analysis (1.5 cr)
- PA 5031 - Empirical Analysis I (4.0 cr)
- PA 5035 - Survey Research and Data Collection (1.5 cr)
- PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
- PA 5920 - Skills Workshop (0.5 - 4.0 cr)
- POL 8126 - Qualitative Methods (3.0 cr)
- PUBH 7250 - Designing and Conducting Focus Group Interviews (1.0 cr)
- PUBH 7407 - Analysis of Categorical Data (3.0 cr)
- SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
- SOC 8801 - Sociological Research Methods (4.0 cr)
- SOC 8811 - Advanced Social Statistics (4.0 cr)
- STAT 5021 - Statistical Analysis (4.0 cr)
- STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
- STAT 5302 - Applied Regression Analysis (4.0 cr)
- STAT 5303 - Designing Experiments (4.0 cr)
- STAT 5401 - Applied Multivariate Methods (3.0 cr)
- STAT 5421 - Analysis of Categorical Data (3.0 cr)
- STAT 5601 - Nonparametric Methods (3.0 cr)
- STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
- STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
- STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
- STAT 8054 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
- WRIT 5051 - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)

Degree Plan Options

Plan A
Plan A students are required to complete 10 thesis credits of NR 8777.

-OR-

Plan B
Plan B students do not need to complete additional research credits.

Recreation Resources, Tourism, and Environmental Education
Focuses on the use and management of natural resources for recreation and tourism. Graduate students in this track may specialize in areas such as recreational land management, resource-based tourism, planning for recreation and tourism, and the human dimensions of natural resource uses. Additionally, students may focus on environmental education and leadership for effective communication with diverse publics about natural resources.

**Recreation Resources, Tourism, and Environmental Education - Suggested Course List**

NRSM students in the recreation resources, tourism, and environmental education track should refer to this list when enrolling in courses that are appropriate for their area of study. Plan A students must enroll in 19 coursework credits in addition to their seminar requirement and thesis credits, and Plan B students must enroll in 29 credits in addition to their seminar requirement. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

- AGRO 5121 - Applied Experimental Design (4.0 cr)
- APEC 4311 - Tourism Development: Principles, Processes, Policies (3.0 cr)
- APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
- APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- APEC 8211 - Econometric Analysis I (4.0 cr)
- APEC 8212 - Econometric Analysis II (4.0 cr)
- CI 5537 - Principles of Environmental Education (3.0 cr)
- CI 5747 - Global and Environmental Education: Content and Practice (3.0 cr)
- CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
- EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
- EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
- EPSY 5243 - Principles and Methods of Evaluation (3.0 cr)
- EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
- EPSY 5247 - Qualitative Methods in Educational Psychology (3.0 cr)
- EPSY 5261 - Introductory Statistical Methods (3.0 cr)
- EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
- EPSY 8251 - Statistical Methods in Education I (3.0 cr)
- EPSY 8261 - Statistical Methods in Education I (3.0 cr)
- EPSY 8262 - Statistical Methods in Education II (3.0 cr)
- EPSY 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESPM 5202 - Environmental Conflict Management, Leadership, and Planning (3.0 cr)
- ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- ESPM 5242 - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- ESPM 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
- ESPM 5261 - Economics and Natural Resources Management (4.0 cr)
- ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
- ESPM 5811 - Environmental Interpretation (3.0 cr)
- FNRM 5101 - Park and Protected Area Tourism (3.0 cr)
- FNRM 5104 - Forest Ecology (4.0 cr)
- FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- FNRM 5201 - Introduction to Travel and Tourism (3.0 cr)
- FNRM 5232 - Managing Recreational Lands (4.0 cr)
- FNRM 5259 - Visitor Behavior Analysis (3.0 cr)
- FNRM 8101 - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
- FNRM 8102 - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
- FNRM 8103 - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
- FNRM 8104 - Research Problems: Forest Ecology (1.0 - 5.0 cr)
- FNRM 8105 - Research Problems: Silviculture (1.0 - 5.0 cr)
- FNRM 8106 - Research Problems: Urban Forestry--Biologie and Management (1.0 - 5.0 cr)
- FNRM 8201 - Research Problems: Forest Economics (1.0 - 5.0 cr)
- FNRM 8202 - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
- FNRM 8203 - Research Problems: Forest Recreation (1.0 - 5.0 cr)
- FNRM 8204 - Research Problems: Forest Policy (1.0 - 5.0 cr)
- FNRM 8205 - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
- FNRM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
- FNRM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
- FNRM 8208 - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
- FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
- GIS 5555 - Basic Spatial Analysis (3.0 cr)
- LS 5950 - Special Topics (1.0 - 4.0 cr)
- OLPD 5061 - Ethnographic Research Methods (3.0 cr)
- OLPD 5501 - Principles and Methods of Evaluation (3.0 cr)
- OLPD 5502 - Theory and Models of Evaluation (3.0 cr)
- OLPD 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
- OLPD 5611 - Facilitation and Meeting Skills (1.0 cr)
- PA 4101 - Nonprofit Management and Governance (3.0 cr)
- PA 5002 - Introduction to Policy Analysis (1.5 cr)
- PA 5011 - Management of Organizations (3.0 cr)
- PA 5031 - Empirical Analysis I (4.0 cr)
- PA 5035 - Survey Research and Data Collection (1.5 cr)
- PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
- PA 5111 - Financing Public and Nonprofit Organizations (3.0 cr)
- PA 5501 - Theories and Policies of Development (3.0 cr)
- PA 5920 - Skills Workshop (0.5 - 4.0 cr)
- POL 8126 - Qualitative Methods (3.0 cr)
- PSY 5202 - Attitudes and Social Behavior (3.0 cr)
- PSY 5960 - Topics in Psychology (1.0 - 4.0 cr)
- PUBH 7250 - Designing and Conducting Focus Group Interviews (1.0 cr)
- PUBH 7407 - Analysis of Categorical Data (3.0 cr)
- SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
- SOC 8701 - Sociological Theory (4.0 cr)
- SOC 8801 - Sociological Research Methods (4.0 cr)
- SOC 8811 - Advanced Social Statistics (4.0 cr)
- STAT 5021 - Statistical Analysis (4.0 cr)
- STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
- STAT 5302 - Applied Regression Analysis (4.0 cr)
- STAT 5303 - Designing Experiments (4.0 cr)
- STAT 5401 - Applied Multivariate Methods (3.0 cr)
- STAT 5421 - Analysis of Categorical Data (3.0 cr)
- STAT 5601 - Nonparametric Methods (3.0 cr)
- STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
- STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
- STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
- STAT 8054 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
- WRIT 5051 - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)

**Degree Plan Options**

**Plan A**

- Plan A students are required to complete 10 thesis credits of NR 8777.

- **OR**-

**Plan B**

- Plan B students do not need to complete additional research credits.

**Wildlife Ecology and Management**

For students interested in working with leaders in ecology, physiology, evolution, genetics, statistics, computer science, forestry, natural resource policy, and the social sciences as they relate to wildlife; ecology and management; and conservation biology.

**Wildlife Ecology and Management - Suggested Course List**

NRSM students in the wildlife ecology and management track should refer to this list when enrolling in courses that are appropriate for their area of study. Plan A students must enroll in 19 coursework credits in addition to their seminar requirement and thesis credits, and Plan B students must enroll in 29 credits in addition to their seminar requirement. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

- AGRO 5121 - Applied Experimental Design (4.0 cr)
- APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
- APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- APEC 5321 - Regional Economic Analysis (3.0 cr)
- APEC 5711 - U.S. Agricultural and Environmental Policy (3.0 cr)
- APEC 8211 - Econometric Analysis I (4.0 cr)
- APEC 8212 - Econometric Analysis II (4.0 cr)
- BIOL 5407 - Ecology (3.0 cr)
- CONS 8001 - Conservation Biology Seminar (1.0 cr)
- CONS 8004 - Economic and Social Aspects of Conservation Biology (3.0 cr)
- CONS 8201 - How to Excel in Graduate School (2.0 cr)
- CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)

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Information current as of December 20, 2016
• DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
• EEB 4129 - Mammalogy (4.0 cr)
• EEB 4134 - Introduction to Ornithology (4.0 cr)
• EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
• EEB 5322 - Evolution and Animal Cognition (3.0 cr)
• EEB 5601 - Limnology (3.0 cr)
• EEB 5609 - Ecosystem Ecology (3.0 cr)
• ENT 5910 - Special Problems in Entomology (1.0 - 6.0 cr)
• EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
• EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
• EPSY 5247 - Qualitative Methods in Educational Psychology (3.0 cr)
• EPSY 5261 - Introductory Statistical Methods (3.0 cr)
• EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
• EPSY 8251 - Statistical Methods in Education I (3.0 cr)
• EPSY 8252 - Statistical Methods in Education II (3.0 cr)
• EPSY 8261 - Statistical Methods in Education I (3.0 cr)
• EPSY 8262 - Statistical Methods in Education II (3.0 cr)
• ESB 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
• EPSY 8268 - Hierarchical Linear Modeling in Educational Research (3.0 cr)
• ESPM 5108 - Ecology of Managed Systems (4.0 cr)
• ESPM 5202 - Environmental Conflict Management, Leadership, and Planning (3.0 cr)
• ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
• ESPM 5241 - Natural Resource and Environmental Policy (3.0 cr)
• ESPM 5242 - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
• ESPM 5251 - Natural Resources in Sustainable International Development (3.0 cr)
• ESPM 5256 - Economics and Natural Resources Management (4.0 cr)
• ESPM 5257 - GIS in Environmental Science and Management (4.0 cr)
• ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
• FNRM 5104 - Forest Ecology (4.0 cr)
• FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
• FNRM 5204 - Landscape Ecology and Management (3.0 cr)
• FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
• FNRM 5411 - Managing Forest Ecosystems: Silviculture (3.0 cr)
• FNRM 8101 - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
• FNRM 8102 - Research Problems: Forest-Treese Genetics (1.0 - 5.0 cr)
• FNRM 8103 - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
• FNRM 8104 - Research Problems: Forest Ecology (1.0 - 5.0 cr)
• FNRM 8105 - Research Problems: Silviculture (1.0 - 5.0 cr)
• FNRM 8106 - Research Problems: Urban Forestry--Biology and Management (1.0 - 5.0 cr)
• FNRM 8201 - Research Problems: Forest Economics (1.0 - 5.0 cr)
• FNRM 8202 - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
• FNRM 8203 - Research Problems: Forest Recreation (1.0 - 5.0 cr)
• FNRM 8204 - Research Problems: Forest Policy (1.0 - 5.0 cr)
• FNRM 8205 - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
• FNRM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
• FNRM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
• FNRM 8208 - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
• FW 4001 - Biometry (4.0 cr)
• FW 4101 - Herpetology (4.0 cr)
• FW 4103 - Principles of Wildlife Management (3.0 cr)
• FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
• FW 5051 - Analysis of Populations (4.0 cr)
• FW 5063W - Habitats and Regulation of Wildlife [WI] (3.0 cr)
• FW 5625 - Wildlife Handling and Immobilization for Research and Management (2.0 cr)
• FW 8051 - Statistical Modeling of Ecological Data using R and WinBugs/JAGS (4.0 cr)
• FW 8200 - Seminar (1.0 - 4.0 cr)
• FW 8452 - Conservation Biology (3.0 cr)
• FW 8494 - Research in Wildlife (1.0 - 4.0 cr)
• GIS 5555 - Basic Spatial Analysis (3.0 cr)
• OLPD 5061 - Ethnographic Research Methods (3.0 cr)
• OLPD 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
• PA 5002 - Introduction to Policy Analysis (1.5 cr)
• PA 5031 - Empirical Analysis I (4.0 cr)
• PA 5035 - Survey Research and Data Collection (1.5 cr)
• PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
• PA 5920 - Skills Workshop (0.5 - 4.0 cr)
• PBIO 4321 - Minnesota Flora (3.0 cr)
• POL 8126 - Qualitative Methods (3.0 cr)
• PUBH 6420 - Introduction to SAS Programming (1.0 cr)
• PUBH 7250 - Designing and Conducting Focus Group Interviews (1.0 cr)
• PUBH 7407 - Analysis of Categorical Data (3.0 cr)
• SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
• SOC 8801 - Sociological Research Methods (4.0 cr)
• SOC 8811 - Advanced Social Statistics (4.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• STAT 5102 - Theory of Statistics II (4.0 cr)
• STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
• STAT 5302 - Applied Regression Analysis (4.0 cr)
• STAT 5303 - Designing Experiments (4.0 cr)
• STAT 5401 - Applied Multivariate Methods (3.0 cr)
• STAT 5421 - Analysis of Categorical Data (3.0 cr)
• STAT 5601 - Nonparametric Methods (3.0 cr)
• STAT 8051 - Advanced Regression Techniques; linear, nonlinear and nonparametric methods (3.0 cr)
• STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
• STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
• STAT 8054 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
• STAT 8101 - Theory of Statistics 1 (3.0 cr)
• STAT 8102 - Theory of Statistics 2 (3.0 cr)
• WRIT 5051 - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)

Degree Plan Options

Plan A

Plan A students are required to complete 10 thesis credits of NR 8777.

-OR-

Plan B

Plan B students do not need to complete additional research credits.
Twin Cities Campus

Natural Resources Science and Management Minor
Bioproducts and Biosystems Engineering, Fisheries, Wildlife, and Conservation Biology, Forest Resources
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Forest Resources, 116d Green Hall, 1530 Cleveland Avenue N., St. Paul MN 55108 (612-624-7683; fax 612-625-5212)
Email: nrsm@umn.edu
Website: http://www.nrsm.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 8
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.


Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

Students majoring in other programs who wish to declare a minor in Natural Resources Science and Management must file a proposal with the NRSM program office.

The NRSM program does not require specific courses for completion of the minor. Rather, the student should work in consultation with their major advisor(s) and with the NRSM faculty member who will serve on the student's examination committee as the representative of the program minor.

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters

Minor Requirements
The NRSM program does not require specific courses for completion of this minor. The minor requires at least 8 credits of graduate-level courses to be chosen in consultation with the student's major advisor and the NRSM faculty member who will serve on the student's examination committee as the minor program representative.

The proposed coursework will be reviewed by NRSM's Director of Graduate Studies, and must be approved before the student can submit their Graduate Degree Plan.
Doctoral

Requirements
The NRSM program does not require specific courses for completion of this minor. The minor requires at least 12 credits of graduate-level courses to be chosen in consultation with the student's major advisor and the NRSM faculty member who will serve on the student's examination committee as the minor program representative.

The proposed coursework will be reviewed by NRSM's Director of Graduate Studies, and must be approved before the student can submit their Graduate Degree Plan.
Twin Cities Campus
Natural Resources Science and Management Ph.D.
Bioproducts and Biosystems Engineering, Fisheries, Wildlife, and Conservation Biology, Forest Resources
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Forest Resources, 116d Green Hall, 1530 Cleveland Avenue N, St. Paul MN 55108 (612-624-7683; fax: 612-625-5212)
Email: nrsm@umn.edu
Website: http://www.nrsm.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2016
- Length of program in credits: 59 to 72
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Students in the Natural Resources Science and Management (NRSM) PhD program emphasize one of the following tracks: 1) forests: biology, ecology, conservation, and management; 2) economics, policy, management, and society; 3) assessment, monitoring, and geospatial analysis; 4) recreation resources, tourism, and environmental education; 5) forest hydrology and watershed management; 6) forest products; 7) paper science and engineering; or 8) wildlife ecology and management.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Most admitted students have earned degrees in natural resource-related majors. Applicants with exceptional academic records but no related background are eligible; if admitted, they may complete the prerequisites for advanced courses during the early stages of their graduate program. These prerequisites will vary depending upon the student's chosen track and major advisor.

Applicants will not be admitted unless a member of the program faculty agrees to advise the student ahead of time. This decision depends on admissibility (the applicant's overall credentials), mutual research interests, and the faculty member's ability to take on a new student. Some faculty members will not advise students unless they have funding for the student. Applicants are encouraged to review faculty profiles on the program website and begin making contacts prior to and during the application process.

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
  - Reading Score: 6.5
  - Writing Score: 6.5
- MELAB
  - Final score: 80

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
35 to 48 credits are required in the major.
0 credits are required outside the major.
24 thesis credits are required.

Plan A: Plan A requires up to null major credits, up to null credits outside the major, and up to null thesis credits. The final exam is oral.

Plan B: Plan B requires up to null major credits and up to null credits outside the major. The final exam is oral.

This program may not be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

The University of Minnesota requires at least 48 credits for a doctoral degree, 24 of which must be thesis credits [NR 8888]. The NRSM graduate program will typically expect to see 40 to 48 course credits. If a student enters the program with a relevant master's degree, relevant credits from the prior degree can be transferred in to apply toward the doctoral degree pending advisor, committee, graduate program, and college approval. Normally, a student who enters the doctoral program with a master's degree will complete 30-40 additional credits in the major program. There are no minor courses required, but students have the option of formally declaring a minor.

Course selection and thesis proposals are developed by each student in consultation with the faculty advisor and are approved by the Natural Resources Science and Management Graduate Studies Committee. Students must also receive training in the ethical conduct of research and present a formal seminar to faculty and peers. This presentation is separate from the final exam seminar.

Required Seminar
All students in NRSM must take the Forest Resources Seminar course. This is the only required course for all students. Please see the specific subplan for further course suggestions.

FNRM 8107 - Seminar: Forest Resources (1.0 cr)

Joint- or Dual-degree Coursework: Law, Science & Technology
Student may take a total of 12 credits in common among the academic programs.

Program Sub-plans
Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.

Assessment, Monitoring, and Geospatial Analysis
Addresses measurements and related technology applications and resource analysis. Graduate students in this track may choose to specialize in topics such as: geographic information systems (GIS); remote sensing; geospatial analysis; survey design (including forest inventory and monitoring), measurement, modeling; and biometrics. Studies typically focus on landscape, region, or global levels.

Assessment, Monitoring, and Geospatial Analysis - Suggested Course List
NRSM students in the assessment, monitoring, and geospatial analysis track should refer to this list when enrolling in courses that are appropriate for their area of study. Students must enroll in at least 34 credits in addition to their seminar and thesis credit (24 credits of NR 8888) requirements. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:
• AGRO 5121 - Applied Experimental Design (4.0 cr)
• APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
• APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
• APEC 8211 - Econometric Analysis I (4.0 cr)
• APEC 8212 - Econometric Analysis II (4.0 cr)
• CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
• CSCI 5302 - Analysis of Numerical Algorithms (3.0 cr)
• CSCI 5707 - Principles of Database Systems (3.0 cr)
• DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
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<td>Applied Global Positioning Systems for Geographic Information Systems (3.0 cr)</td>
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<td>ESPM 5071</td>
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<td>Hydrology and Water Quality Field Methods (3.0 cr)</td>
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<td>Measuring and Modeling Forests (3.0 cr)</td>
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<td>PUBH 7407</td>
<td>Analysis of Categorical Data (3.0 cr)</td>
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• **PUBH 8472** - Spatial Biostatistics (3.0 cr)
• **SOC 5811** - Social Statistics for Graduate Students [MATH] (4.0 cr)
• **SOC 8801** - Sociological Research Methods (4.0 cr)
• **SOC 8811** - Advanced Social Statistics (4.0 cr)
• **SOIL 5555** - Wetland Soils (3.0 cr)
• **STAT 5021** - Statistical Analysis (4.0 cr)
• **STAT 5101** - Theory of Statistics I (4.0 cr)
• **STAT 5102** - Theory of Statistics II (4.0 cr)
• **STAT 5201** - Sampling Methodology in Finite Populations (3.0 cr)
• **STAT 5302** - Applied Regression Analysis (4.0 cr)
• **STAT 5303** - Designing Experiments (4.0 cr)
• **STAT 5401** - Applied Multivariate Methods (3.0 cr)
• **STAT 5421** - Applied Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
• **STAT 5802** - Applied Statistical Methods 2: Design of Experiments and Mixed-Effects Modeling (3.0 cr)
• **STAT 5803** - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
• **STAT 5804** - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
• **WRIT 5051** - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)

**Economics, Policy, Management, and Society**

For students interested in focusing on how society values and makes decisions about the use, management, and protection of natural and environmental resources. Graduate students in this track can specialize in areas such as: economics, policy, administration and management, planning, operations research, conflict resolution, human dimensions, and land use planning. Studies might consider choices, impacts, and tradeoffs in protecting, restoring, developing, and allocating natural and environmental resources. The research conducted by students in this track may address a wide range of issues and problems from local to international in scope.

**Economics, Policy, Management, and Society - Suggested Course List**

NRSM students in the economics, policy, management, and society track should refer to this list when enrolling in courses that are appropriate for their area of study. Students must enroll in at least 34 credits in addition to their seminar and thesis credit (24 credits of NR 8888) requirements. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

- **AGRO 5121** - Applied Experimental Design (4.0 cr)
- **APEC 5031** - Methods of Economic Data Analysis (3.0 cr)
- **APEC 5032** - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- **APEC 5151** - Applied Microeconomics: Firm and Household (3.0 cr)
- **APEC 5152** - Applied Macroeconomics: Income and Employment (3.0 cr)
- **APEC 5321** - Regional Economic Analysis (3.0 cr)
- **APEC 5651** - Economics of Natural Resource and Environmental Policy (3.0 cr)
- **APEC 5721** - Economics of Science and Technology Policy (3.0 cr)
- **APEC 8004** - Applied Microeconomic Analysis of Social Choice and Welfare (2.0 cr)
- **APEC 8202** - Mathematical Optimization in Applied Economics (3.0 cr)
- **APEC 8203** - Applied Welfare Economics and Public Policy (3.0 cr)
- **APEC 8211** - Econometric Analysis I (4.0 cr)
- **APEC 8212** - Econometric Analysis II (4.0 cr)
- **APEC 8601** - Natural Resource Economics (3.0 cr)
- **APEC 8602** - Economics of the Environment (3.0 cr)
- **BIOL 5407** - Ecology (3.0 cr)
- **CEGE 5570** - Design for Sustainable Development: Discovery (3.0 - 9.0 cr)
- **CEGE 5573** - Design for Sustainable Development: Create II (1.0 - 5.0 cr)
- **CI 5537** - Principles of Environmental Education (3.0 cr)
- **CI 5574** - Global and Environmental Education: Content and Practice (3.0 cr)
- **CI 8149** - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- **COMM 5250** - Environmental Communication (3.0 cr)
- **COMM 5402** - Advanced Interpersonal Communication (3.0 cr)
- **COMM 5441** - Communication in Human Organizations (3.0 cr)
- **DES 8103** - Qualitative and Mixed Methods Research (3.0 cr)
- **ECON 8105** - Macroeconomic Theory (2.0 cr)
- **ECON 8106** - Macroeconomic Theory (2.0 cr)
- **EEB 5609** - Ecosystem Ecology (3.0 cr)
- **EEB 8200** - Sustainability Science Distributed Graduate Seminar (3.0 cr)
- **EEB 8550** - Graduate Research Fellowship Proposal Writing Seminar (1.0 cr)
- **EPSY 5221** - Principles of Educational and Psychological Measurement (3.0 cr)
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<td>Survey Design, Sampling, and Implementation</td>
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<td>EPSY 5247</td>
<td>Qualitative Methods in Educational Psychology</td>
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<td>Introductory Statistical Methods</td>
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<td>EPSY 5262</td>
<td>Intermediate Statistical Methods</td>
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<td>Environmental Conflict Management, Leadership, and Planning</td>
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<td>Survey, Measurement, and Modeling for Environmental Analysis</td>
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<td>Natural Resource and Environmental Policy</td>
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<td>Methods for Environmental and Natural Resource Policy Analysis</td>
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<td>Natural Resources in Sustainable International Development</td>
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<td>Natural Resource Law and the Management of Public Lands and Waters</td>
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<td>Economics and Natural Resources Management</td>
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<td>Regulations and Corporate Environmental Management</td>
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<td>FNRI 5131</td>
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<td>Forest Fire and Disturbance Ecology</td>
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<td>Landscape Ecology and Management</td>
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<td>Advanced Remote Sensing and Geospatial Analysis</td>
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<td>Timber Harvesting and Road Planning</td>
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<td>FNRI 5471</td>
<td>Forest Planning and Management</td>
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<td>FNRI 5501</td>
<td>Urban Forest Management: Managing Greenspaces for People</td>
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<td>Research Problems: Physiological Ecology</td>
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<td>Research Problems: Silviculture</td>
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<td>FNRI 8106</td>
<td>Research Problems: Urban Forestry--Biology and Management</td>
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<td>Research Problems: Forest Economics</td>
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<td>FNRI 8202</td>
<td>Research Problems: Forest Biometry and Measurements</td>
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<td>Research Problems: Forest Recreation</td>
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<td>Research Problems: Forest Policy</td>
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<td>FNRI 8206</td>
<td>Research Problems: Forest Management</td>
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<td>FNRI 8207</td>
<td>Economic Analysis of Natural Resource Projects</td>
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<td>FNRI 8208</td>
<td>Research Problems: Environmental Learning and Leadership</td>
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Forest Hydrology and Watershed Management
Brings together the integrally related areas of earth sciences, soils, and water resources management with an applied focus on wildland ecosystems, which may include the interface of forests with grasslands, wetlands, and agriculture. Graduate students in this track may specialize in areas such as: forest hydrology, water quality, and watershed management. Research would focus on forest, riparian, and wetland ecosystems.

Forest Hydrology and Watershed Management - Suggested Course List
NRSN students in the forest hydrology and watershed management track should refer to this list when enrolling in courses that are appropriate for their area of study. Students must enroll in at least 34 credits in addition to their seminar and thesis credit (24 credits of
NR 8888) requirements. Students may elect to take courses outside of this list if advised to do so by their advisor or committee. Take 0 or more course(s) from the following:

- **AGRO 5121** - Applied Experimental Design (4.0 cr)
- **APEC 5031** - Methods of Economic Data Analysis (3.0 cr)
- **APEC 5032** - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- **APEC 8211** - Econometric Analysis I (4.0 cr)
- **APEC 8212** - Econometric Analysis II (4.0 cr)
- **BBE 5513** - Watershed Engineering (3.0 cr)
- **BBE 5523** - Ecological Engineering Design (3.0 cr)
- **BBE 5535** - Assessment and Diagnosis of Impaired Waters (3.0 cr)
- **BBE 8013** - Parameter Estimation in Biosystems and Agricultural Engineering (3.0 cr)
- **BBE 8513** - Hydrologic Modeling of Small Watersheds (3.0 cr)
- **CEGE 4501** - Hydrologic Design (4.0 cr)
- **CEGE 4512** - Open Channel Hydraulics (4.0 cr)
- **CEGE 5541** - Environmental Water Chemistry (3.0 cr)
- **CEGE 8506** - Stochastic Hydrology (4.0 cr)
- **CEGE 8511** - Mechanics of Sediment Transport (3.0 cr)
- **CEGE 8561** - Analysis and Modeling of Aquatic Environments I (3.0 cr)
- **CEGE 8562** - Analysis and Modeling of Aquatic Environments II (3.0 cr)
- **CEGE 8601** - Introduction to Stream Restoration (3.0 cr)
- **CI 8149** - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- **DES 8103** - Qualitative and Mixed Methods Research (3.0 cr)
- **EEB 5053** - Ecology: Theory and Concepts (4.0 cr)
- **EEB 5601** - Limnology (3.0 cr)
- **EEB 5609** - Ecosystem Ecology (3.0 cr)
- **EEB 8550** - Graduate Research Fellowship Proposal Writing Seminar (1.0 cr)
- **EEB 8601** - Introduction to Stream Restoration (3.0 cr)
- **EEB 8602** - Stream Restoration Practice (2.0 cr)
- **EPSY 5221** - Principles of Educational and Psychological Measurement (3.0 cr)
- **EPSY 5244** - Survey Design, Sampling, and Implementation (3.0 cr)
- **EPSY 5247** - Qualitative Methods in Educational Psychology (3.0 cr)
- **EPSY 5261** - Introductory Statistical Methods (3.0 cr)
- **EPSY 5262** - Intermediate Statistical Methods (3.0 cr)
- **EPSY 8261** - Statistical Methods in Education I (3.0 cr)
- **EPSY 8262** - Statistical Methods in Education II (3.0 cr)
- **EPSY 8266** - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- **ESCI 4401** - Aqueous Environmental Geochemistry (3.0 cr)
- **ESCI 4702** - General Hydrogeology (3.0 cr)
- **ESCI 4703** - Glacial Geology (4.0 cr)
- **ESCI 5205** - Fluid Mechanics in Earth and Environmental Sciences (3.0 cr)
- **ESPM 4216** - Contaminant Hydrology (3.0 cr)
- **ESPM 5061** - Water Quality and Natural Resources (3.0 cr)
- **ESPM 5071** - Ecological Restoration (4.0 cr)
- **ESPM 5111** - Hydrology and Water Quality Field Methods (3.0 cr)
- **ESPM 5211** - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- **ESPM 5241** - Natural Resource and Environmental Policy (3.0 cr)
- **ESPM 5242** - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- **ESPM 5261** - Economics and Natural Resources Management (4.0 cr)
- **ESPM 5295** - GIS in Environmental Science and Management (4.0 cr)
- **ESPM 5402** - Biometeorology (3.0 cr)
- **ESPM 5555** - Wetland Soils (3.0 cr)
- **ESPM 5575** - Wetlands (3.0 cr)
- **ESPM 5603** - Environmental Life Cycle Analysis (3.0 cr)
- **ESPM 5703** - Agroforestry in Watershed Management (3.0 cr)
- **ESPM 5811** - Environmental Interpretation (3.0 cr)
- **FNRM 5114** - Hydrology and Watershed Management (3.0 cr)
- **FNRM 5131** - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- **FNRM 5153** - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
- **FNRM 8101** - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
- **FNRM 8102** - Research Problems: Forest Tree Genetics (1.0 - 5.0 cr)
- **FNRM 8103** - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
- **FNRM 8104** - Research Problems: Forest Ecology (1.0 - 5.0 cr)
- **FNRM 8105** - Research Problems: Silviculture (1.0 - 5.0 cr)
- **FNRM 8106** - Research Problems: Urban Forestry–Biology and Management (1.0 - 5.0 cr)
- **FNRM 8201** - Research Problems: Forest Economics (1.0 - 5.0 cr)
Forest Products

For students who wish to specialize in areas such as: wood and fiber as raw materials; deterioration of wood; wood mechanics and structural design; wood moisture interactions and drying; processing and performance of composites; economics of manufacturing systems; technology and processing of solid wood products; marketing, design and production of housing components; and energy-efficient building construction.

Forest Products - Suggested Course List

NRSM students in the forest products track should refer to this list when enrolling in courses that are appropriate for their area of study. Students must enroll in at least 34 credits in addition to their seminar and thesis credit (24 credits of NR 8888) requirements. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

• AGRO 5121 - Applied Experimental Design (4.0 cr)
• APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
• APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
• APEC 8211 - Econometric Analysis I (4.0 cr)
• APEC 8212 - Econometric Analysis II (4.0 cr)
• BBE 5001 - Chemistry of Biomass and Biomass Conversion to Fuels and Products (4.0 cr)
• BBE 5023 - Process Control and Instrumentation (3.0 cr)
• BBE 5301 - Applied Surface and Colloid Science (3.0 cr)
• BBE 5302 - Biodegradation of Bioproducts (3.0 cr)
• BBE 5303 - Introduction to Bio-based Materials Science (3.0 cr)
• BBE 5401 - Bioproducts Separation and Purification Processes (3.0 cr)
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<td>Bio-based Products Engineering Lab II</td>
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<td>BBE 5404</td>
<td>Biopolymers and Biocomposites Engineering</td>
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<td>BBE 5412</td>
<td>Biocomposites and Biomass Energy</td>
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<td>BBE 5414</td>
<td>Advanced Residential Building Science</td>
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<td>Building Testing &amp; Diagnostics</td>
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<td>Environmental and Industrial Microbiology</td>
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<td>STAT 5302</td>
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Forests: Biology, Ecology, Conservation, and Management

Focuses on forest resources and allows students to choose from specializations in the following areas: forest biology, ecology, ecophysiology; genetics and tree improvement; tree physiology; reproductive biology and forest regeneration; forest growth and vegetation dynamics; timber harvesting, silviculture, and sustainable forest management; landscape ecology, restoration, and management; conservation of biodiversity and wildlife habitat management; forest health; disturbance (including fire) ecology; urban and community forestry; and agroforestry. Research normally focuses on forest and related ecosystems.

Forests: Biology, Ecology, Conservation, and Management - Suggested Course List

NRSM students in the forests: biology, ecology, conservation, and management track should refer to this list when enrolling in courses that are appropriate for their area of study. Students must enroll in at least 34 credits in addition to their seminar and thesis credit (24 credits of NR 8888) requirements. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

- AGRO 5121 - Applied Experimental Design (4.0 cr)
- APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
- APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- APEC 5651 - Economics of Natural Resource and Environmental Policy (3.0 cr)
- APEC 8211 - Econometric Analysis I (4.0 cr)
- APEC 8212 - Econometric Analysis II (4.0 cr)
- BBE 5001 - Chemistry of Biomass and Biomass Conversion to Fuels and Products (4.0 cr)
- BBE 5302 - Biodegradation of Bioproducts (3.0 cr)
- BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
- CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
- EEB 4609W - Ecosystem Ecology [ENV, WI] (3.0 cr)
- EEB 5068 - Plant Physiological Ecology (3.0 cr)
- EEB 5608 - Ecosystem Ecology (3.0 cr)
- EEB 8200 - Sustainability Science Distributed Graduate Seminar (3.0 cr)
- EEB 8550 - Graduate Research Fellowship Proposal Writing Seminar (1.0 cr)
- ENT 4251 - Forest and Shade Tree Entomology (3.0 cr)
- EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
- EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
- EPSY 5247 - Qualitative Methods in Educational Psychology (3.0 cr)
- EPSY 5261 - Introductory Statistical Methods (3.0 cr)
- EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
- EPSY 8261 - Statistical Methods in Education I (3.0 cr)
- EPSY 8262 - Statistical Methods in Education II (3.0 cr)
- EPSY 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESPM 5071 - Ecological Restoration (4.0 cr)
- ESPM 5101 - Conservation of Plant Biodiversity (3.0 cr)
- ESPM 5108 - Ecology of Managed Systems (4.0 cr)
- ESPM 5202 - Environmental Conflict Management, Leadership, and Planning (3.0 cr)
- ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- ESPM 5242 - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- ESPM 5256 - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
- ESPM 5555 - Wetland Soils (3.0 cr)
- ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
- ESPM 5703 - Agroforestry in Watershed Management (3.0 cr)
- FNRM 5104 - Forest Ecology (4.0 cr)
- FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
- FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
- FNRM 5203 - Forest Fire and Disturbance Ecology (3.0 cr)
- FNRM 5204 - Landscape Ecology and Management (3.0 cr)
- FNRM 5205 - Productivity and Ecology of Forest Soils (3.0 cr)
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<td>Remote Sensing and Geospatial Analysis of Natural Resources and Environment</td>
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<td>Graduate Research Writing Practice for Non-native Speakers of English</td>
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**Paper Science and Engineering**

Specializes in areas such as: the chemistry and biotechnology of lignocellulosic materials; material science of paper and fiber products; paper recycling; energy and manufacturing efficiency in the pulp and paper-making process; novel and environmentally friendly pulping and bleaching, transport processes through porous media, surface and colloid science of papermaking; chemical engineering
applications in pulp and paper processes; and statistical process control.

**Paper Science and Engineering - Suggested Course List**

NRSM students in the paper science and engineering track should refer to this list when enrolling in courses that are appropriate for their area of study. Students must enroll in at least 34 credits in addition to their seminar and thesis credit (24 credits of NR 8888) requirements. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

- **AGRO 5121** - Applied Experimental Design (4.0 cr)
- **APEC 5031** - Methods of Economic Data Analysis (3.0 cr)
- **APEC 5032** - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- **APEC 8211** - Econometric Analysis I (4.0 cr)
- **APEC 8212** - Econometric Analysis II (4.0 cr)
- **BBE 5001** - Chemistry of Biomass and Biomass Conversion to Fuels and Products (4.0 cr)
- **BBE 5023** - Process Control and Instrumentation (3.0 cr)
- **BBE 5301** - Applied Surface and Colloid Science (3.0 cr)
- **BBE 5302** - Biodegradation of Bioproducts (3.0 cr)
- **BBE 5303** - Introduction to Bio-based Materials Science (3.0 cr)
- **BBE 5305** - Pulp and Paper Technology [WI] (3.0 cr)
- **BBE 5401** - Bioproducts Separation and Purification Processes (3.0 cr)
- **BBE 5402** - Bio-based Products Engineering Lab I (1.0 cr)
- **BBE 5403** - Bio-based Products Engineering Lab II (1.0 cr)
- **BBE 5404** - Biopolymers and Biocomposites Engineering (3.0 cr)
- **BBE 5412** - Biocomposites and Biomass Energy (4.0 cr)
- **BBE 5608** - Environmental and Industrial Microbiolog (3.0 cr)
- **BBE 5713** - Biological Process Engineering (3.0 cr)
- **BBE 5733** - Renewable Energy Technologies (3.0 cr)
- **BBE 8001** - Seminar I (1.0 cr)
- **BBE 8002** - Seminar II (1.0 cr)
- **BBE 8013** - Parameter Estimation in Biosystems and Agricultural Engineering (3.0 cr)
- **BBE 8300** - Research Problems (1.0 - 10.0 cr)
- **CHEM 5210** - Materials Characterization (4.0 cr)
- **CI 8149** - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- **DES 8103** - Qualitative and Mixed Methods Research (3.0 cr)
- **EEB 8550** - Graduate Research Fellowship Proposal Writing Seminar (1.0 cr)
- **EPSY 5221** - Principles of Educational and Psychological Measurement (3.0 cr)
- **EPSY 5244** - Survey Design, Sampling, and Implementation (3.0 cr)
- **EPSY 5248** - Qualitative Methods in Educational Psychology (3.0 cr)
- **EPSY 5261** - Introductory Statistical Methods (3.0 cr)
- **EPSY 5262** - Intermediate Statistical Methods (3.0 cr)
- **EPSY 8261** - Statistical Methods in Education I (3.0 cr)
- **EPSY 8262** - Statistical Methods in Education II (3.0 cr)
- **EPSY 8266** - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- **ESPM 5211** - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- **ESPM 5242** - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- **ESPM 5603** - Environmental Life Cycle Analysis (3.0 cr)
- **FNRM 5104** - Forest Ecology (4.0 cr)
- **FNRM 5131** - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- **FNRM 8101** - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
- **FNRM 8102** - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
- **FNRM 8103** - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
- **FNRM 8104** - Research Problems: Forest Ecology (1.0 - 5.0 cr)
- **FNRM 8105** - Research Problems: Silviculture (1.0 - 5.0 cr)
- **FNRM 8106** - Research Problems: Urban Forestry--Biology and Management (1.0 - 5.0 cr)
- **FNRM 8201** - Research Problems: Forest Economics (1.0 - 5.0 cr)
- **FNRM 8202** - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
- **FNRM 8203** - Research Problems: Forest Recreation (1.0 - 5.0 cr)
- **FNRM 8204** - Research Problems: Forest Policy (1.0 - 5.0 cr)
- **FNRM 8205** - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
- **FNRM 8206** - Research Problems: Forest Management (1.0 - 5.0 cr)
- **FNRM 8207** - Economic Analysis of Natural Resource Projects (2.0 cr)
- **FNRM 8208** - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
- **GIS 5555** - Basic Spatial Analysis (3.0 cr)
- **GRAD 8101** - Teaching in Higher Education (3.0 cr)
- **GRAD 8200** - Teaching and Learning Topics in Higher Education (1.0 cr)
- **ME 5228** - Introduction to Finite Element Modeling, Analysis, and Design (4.0 cr)
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<td>OLPD 5061</td>
<td>Ethnographic Research Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>OLPD 5528</td>
<td>Focus Group Interviewing Research Methods</td>
<td>1.0 - 3.0 cr</td>
</tr>
<tr>
<td>PA 5002</td>
<td>Introduction to Policy Analysis</td>
<td>1.5 cr</td>
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<tr>
<td>PA 5031</td>
<td>Empirical Analysis I</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>PA 5035</td>
<td>Survey Research and Data Collection</td>
<td>1.5 cr</td>
</tr>
<tr>
<td>PA 5041</td>
<td>Qualitative Methods for Policy Analysts</td>
<td>4.0 cr</td>
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<tr>
<td>PA 5920</td>
<td>Skills Workshop</td>
<td>0.5 - 4.0 cr</td>
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<tr>
<td>POL 8126</td>
<td>Qualitative Methods</td>
<td>3.0 cr</td>
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<tr>
<td>PUBH 7250</td>
<td>Designing and Conducting Focus Group Interviews</td>
<td>1.0 cr</td>
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<td>PUBH 7407</td>
<td>Analysis of Categorical Data</td>
<td>3.0 cr</td>
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<tr>
<td>SOC 5811</td>
<td>Social Statistics for Graduate Students [MATH]</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>SOC 8801</td>
<td>Sociological Research Methods</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>SOC 8811</td>
<td>Advanced Social Statistics</td>
<td>4.0 cr</td>
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<tr>
<td>STAT 5021</td>
<td>Statistical Analysis</td>
<td>4.0 cr</td>
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<tr>
<td>STAT 5201</td>
<td>Sampling Methodology in Finite Populations</td>
<td>3.0 cr</td>
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<tr>
<td>STAT 5302</td>
<td>Applied Regression Analysis</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>STAT 5303</td>
<td>Designing Experiments</td>
<td>4.0 cr</td>
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<tr>
<td>STAT 5401</td>
<td>Applied Multivariate Methods</td>
<td>3.0 cr</td>
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<tr>
<td>STAT 5421</td>
<td>Analysis of Categorical Data</td>
<td>3.0 cr</td>
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<tr>
<td>STAT 5601</td>
<td>Nonparametric Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>STAT 8051</td>
<td>Advanced Regression Techniques: linear, nonlinear and nonparametric methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>STAT 8052</td>
<td>Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>STAT 8053</td>
<td>Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>STAT 8054</td>
<td>Statistical Methods 4: Advanced Statistical Computing</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>WRIT 5051</td>
<td>Graduate Research Writing Practice for Non-native Speakers of English</td>
<td>3.0 cr</td>
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</tbody>
</table>

**Recreation Resources, Tourism, and Environmental Education**

Focuses on the use and management of natural resources for recreation and tourism. Graduate students in this track may specialize in areas such as recreational land management, resource-based tourism, planning for recreation and tourism, and the human dimensions of natural resource uses. Additionally, students may focus on environmental education and leadership for effective communication with diverse publics about natural resources.

**Recreation Resources, Tourism, and Environmental Education - Suggested Course List**

NRSM students in the recreation resources, tourism, and environmental education track should refer to this list when enrolling in courses that are appropriate for their area of study. Students must enroll in at least 34 credits in addition to their seminar and thesis credit (24 credits of NR 8888) requirements. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

- AGRO 5121 - Applied Experimental Design (4.0 cr)
- APEC 4311 - Tourism Development: Principles, Processes, Policies (3.0 cr)
- APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
- APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- APEC 8211 - Econometric Analysis I (4.0 cr)
- APEC 8212 - Econometric Analysis II (4.0 cr)
- CI 5537 - Principles of Environmental Education (3.0 cr)
- CI 5747 - Global and Environmental Education: Content and Practice (3.0 cr)
- CI 8149 - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- DES 8103 - Qualitative and Mixed Methods Research (3.0 cr)
- EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
- EEB 8550 - Graduate Research Fellowship Proposal Writing Seminar (1.0 cr)
- EPSY 5221 - Principles of Educational and Psychological Measurement (3.0 cr)
- EPSY 5243 - Principles and Methods of Evaluation (3.0 cr)
- EPSY 5244 - Survey Design, Sampling, and Implementation (3.0 cr)
- EPSY 5247 - Qualitative Methods in Educational Psychology (3.0 cr)
- EPSY 5261 - Introductory Statistical Methods (3.0 cr)
- EPSY 5262 - Intermediate Statistical Methods (3.0 cr)
- EPSY 8251 - Statistical Methods in Education I (3.0 cr)
- EPSY 8261 - Statistical Methods in Education I (3.0 cr)
- EPSY 8262 - Statistical Methods in Education II (3.0 cr)
- EPSY 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESPM 5202 - Environmental Conflict Management, Leadership, and Planning (3.0 cr)
- ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- ESPM 5242 - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- ESPM 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
- ESPM 5251 - Natural Resources in Sustainable International Development (3.0 cr)
• ESPM 5261 - Economics and Natural Resources Management (4.0 cr)
• ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
• ESPM 5811 - Environmental Interpretation (3.0 cr)
• FNRM 5101 - Park and Protected Area Tourism (3.0 cr)
• FNRM 5104 - Forest Ecology (4.0 cr)
• FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
• FNRM 5201 - Introduction to Travel and Tourism (3.0 cr)
• FNRM 5232 - Managing Recreational Lands (4.0 cr)
• FNRM 5259 - Visitor Behavior Analysis (3.0 cr)
• FNRM 8101 - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
• FNRM 8102 - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
• FNRM 8103 - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
• FNRM 8104 - Research Problems: Forest Ecology (1.0 - 5.0 cr)
• FNRM 8105 - Research Problems: Silviculture (1.0 - 5.0 cr)
• FNRM 8106 - Research Problems: Urban Forestry - Biology and Management (1.0 - 5.0 cr)
• FNRM 8107 - Research Problems: Forest Economics (1.0 - 5.0 cr)
• FNRM 8202 - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
• FNRM 8203 - Research Problems: Forest Recreation (1.0 - 5.0 cr)
• FNRM 8204 - Research Problems: Forest Policy (1.0 - 5.0 cr)
• FNRM 8205 - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
• FNRM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
• FNRM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
• FNRM 8208 - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
• FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
• GIS 5555 - Basic Spatial Analysis (3.0 cr)
• GRAD 8101 - Teaching in Higher Education (3.0 cr)
• GRAD 8200 - Teaching and Learning Topics in Higher Education (1.0 cr)
• LS 5950 - Special Topics (1.0 - 4.0 cr)
• OLPD 5061 - Ethnographic Research Methods (3.0 cr)
• OLPD 5501 - Principles and Methods of Evaluation (3.0 cr)
• OLPD 5502 - Theory and Models of Evaluation (3.0 cr)
• OLPD 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
• OLPD 5611 - Facilitation and Meeting Skills (1.0 cr)
• PA 4101 - Nonprofit Management and Governance (3.0 cr)
• PA 5002 - Introduction to Policy Analysis (1.5 cr)
• PA 5011 - Management of Organizations (3.0 cr)
• PA 5031 - Empirical Analysis I (4.0 cr)
• PA 5035 - Survey Research and Data Collection (1.5 cr)
• PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
• PA 5111 - Financing Public and Nonprofit Organizations (3.0 cr)
• PA 5501 - Theories and Policies of Development (3.0 cr)
• PA 5920 - Skills Workshop (0.5 - 4.0 cr)
• POL 8126 - Qualitative Methods (3.0 cr)
• PSY 5202 - Attitudes and Social Behavior (3.0 cr)
• PSY 5960 - Topics in Psychology (1.0 - 4.0 cr)
• PUBH 7250 - Designing and Conducting Focus Group Interviews (1.0 cr)
• PUBH 7407 - Analysis of Categorical Data (3.0 cr)
• SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
• SOC 8701 - Sociological Theory (4.0 cr)
• SOC 8801 - Sociological Research Methods (4.0 cr)
• SOC 8811 - Advanced Social Statistics (4.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
• STAT 5302 - Applied Regression Analysis (4.0 cr)
• STAT 5303 - Designing Experiments (4.0 cr)
• STAT 5401 - Applied Multivariate Methods (3.0 cr)
• STAT 5421 - Analysis of Categorical Data (3.0 cr)
• STAT 5601 - Nonparametric Methods (3.0 cr)
• STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
• STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
• STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
• STAT 8054 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
• WRIT 5051 - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)
For students interested in working with leaders in ecology, physiology, evolution, genetics, statistics, computer science, forestry, natural resource policy, and the social sciences as they relate to wildlife, ecology and management, and conservation biology.

**Wildlife Ecology and Management - Suggested Course List**

NRSM students in the wildlife ecology and management track should refer to this list when enrolling in courses that are appropriate for their area of study. Students must enroll in at least 34 credits in addition to their seminar and thesis credit (24 credits of NR 8888) requirements. Students may elect to take courses outside of this list if advised to do so by their advisor or committee.

Take 0 or more course(s) from the following:

- **AGRO 5121** - Applied Experimental Design (4.0 cr)
- **APEC 5031** - Methods of Economic Data Analysis (3.0 cr)
- **APEC 5032** - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)
- **APEC 5321** - Regional Economic Analysis (3.0 cr)
- **APEC 5711** - U.S. Agricultural and Environmental Policy (3.0 cr)
- **APEC 8211** - Econometric Analysis I (4.0 cr)
- **APEC 8212** - Econometric Analysis II (4.0 cr)
- **BIOL 5407** - Ecology (3.0 cr)
- **CONS 8001** - Conservation Biology Seminar (1.0 cr)
- **CONS 8004** - Economic and Social Aspects of Conservation Biology (3.0 cr)
- **CONS 8201** - How to Excel in Graduate School (2.0 cr)
- **CI 8149** - Qualitative Research: Coding, Analysis, Interpretation, and Writing (3.0 cr)
- **DES 8103** - Qualitative and Mixed Methods Research (3.0 cr)
- **EEB 4129** - Mammalogy (4.0 cr)
- **EEB 4134** - Introduction to Ornithology (4.0 cr)
- **EEB 5053** - Ecology: Theory and Concepts (4.0 cr)
- **EEB 5322** - Evolution and Animal Cognition (3.0 cr)
- **EEB 5601** - Limnology (3.0 cr)
- **EEB 5609** - Ecosystem Ecology (3.0 cr)
- **EEB 8550** - Graduate Research Fellowship Proposal Writing Seminar (1.0 cr)
- **ENT 5910** - Special Problems in Entomology (1.0 - 6.0 cr)
- **EPSY 5221** - Principles of Educational and Psychological Measurement (3.0 cr)
- **EPSY 5244** - Survey Design, Sampling, and Implementation (3.0 cr)
- **EPSY 5247** - Qualitative Methods in Educational Psychology (3.0 cr)
- **EPSY 5261** - Introductory Statistical Methods (3.0 cr)
- **EPSY 5262** - Intermediate Statistical Methods (3.0 cr)
- **EPSY 5251** - Statistical Methods in Education I (3.0 cr)
- **EPSY 5252** - Statistical Methods in Education II (3.0 cr)
- **EPSY 5261** - Statistical Methods in Education I (3.0 cr)
- **EPSY 5262** - Statistical Methods in Education II (3.0 cr)
- **EPSY 8266** - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- **EPSY 8268** - Hierarchical Linear Modeling in Educational Research (3.0 cr)
- **ESPM 5108** - Ecology of Managed Systems (4.0 cr)
- **ESPM 5202** - Environmental Conflict Management, Leadership, and Planning (3.0 cr)
- **ESPM 5211** - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- **ESPM 5241** - Natural Resource and Environmental Policy (3.0 cr)
- **ESPM 5242** - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- **ESPM 5251** - Natural Resources in Sustainable International Development (3.0 cr)
- **ESPM 5261** - Economics and Natural Resources Management (4.0 cr)
- **ESPM 5295** - GIS in Environmental Science and Management (4.0 cr)
- **ESPM 5603** - Environmental Life Cycle Analysis (3.0 cr)
- **FNRM 5104** - Forest Ecology (4.0 cr)
- **FNRM 5131** - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- **FNRM 5204** - Landscape Ecology and Management (3.0 cr)
- **FNRM 5262** - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
- **FNRM 5411** - Managing Forest Ecosystems: Silviculture (3.0 cr)
- **FNRM 8101** - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
- **FNRM 8102** - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
- **FNRM 8103** - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
- **FNRM 8104** - Research Problems: Forest Ecology (1.0 - 5.0 cr)
- **FNRM 8105** - Research Problems: Silviculture (1.0 - 5.0 cr)
- **FNRM 8106** - Research Problems: Urban Forestry--Biology and Management (1.0 - 5.0 cr)
- **FNRM 8201** - Research Problems: Forest Economics (1.0 - 5.0 cr)
- **FNRM 8202** - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
- **FNRM 8203** - Research Problems: Forest Recreation (1.0 - 5.0 cr)
- **FNRM 8204** - Research Problems: Forest Policy (1.0 - 5.0 cr)
- **FNRM 8205** - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
• FNRM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
• FNRM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
• FNRM 8208 - Research Problems: Environmental Learning and Leadership (1.0 - 5.0 cr)
• FW 4001 - Biometry (4.0 cr)
• FW 4101 - Herpetology (4.0 cr)
• FW 4103 - Principles of Wildlife Management (3.0 cr)
• FW 5003 - Human Dimensions of Biological Conservation (3.0 cr)
• FW 5051 - Analysis of Populations (4.0 cr)
• FW 5603W - Habitats and Regulation of Wildlife [WI] (3.0 cr)
• FW 5625 - Wildlife Handling and Immobilization for Research and Management (2.0 cr)
• FW 8051 - Statistical Modeling of Ecological Data using R and WinBugs/JAGS (4.0 cr)
• FW 8200 - Seminar (1.0 - 4.0 cr)
• FW 8452 - Conservation Biology (3.0 cr)
• FW 8494 - Research in Wildlife (1.0 - 4.0 cr)
• GIS 5555 - Basic Spatial Analysis (3.0 cr)
• GRAD 8101 - Teaching in Higher Education (3.0 cr)
• GRAD 8200 - Teaching and Learning Topics in Higher Education (1.0 cr)
• OLPD 5061 - Ethnographic Research Methods (3.0 cr)
• OLPD 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
• PA 5002 - Introduction to Policy Analysis (1.5 cr)
• PA 5031 - Empirical Analysis I (4.0 cr)
• PA 5035 - Survey Research and Data Collection (1.5 cr)
• PA 5041 - Qualitative Methods for Policy Analysts (4.0 cr)
• PA 5920 - Skills Workshop (0.5 - 4.0 cr)
• PBIO 4321 - Minnesota Flora (3.0 cr)
• POL 8126 - Qualitative Methods (3.0 cr)
• PUBH 7250 - Designing and Conducting Focus Group Interviews (1.0 cr)
• PUBH 7407 - Analysis of Categorical Data (3.0 cr)
• SOC 5811 - Social Statistics for Graduate Students [MATH] (4.0 cr)
• SOC 8801 - Sociological Research Methods (4.0 cr)
• SOC 8811 - Advanced Social Statistics (4.0 cr)
• STAT 5021 - Statistical Analysis (4.0 cr)
• STAT 5102 - Theory of Statistics II (4.0 cr)
• STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
• STAT 5302 - Applied Regression Analysis (4.0 cr)
• STAT 5303 - Designing Experiments (4.0 cr)
• STAT 5401 - Applied Multivariate Methods (3.0 cr)
• STAT 5421 - Analysis of Categorical Data (3.0 cr)
• STAT 5601 - Nonparametric Methods (3.0 cr)
• STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
• STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
• STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
• STAT 8054 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
• STAT 8101 - Theory of Statistics I (3.0 cr)
• STAT 8102 - Theory of Statistics 2 (3.0 cr)
• WRIT 5051 - Graduate Research Writing Practice for Non-native Speakers of English (3.0 cr)
Twin Cities Campus  
Nutrition M.S.  
College of Food, Agricultural and Natural Resource Sciences  

Link to a list of faculty for this program.

Contact Information:  
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)  
Email: fsgrad@umn.edu  
Website: http://fscn.cfans.umn.edu/graduate-programs/nutrition

- Program Type: Master's
- Requirements for this program are current for Fall 2016
- Length of program in credits: 30
- This program does not require summer semesters for timely completion.
- Degree: Master of Science

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Nutrition is the study of how nutrients, both essential and nonessential, affect health and all life processes. Consequently, nutrition is an extremely broad field that encompasses physiology, biochemistry, education, public health, and public policy. The nutrition graduate program is interdisciplinary. Advisors and financial support may come from any of the departments or schools in which nutrition graduate faculty reside, including the Department of Food Science and Nutrition (College of Food, Agricultural and Natural Resource Sciences); Division of Epidemiology (School of Public Health); Departments of Medicine, Surgery, Psychiatry, Lab Medicine and Pathology, and Family Medicine and Community Health (Medical School); Department of Kinesiology and Leisure Studies (College of Education and Human Development); Department of Biochemistry and Molecular Biology (University of Minnesota Duluth); University of Minnesota Extension; Hormel Institute (Austin, MN); and V.A. Medical Center and Park Nicollet Institute (Minneapolis, MN).

Three subspecialty areas are offered in the program: human nutrition, nutritional biochemistry, and public health nutrition. Thesis work can be conducted locally or internationally in the laboratory, clinic, or field.

Students are allowed a maximum of 5 years in the program.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Applicants to the program need a bachelor's degree in any field or its international equivalent.

Other requirements to be completed before admission:
A strong foundation in the biological and physical sciences is required. This background includes college mathematics, the equivalent of one semester of general chemistry, organic chemistry, general biology, biochemistry, physiology, and statistics. For the doctoral program, additional prerequisite courses include calculus and physics. If there is evidence that the applicant has a good background in the sciences, some of the prerequisites can be met after admission. The M.S. program also requires the following nutrition courses, or equivalent, which may be completed after the student's admission to the program: Principles of Nutrition (FSCN 1112), Life Cycle Nutrition (FSCN 3612), and Human Nutrition (FSCN 4612).

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
- Paper Based - Total Score: 550
  • IELTS
    - Total Score: 6.5
  • MELAB
    - Final score: 80

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

Plan A: Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

Plan B: Plan B requires 24 major credits and 6 credits outside the major. The final exam is oral. A capstone project is required.

Capstone Project: The Plan B project is a combined total of approximately 120 hours (the equivalent of three full-time weeks) of work. The graduate faculty, including the student's advisor and director of Graduate Studies, specify both the nature and extent of the course and project work necessary to satisfy this requirement.

This program may not be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 2.80 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

All students are expected to obtain teaching experience, subject to the policies of the advisor's department or division.

Required Coursework
All students must take the following courses for at least 20 credits:

Orientation Course
NUTR 8621 - Presentation Skills (1.0 cr)

Core Coursework
NUTR 5625 - Nutritional Biochemistry (3.0 cr)
NUTR 5626 - Nutritional Physiology (3.0 cr)
NUTR 5622 - Vitamin and Mineral Biochemistry (3.0 cr)

Advanced Topics Course
Take at least one course from the following list after completing two semesters in the program:
NUTR 8620 - Advances in Nutrition (2.0 cr)
or NUTR 8611 - The Role of Nutrition in Cancer Causation and Prevention (2.0 cr)
Take at least 2 credits from the following:
NUTR 5627 - Nutritional and Food Toxicology (3.0 cr)
or NUTR 8xxx
or NUTR 5xxx

Outside Coursework
All students must complete at least 6 credits outside the major, including at least one statistics course and at least one methods course.

Statistics Course
Take at least one statistics course from the following list. A different statistics course can be substituted with advisor approval.
PUBH 6450 - Biostatistics I (4.0 cr)
or PUBH 6451 - Biostatistics II (4.0 cr)
or PUBH 6414 - Biostatistical Literacy (3.0 cr)
or STAT 5021 - Statistical Analysis (4.0 cr)

Research Methods Course
Take one or more courses for at least 2 credits of research methods coursework from this list, or graduate-level methods coursework from another field with advisor approval.
ANSC 5091 - Research Proposals: From Ideas to Strategic Plans [WI] (3.0 cr)
NURS 8173 - Principles and Methods of Implementing Research (3.0 cr)
PUBH 6341 - Epidemiologic Methods I (3.0 cr)
PUBH 6617 - Practical Methods for Secondary Data Analysis (3.0 cr)
PUBH 6803 - Conducting a Systematic Literature Review (3.0 cr)
PUBH 6806 - Principles of Public Health Research (2.0 cr)
FSCN 4622 - Nutritional Toxicology, the basic science of diet-related toxicants (3.0 cr)
PUBH 6902 - Maternal, Infant, and Preschool Nutrition (2.0 cr)
PUBH 6903 - Child and Adolescent Nutrition (2.0 cr)
PUBH 6914 - Community Nutrition Intervention (3.0 cr)

Plan Options

Plan A: Master's Thesis Credits
Plan A students take at least 10 credits of the following:
NUTR 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)

-OR-

Plan B: Additional Coursework
Plan B students must take at least 10 credits from the following, or other graduate-level coursework with advisor approval:
NUTR 8695 - Independent Study: Nutrition (1.0 - 10.0 cr)
NUTR 8xxx
NUTR 5xxx

Program Sub-plans
A sub-plan is not required for this program.
Students may not complete the program with more than one sub-plan.

Rochester
Twin Cities Campus

Nutrition Minor

Food Science & Nutrition

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/graduate-programs/nutrition

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 13
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Nutrition is the study of how nutrients, both essential and nonessential, affect health and all life processes. Consequently, nutrition is an extremely broad field that encompasses physiology, biochemistry, education, public health, and public policy. The nutrition graduate program is interdisciplinary. Advisers and financial support may come from any of the departments or schools in which nutrition graduate faculty reside, including the Department of Food Science and Nutrition (College of Food, Agricultural and Natural Resource Sciences); Division of Epidemiology (School of Public Health); Departments of Medicine, Surgery, Psychiatry, Lab Medicine and Pathology, and Family Medicine and Community Health (Medical School); Department of Kinesiology and Leisure Studies (College of Education and Human Development); Department of Biochemistry and Molecular Biology (University of Minnesota Duluth); University of Minnesota Extension; Hormel Institute (Austin, Minn.); V.A. Medical Center and Park Nicollet Institute (Minneapolis, Minn.).

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters
Coursework
Take the following two courses for the master's minor in Nutrition.

NUTR 5625 - Nutritional Biochemistry (3.0 cr)
NUTR 5626 - Nutritional Physiology (3.0 cr)

Doctoral
Coursework
Take at least 13 credits from the following list of courses. NUTR 8620 and 8611 are available to students after completing two semesters in the minor. Consult with the Nutrition Director of Graduate Studies.

NUTR 5624 - Nutrition and Genetics (2.0 cr)
NUTR 5625 - Nutritional Biochemistry (3.0 cr)
NUTR 5626 - Nutritional Physiology (3.0 cr)
NUTR 5622 - Vitamin and Mineral Biochemistry (3.0 cr)
NUTR 8620 - Advances in Nutrition (2.0 cr)
NUTR 8611 - The Role of Nutrition in Cancer Causation and Prevention (2.0 cr)
Nutrition Ph.D.

College of Food, Agricultural and Natural Resource Sciences

Contact Information:
Department of Food Science and Nutrition, 225 Food Science and Nutrition Building, 1334 Eckles Avenue, Saint Paul, MN 55108 (612-624-6753; fax: 612-625-5272)
Email: fsgrad@umn.edu
Website: http://fscn.cfans.umn.edu/graduate-programs/nutrition/phd

- Program Type: Doctorate
- Requirements for this program are current for Fall 2016
- Length of program in credits: 52
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Nutrition is the study of how nutrients, both essential and nonessential, affect health and all life processes. Consequently, nutrition is an extremely broad field that encompasses physiology, biochemistry, education, public health, and public policy. The nutrition graduate program is interdisciplinary. Advisers and financial support may come from any of the departments or schools in which nutrition graduate faculty reside, including the Department of Food Science and Nutrition (College of Food, Agricultural and Natural Resource Sciences); Division of Epidemiology (School of Public Health); Departments of Medicine, Surgery, Psychiatry, Lab Medicine and Pathology, and Family Medicine and Community Health (Medical School); Department of Kinesiology and Leisure Studies (College of Education and Human Development); Department of Biochemistry and Molecular Biology (University of Minnesota Duluth); University of Minnesota Extension; Hormel Institute (Austin, MN.); V.A. Medical Center and Park Nicollet Institute (Minneapolis, MN.).

Three subspecialty areas are offered in the doctoral degree program: human nutrition, nutritional biochemistry, and public health nutrition. Thesis work may be conducted locally or internationally in the laboratory, clinic, or field.

Students may spend a maximum of 8 years in the program.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Applicants to the program need a bachelor's degree in any field or its international equivalent, along with demonstrated research ability such as a MS degree or publications.

Other requirements to be completed before admission:
A strong foundation in the biological and physical sciences is required. This background includes college mathematics, the equivalent of one semester of general chemistry, organic chemistry, general biology, biochemistry, physiology, and statistics. For the doctoral program, additional prerequisite courses include calculus and physics. If there is evidence that the applicant has a good background in the sciences, some of the prerequisites can be met after admission. The PhD program also requires the following nutrition courses, or equivalents, which may be completed after admission to the program: Principles of Nutrition (FSCN 1112), Life Cycle Nutrition (FSCN 3612), and Human Nutrition (FSCN 4612).

Applicants must submit their test score(s) from the following:
- GRE

International applicants must submit score(s) from one of the following tests:
- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
- Internet Based - Reading Score: 19
- Paper Based - Total Score: 550
  • IELTS
    - Total Score: 6.5
  • MELAB
    - Final score: 80

Key to test abbreviations (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
16 credits are required in the major.
12 credits are required outside the major.
24 thesis credits are required.

This program may not be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

PhD students are expected to obtain teaching experience through assisting with course instruction three times. Teaching experience is subject to the policies of the advisor's department or division.

Thesis work may be conducted in the laboratory, clinic, or field, either locally or internationally.

Required Coursework
Orientation Course
  NUTR 8621 - Presentation Skills (1.0 cr)
Core Courses
  NUTR 5625 - Nutritional Biochemistry (3.0 cr)
  NUTR 5626 - Nutritional Physiology (3.0 cr)
  NUTR 5622 - Vitamin and Mineral Biochemistry (3.0 cr)
Advanced Topics Courses
  Take at least two courses from the following list after completing two semesters in the program:
    NUTR 8620 - Advances in Nutrition (2.0 cr)
    NUTR 8611 - The Role of Nutrition in Cancer Causation and Prevention (2.0 cr)
Remaining Nutrition Coursework
  Take at least 2 credits from the following:
    NUTR 5627 - Nutritional and Food Toxicology (3.0 cr)
    or NUTR 8xxx
Outside Coursework
  PhD students must complete at least 12 credits outside the major, including at least one statistics course and at least one methods course.
Statistics Course
  Take at least one statistics course from the following list. A different statistics course can be substituted with advisor approval.
    PUBH 6450 - Biostatistics I (4.0 cr)
    or PUBH 6451 - Biostatistics II (4.0 cr)
    or PUBH 6414 - Biostatistical Literacy (3.0 cr)
    or STAT 5021 - Statistical Analysis (4.0 cr)
Research Methods Course
  Take one or more courses totaling at least two credits of research methods coursework from this list, or graduate-level methods coursework from another field with advisor approval.
    ANSC 5091 - Research Proposals: From Ideas to Strategic Plans [WI] (3.0 cr)
    NURS 8173 - Principles and Methods of Implementing Research (3.0 cr)
    PUBH 6341 - Epidemiologic Methods I (3.0 cr)
PUBH 6617 - Practical Methods for Secondary Data Analysis (3.0 cr)
PUBH 6803 - Conducting a Systematic Literature Review (3.0 cr)
PUBH 6806 - Principles of Public Health Research (2.0 cr)
FSCN 4622 - Nutritional Toxicology, the basic science of diet-related toxicants (3.0 cr)
PUBH 6902 - Maternal, Infant, and Preschool Nutrition (2.0 cr)
PUBH 6903 - Child and Adolescent Nutrition (2.0 cr)
PUBH 6914 - Community Nutrition Intervention (3.0 cr)

Doctoral Thesis Credits
Take at least 24 credits of the following:
NUTR 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)
Plant pathology focuses on the biology of plant-microbe interactions, and incorporates research involving biochemical, molecular, genetic, physiological, whole organism, population, and community levels of biological organization. Plant pathology interfaces with all plant science disciplines, and with many other fields including food sciences, veterinary medicine, biobased products, and ecology. Areas of concentration include molecular plant pathology (offered as a special emphasis), plant disease management, biological control of plant disease, forest pathology and microbial degradation of wood, microbial ecology, population biology, plant-microbe interactions, disease resistance, host-parasite coevolution, plant microbe mutualisms, and virology. Students have opportunities for laboratory and field research locally, as well as nationally and internationally. The course of study varies with the requirements for the area of concentration and interests of the student. Students who choose the emphasis in molecular plant pathology enhance their ability to design and use molecular approaches to investigate plant disease, increase basic knowledge, and develop new strategies for disease control.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.50.

Other requirements to be completed before admission:
Applicants must have completed 35 semester credits in biology with at least one course in each of the following areas: botany, zoology, genetics, plant physiology, and microbiology. Applicants must also have completed at least one course each in inorganic chemistry, organic chemistry, biochemistry, and physics. If deficiencies exist in the prerequisites, students must correct them during the first year of the graduate program. These courses cannot be counted as part of the degree program. All students accepted into the department with a BS degree are admitted into the MS program. After a minimum of two semesters, students who qualify may elect to change their degree status to the PhD program. Criteria for the change include scholastic standing, potential for success in completing a PhD, and writing competency.

Special Application Requirements:
GRE scores are required for all students and TOEFL or IELTS scores are required for international students. A clearly written statement of career interests as well as three letters of recommendation are required of all students. Students may apply at any time; however, submission of all application materials by December 10 will ensure priority consideration for fellowships and research assistantships for the next academic year. Students can be admitted any semester.

Applicants must submit their test score(s) from the following:
• GRE
  - General Test - Verbal Reasoning: 153
  - General Test - Quantitative Reasoning: 148
  - General Test - Analytical Writing: 4.5
International applicants must submit score(s) from one of the following tests:

- **TOEFL**
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550

- **IELTS**
  - Total Score: 6.5

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

## Program Requirements

**Plan A:** Plan A requires 14 major credits, 6 credits outside the major, and 10 thesis credits. The final exam is oral.

**Plan B:** Plan B requires 20 major credits and 10 credits outside the major. The final exam is oral. A capstone project is required.  
**Capstone Project:** The Plan B option requires one to three projects, determined and approved by the advisor and director of graduate studies, totaling approximately 120 hours of work.

This program may be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 2.80 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

All students:

- Students must enroll in a credit or non-credit teaching methods seminar or workshop, chosen in consultation with the advisor and director of graduate studies.
- Regular attendance at weekly plant pathology seminars is expected.
- Internships are encouraged as part of the graduate experience. Financial support for international or domestic internships is available on a competitive basis.

Students pursuing the non-molecular plant pathology option:

- Take PLPA 5480 (3 credits), if an introductory plant pathology course has not previously been taken.

### Required Coursework

All students take the following courses. Take PLPA 8090 (S-N grade basis) for 2 credits if completing a one-semester teaching experience, or 1 credit for a half-semester experience. Consult with the advisor and director of graduate studies regarding the additional teaching methods seminar/workshop requirement.

- **PLPA 8123 - Research Ethics in Plant and Environmental Sciences** (0.5 cr)
- **PLPA 8200 - Seminar** (1.0 cr)
- **PLPA 8090 - Advanced Procedures and Research in Plant Pathology** (1.0 - 8.0 cr)
- **PLPA 5480 - Principles of Plant Pathology** (3.0 cr)

### Outside Coursework

Take at least 6 credits (Plan A) or 10 credits (Plan B) outside the major. Select courses in consultation with the advisor, director of graduate studies, and advisory committee. Suggested courses include the following:

- **AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement** (3.0 cr)
- **EEB 5221 - Molecular Evolution** (3.0 cr)
- **GCD 5036 - Molecular Cell Biology** (3.0 cr)

### Thesis Credits

- All students completing the Molecular Plant Pathology option, and students completing the non-molecular plant pathology Plan A option, take at least 10 master's thesis credits.

- **PLPA 8777 - Thesis Credits:** Master's (1.0 - 18.0 cr)

### Non-Molecular and Molecular Plant Pathology Options
Non-Molecular Plant Pathology Option

Required Coursework
In addition to courses required of all MS students, students pursuing the non-molecular plant pathology option must complete the following courses:
PLPA 8104 - Plant Virology (2.0 cr)
PLPA 8105 - Plant Bacteriology (2.0 cr)

Electives
Take elective credits from the following list, chosen in consultation with the advisor, director of graduate studies, and advisory committee, to meet the 14-credit (Plan A) or 20-credit (Plan B) minimum requirement for the major.
PLPA 5003 - Diseases of Forest and Shade Trees (3.0 cr)
PLPA 5202 - Field Plant Pathology (2.0 cr)
PLPA 5203 - Introduction to Fungal Biology (3.0 cr)
PLPA 5300 - Current Topics in Molecular Plant Pathology (1.0 - 2.0 cr)
PLPA 5301 - Plant Genomics (3.0 cr)
PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
PLPA 8103 - Plant-Microbe Interactions (3.0 cr)

-OR-

Molecular Plant Pathology Option

Required Coursework
In addition to courses required of all MS students, students pursuing the molecular plant pathology option must complete the following courses:
PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
PLPA 5300 - Current Topics in Molecular Plant Pathology (1.0 - 2.0 cr)

Electives
Take elective credits from the following list, chosen in consultation with the advisor, director of graduate studies, and advisory committee, to meet the 14-credit (Plan A) minimum requirement for the major.
PLPA 5003 - Diseases of Forest and Shade Trees (3.0 cr)
PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
PLPA 5202 - Field Plant Pathology (2.0 cr)
PLPA 5203 - Introduction to Fungal Biology (3.0 cr)
PLPA 5301 - Plant Genomics (3.0 cr)
PLPA 8104 - Plant Virology (2.0 cr)
PLPA 8105 - Plant Bacteriology (2.0 cr)
Twin Cities Campus
Plant Pathology Minor
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Plant Pathology Graduate Program, 495 Borlaug Hall, 1991 Buford Circle, Saint Paul, MN 55108 (612-625-8200)
Email: plpath@umn.edu
Website: http://plpa.cfans.umn.edu

• Program Type: Graduate minor related to major
• Requirements for this program are current for Fall 2016
• Length of program in credits (Masters): 6
• Length of program in credits (Doctorate): 12
• This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Plant pathology focuses on the biology of plant-microbe interactions, and incorporates research involving biochemical, molecular, genetic, physiological, whole organism, population, and community levels of biological organization. Plant pathology interfaces with all plant science disciplines, and with many other fields including food sciences, veterinary medicine, biobased products, and ecology. Areas of concentration include molecular plant pathology, plant disease management, biological control of plant disease, forest pathology and microbial degradation of wood, microbial ecology, population biology, plant-microbe interactions, disease resistance, host-parasite coevolution, plant microbe mutualisms, and virology.

Program Delivery
This program is available:
• via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses towards program requirements is not permitted.

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Doctoral

Doctoral
Take 12 or more credit(s) from the following:
• PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
• PLPA 5300 - Current Topics in Molecular Plant Pathology (1.0 - 2.0 cr)
• PLPA 5301 - Plant Genomics (3.0 cr)
• PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
• PLPA 5480 - Principles of Plant Pathology (3.0 cr)
• PLPA 8104 - Plant Virology (2.0 cr)
• PLPA 8105 - Plant Bacteriology (2.0 cr)
• PLPA 8123 - Research Ethics in Plant and Environmental Sciences (0.5 cr)

Masters

Master's Minor
Take 6 or more credit(s) from the following:

- PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
- PLPA 5300 - Current Topics in Molecular Plant Pathology (1.0 - 2.0 cr)
- PLPA 5301 - Plant Genomics (3.0 cr)
- PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
- PLPA 5480 - Principles of Plant Pathology (3.0 cr)
- PLPA 8104 - Plant Virology (2.0 cr)
- PLPA 8105 - Plant Bacteriology (2.0 cr)
- PLPA 8123 - Research Ethics in Plant and Environmental Sciences (0.5 cr)
Twin Cities Campus
Plant Pathology Ph.D.
Plant Pathology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Plant Pathology Graduate Program, 495 Borlaug Hall, 1991 Buford Circle, Saint Paul, MN 55108 (612-625-8200)
Email: plpath@umn.edu
Website: http://plpa.cfans.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2016
- Length of program in credits: 53
- This program requires summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Plant pathology focuses on the biology of plant-microbe interactions, and incorporates research involving biochemical, molecular, genetic, physiological, whole organism, population, and community levels of biological organization. Plant pathology interfaces with all plant science disciplines, and with food sciences, veterinary medicine, biobased products, and ecology. Areas of concentration include molecular plant pathology (offered as a special emphasis), plant disease management, biological control of plant disease, forest pathology and microbial degradation of wood, microbial ecology, population biology, plant-microbe interactions, disease resistance, host-parasite coevolution, plant microbe mutualisms, and virology. Students have opportunities for laboratory and field research locally as well as nationally and internationally. The course of study varies with the requirements of the area of concentration and interests of the student. Students who choose the emphasis in molecular plant pathology enhance their ability to design and use molecular approaches to investigate plant disease, increase basic knowledge, and develop new strategies for disease control.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.50.

Applicants must have a sound college background in the basic biological and physical sciences and mathematics.

PhD applicants must satisfy all the prerequisites for the master's degree program in plant pathology or have a master's degree in plant pathology or in a field of natural science.

Other requirements to be completed before admission:
Applicants must have completed 35 semester credits in biology with at least one course in each of the following areas: botany, zoology, genetics, plant physiology, and microbiology. Applicants must also have completed at least one course each in inorganic chemistry, organic chemistry, biochemistry, and physics. If deficiencies exist in the prerequisites, they must be corrected during the first year of the graduate program. Applicants should note that these courses cannot be counted as part of the degree program. All students accepted into the department with only a BS degree are admitted into the MS degree program. After a minimum of two semesters, students who qualify may elect to change their degree status to the PhD program. Criteria for the change include scholastic standing, potential for success in completing a PhD, and writing competency.

Special Application Requirements:
GRE scores are required for all students and TOEFL or IELTS scores are required for international students. A clearly written statement of career interests as well as three letters of recommendation are required of all students. Students may apply at any time; however, submission of all application materials by December 10 will ensure priority consideration for fellowships and research assistantships for the next academic year. Students can be admitted any semester.

Applicants must submit their test score(s) from the following:
- GRE
  - General Test - Verbal Reasoning: 153
International applicants must submit score(s) from one of the following tests:

- **TOEFL**
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550

- **IELTS**
  - Total Score: 6.5

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations (GRE, TOEFL, IELTS).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

**Program Requirements**
17 credits are required in the major.
12 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 2.80 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

Students must enroll in a supervised teaching or extension teaching experience, chosen in consultation with the advisor and director of graduate studies.

Degree plans are determined by the advisory committee, with approval of the director of graduate studies.

Regular attendance at weekly plant pathology seminars is expected.

Internships are encouraged as part of the graduate experience. Financial support for international or domestic internships is available on a competitive basis.

**Required Coursework**
All students take the following courses, if not completed previously. Take PLPA 8200 twice for a total of 2 credits; PLPA 8090 for 2 credits to fulfill the one-semester teaching experience requirement; and take GRAD 8101 or Grad 8102 concurrently with or after completing PLPA 8090.

- PLPA 5480 - Principles of Plant Pathology (3.0 cr)
- PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
- PLPA 8123 - Research Ethics in Plant and Environmental Sciences (0.5 cr)
- PLPA 8200 - Seminar (1.0 cr)
- PLPA 8090 - Advanced Procedures and Research in Plant Pathology (1.0 - 8.0 cr)
- GRAD 8102 - Practicum for Future Faculty (3.0 cr)
  - or GRAD 8101 - Teaching in Higher Education (3.0 cr)

**Electives**
Take at least 12 credits, in consultation with the advisor, to complete the outside credit requirement.

**Thesis Credits**
Take at least 24 doctoral thesis credits.
- PLPA 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

**Non-Molecular and Molecular Plant Pathology Options**

**Molecular Plant Pathology Option**
In addition to courses required of all doctoral students, students pursuing the molecular plant pathology option must complete the
following courses to meet the 17.5-credit minimum for the major. Take PLPA 5300 twice for a total of 2 credits.

PLPA 5301 - Plant Genomics (3.0 cr)
PLPA 5300 - Current Topics in Molecular Plant Pathology (1.0 - 2.0 cr)
PLPA 8104 - Plant Virology (2.0 cr)
  or PLPA 8105 - Plant Bacteriology (2.0 cr)

-OR-

**Non-Molecular Plant Pathology Option**

In addition to courses required of all doctoral students, students pursuing the non-molecular plant pathology option must complete the following courses to meet the 17.5-credit minimum for the major:

PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
PLPA 8104 - Plant Virology (2.0 cr)
PLPA 8105 - Plant Bacteriology (2.0 cr)
Twin Cities Campus
Risk Analysis for Introduced Species and Genotypes Minor
Fisheries, Wildlife, and Conservation Biology
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Entomology, Room 219 Hodson Hall, 6125B, 1980 Folwell Ave., St. Paul, MN 55108
Email: isg-igert@umn.edu
Website: http://isg-igert.umn.edu

- Program Type: Graduate free-standing minor
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 13
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The minor in risk analysis for introduced species and genotypes is available to master's (M.A. and M.S.) and doctoral students. The minor provides an interdisciplinary curriculum that addresses all phases of risk analysis pertaining to the introduction of exotic species and novel genotypes. The curriculum is based on collaborative learning and includes a survey course, discussions, a problem solving practicum, and a cooperative learning practicum. The minor complements major programs in applied economics; applied plant sciences; conservation biology; ecology, evolution, and behavior; entomology; natural resources science and management; plant biological sciences; and water resources science.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

Program Sub-plans
Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Masters
ISG Core Courses
The master's minor requires 6 graduate credits from the core curriculum; ISG 8001 must be taken two times for 1 credit each time.
ISG 5010 - Risk Analysis for Introduced Species and Genotypes (3.0 cr)
ISG 5020 - Risk Analysis Modeling for Introduced Species and Genotypes (1.0 cr)
ISG 8001 - Discussions in Introduced Species and Genotypes (1.0 cr)

Doctoral
ISG Doctoral Minor
In addition to the 10-credit core listed, a 3-credit decision analysis or quantitative modeling course from another program is required.
ISG 8001 must be taken twice for one credit.
ISG 5010 - Risk Analysis for Introduced Species and Genotypes (3.0 cr)
ISG 5020 - Risk Analysis Modeling for Introduced Species and Genotypes (1.0 cr)
ISG 8001 - Discussions in Introduced Species and Genotypes (1.0 cr)
ISG 8021 - Problem Solving Practicum in Risk Analysis (3.0 cr)
ISG 8031 - Cooperative Learning Practicum (1.0 cr)
Twin Cities Campus
Sustainable Agriculture Systems Minor
Agronomy & Plant Genetics
College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Director of Graduate Studies, Sustainable Agriculture Systems Minor, 411 Borlaug Hall, 1991 Buford Circle, St. Paul, MN 55108 (612-625-3754; fax:612-625-1268)
Email: sheaf001@umn.edu
Website: http://www.misa.umn.edu/StudentPrograms/GraduateMinor/index.htm

- Program Type: Graduate free-standing minor
- Requirements for this program are current for Fall 2016
- Length of program in credits (Masters): 6
- Length of program in credits (Doctorate): 12
- This program does not require summer semesters for timely completion.

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The minor in sustainable agriculture systems offers master's (M.A. and M.S.) and doctoral students an interdisciplinary curriculum that considers the biological, sociological, and economic aspects of agriculture. The minor emphasizes a holistic perspective to designing farming and food systems and solving problems in agriculture. The importance of yield and profitability are balanced by considerations of the environment and the health and social well-being of producers, consumers, and communities. The minor complements major programs in ecology, conservation biology, forestry, sociology, geography, political science, and public affairs, as well as majors in the College of Food, Agricultural and Natural Resource Sciences.

Program Delivery
This program is available:
- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission
The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Admission is contingent upon prior admission to a master's or doctoral degree-granting program.

Special Application Requirements:
Contact the director of graduate studies in sustainable agriculture systems for an Intent to Enroll Form. Students are admitted each semester.

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements
Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

The master's minor requires 6 graduate credits from the core curriculum; the doctoral minor requires 12 graduate credits. All students must take SAGR 8010 and 8020. The other core course is AGRO 5321 - Ecology of Agricultural Systems (cross listed with ENT 5321).
A unique component of the minor is an on-site internship with growers, grassroots organizations, or public agencies working in sustainable agriculture.

Program Sub-plans
Students are required to complete one of the following sub-plans. Students may not complete the program with more than one sub-plan.
Masters
The minor in sustainable agriculture systems offers master's (M.A. and M.S.) and doctoral students an interdisciplinary curriculum that considers the biological, sociological, and economic aspects of agriculture. The minor emphasizes a holistic perspective to designing farming and food systems and solving problems in agriculture. The importance of yield and profitability are balanced by considerations of the environment and the health and social well-being of producers, consumers, and communities. The minor complements major programs in ecology, conservation biology, forestry, sociology, geography, political science, and public affairs, as well as majors in the College of Food, Agricultural and Natural Resource Sciences.

The master's minor requires 6 graduate credits from the core curriculum; students must take SAGR 8010 and 8020, and AGRO 5321 (cross listed with ENT 5321). A unique component of the minor is an on-site internship with growers, grassroots organizations, or public agencies working in sustainable agriculture.

SAGR Master's Minor
6 graduate-level credits required. AGRO 5321 is cross listed with ENT 5321.
SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
SAGR 8020 - Field Experience in Sustainable Agriculture (1.0 - 4.0 cr)
AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)

Doctoral
The minor in sustainable agriculture systems offers master's (M.A. and M.S.) and doctoral students an interdisciplinary curriculum that considers the biological, sociological, and economic aspects of agriculture. The minor emphasizes a holistic perspective to designing farming and food systems and solving problems in agriculture. The importance of yield and profitability are balanced by considerations of the environment and the health and social well-being of producers, consumers, and communities. The minor complements major programs in ecology, conservation biology, forestry, sociology, geography, political science, and public affairs, as well as majors in the College of Food, Agricultural and Natural Resource Sciences.

The doctoral minor requires 12 graduate level course credits. All students must take SAGR 8010 and 8020, and AGRO 5321 (cross listed with ENT 5321). An additional 6 graduate level course credits will be decided in consultation with the DGS. A unique component of the minor is an on-site internship with growers, grassroots organizations, or public agencies working in sustainable agriculture.

SAGR Doctoral Minor
12 graduate-level credits required. AGRO 5321 is cross listed with ENT 5321. Six additional graduate-level course credits will be decided in consultation with the DGS.
SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
SAGR 8020 - Field Experience in Sustainable Agriculture (1.0 - 4.0 cr)
AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)